Undergraduate Catalog
2006-2008
Carnegie Institute of Technology
The College of Fine Arts
The H. John Heinz School of Public Policy and Management
The College of Humanities and Social Sciences
Mellon College of Science
The School of Computer Science
Tepper School of Business
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.

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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 enrollment, 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.


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CARNegie MELLON RESERVES THE RIGHT TO CHANGE ITS PROGRAMS, POLICIES AND PROCEDURES WITHOUT NOTICE.
Foreword

This catalog was primarily assembled to meet the needs of current undergraduate students, faculty, and administrators regarding the University’s academic programs, policies and services. We have tried to present in a readable format the current information available at press time.

While the audience for this catalog is the campus community, we recognize that applicants, prospective students, and many other people will read this material. This publication should give them an understanding of the University.

Since this is a two-year catalog, an addendum will be bound in the back of catalogs distributed after August of 2007. The addendum will be an update of changes in University academic programs, policies and services. Separate copies of the addendum will be published for distribution to undergraduate students who have already obtained this catalog during enrollment in September 200 and to faculty and administrators during the fall by means of campus mail.

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). I will be happy to receive updated information from any member of the campus community so that this catalog will maintain its usefulness until 2008.

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2006 - 2008 Undergraduate Catalog
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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 School of Public Policy and Management, and the School of Computer Science. As time progressed, new research centers and institutes developed on and off campus in specialties ranging from art conservation to sustainable computing. In 2004, GSIA was renamed the Tepper School of Business after alumnus David A. Tepper.

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

Undergraduate students 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 France, as well as educational centers 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 — and their 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 metacurriculum — 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 also emphasizes 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 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, the faculty in the Heinz School 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 combine 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.

Mission

To create and disseminate knowledge and art through research and artistic expression, teaching and learning; and to transfer intellectual products to society.

To serve students by teaching them problem-solving, leadership and teamwork skills, and the value of a commitment to quality, ethical behavior, society and respect for one another.

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

A Carnegie Mellon undergraduate education aims to prepare students for life and leadership. In a continually changing world, the most important qualities the university can help students develop are the abilities to think independently and critically, to learn, and to change and grow. As future leaders they must have confidence to act, be sensitive to the needs and feelings of others, understand and value diversity, and honor the responsibilities that come with specialized knowledge and power.

Carnegie Mellon’s undergraduate educational programs are designed to help students acquire:

Depth of knowledge in their chosen areas of specialization and genuine intellectual breadth in other fields.

Creativity and intellectual playfulness, moving beyond established knowledge and practice to create imaginative ideas and artifacts.

Skilled thoughtfulness and critical judgment, which allow them to evaluate new ideas, identify and solve or explore problems, and appreciate a variety of different forms of analysis and thought.

Skills of independent learning, which enable them to grow in wisdom and keep abreast of changing knowledge and problems in their profession and the world.

A set of values, including commitment to personal excellence and intellectual adventure, concern for the freedoms and dignity of others, and sensitivity to the special professional and social responsibilities that come with advanced learning and positions of leadership.

The self-confidence and resourcefulness necessary to take action and get things done.

The ability to communicate with others on topics both within and outside their chosen field of specialization.

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

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

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

Look At Carnegie Mellon
Degrees Offered

Carnegie Institute of Technology

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

- **Chemical Engineering**
  - B.S. in Chemical Engineering
  - M.S. in Chemical Engineering
  - M.S. in Colloids, Polymers and Surfaces (jointly with the Department of Chemistry)
  - Ph.D. in Chemical Engineering

- **Civil and Environmental Engineering**
  - B.S. in Civil Engineering
  - M.S. in Civil Engineering and Management (jointly with the Tepper School of Business)
  - M.S. in Environmental Engineering
  - Ph.D. in Civil Engineering

- **Electrical and Computer Engineering**
  - B.S. in Electrical and Computer Engineering
  - M.S. in Electrical and Computer Engineering
  - 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 an engineering discipline and Engineering and Public Policy
  - Ph.D. in an engineering discipline and Engineering and Public Policy
  - Ph.D. in Engineering and Public Policy

- **Information Networking Institute**
  - M.S. in Information Networking (jointly with the School of Computer Science and the Tepper School of Business)
  - M.S. in Information Security Technology Management (jointly with the School of Computer Science and the Tepper School of Business)

- **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

College of Fine Arts

- **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.A. in Communication Planning and Information Design (jointly with Department of English)

- **Drama**
  - B.F.A. in Drama
  - B.F.A. in Dramaturgy
  - B.F.A. in Scene Design
  - M.F.A. in Combined Design Programs
  - M.F.A. in Costume Design
  - M.F.A. in Directing
  - M.F.A. in Dramatic Writing
  - M.F.A. in Lighting Design
  - M.F.A. in Production Management
  - M.F.A. in Scene Design
  - M.F.A. in Technical Direction

- **Music**
  - B.F.A. in Composition
  - B.F.A. in Music Performance
  - M. Music in Composition
  - M. Music in Conducting
  - M. Music in Music Education
  - M. Music in Performance

College of Humanities and Social Sciences

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

- **Interdepartmental**
  - B.A. in Ethics, History, and Public Policy (jointly offered by Departments: History and Philosophy)
  - B.A. in European Studies (jointly offered by Departments: Modern Languages and History)
  - B.A. in Russian Studies (jointly offered by Departments: Modern Languages and History)
  - B.S. in Economics and Statistics (jointly by Departments: Statistics and Economics)
  - B.S. in Ethics, History, and Public Policy (jointly offered by Departments: History and Philosophy)
  - B.S. in Information Systems

- **Economics** (jointly with the Tepper School of Business)
  - B.A. in Economics
  - B.S. in Economics
  - B.S. in Quantitative Economics
  - Ph.D. in Economics
  - Ph.D. in Quantitative Economics

- **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 Theory
  - M.A. in Professional Writing
  - M.A. in Rhetoric
  - M. of Communication Planning and Information Design (jointly with the School of Design)

- **Architecture**
  - B.Arch in Architecture (5 year program)
  - M.S. in Architecture - Engineering - Construction Management
  - M.S. in Building Performance and Diagnostics
  - M.S. in Computational Design
  - M.S. in Sustainable Design
  - M. of Urban Design
  - Ph.D. in Architecture
  - Ph.D. in Building Performance and Diagnostics
  - Ph.D. in Computational Design

- **M.M. in Arts Management (jointly with the H. John Heinz III School of Public Policy and Management)**

- **B.A. in European Studies (jointly offered by Departments: History and Philosophy)**
  - B.A. in Modern Languages and History
  - B.S. in Modern Languages and History

- **B.S. in Economics and Statistics (jointly by Departments: Statistics and Economics)**
  - B.S. in Ethics, History, and Public Policy (jointly offered by Departments: History and Philosophy)
  - B.S. in Information Systems

- **Ph.D. in Economics**

- **Ph.D. in Quantitative Economics**

- **Ph.D. in English**
• **History**
  B.A. in Anthropology and History
  B.A. in History and Policy
  B.A. in Social and Cultural History
  B.S. in Anthropology and History
  B.S. in History and Policy
  B.S. in Social and Cultural History
  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
  B.A. in French and Francophone Studies
  B.A. in German
  B.A. in Hispanic Studies
  B.A. in Japanese
  M.A. in Teaching English as a Second Language
  Ph.D. in Second Language Acquisition

• **Philosophy**
  B.A. in Philosophy
  B.S. in Logic and Computation
  M.A. in Philosophy
  M.S. in Logic and Computation
  Ph.D. in Pure and Applied Logic (jointly with the Department of Mathematics and the School of Computer Science)
  Ph.D. in Philosophy

• **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
  Ph.D. in Psychology and Behavioral Decision Research (jointly with the Department of Social & Decision Sciences)

• **Social and Decision Sciences**
  B.S. in Decision Science
  B.S. in Policy and Management
  B.S. in Political Science
  Ph.D. in Behavioral Decision Theory
  Ph.D. in Organization Science
  Ph.D. in Social and Decision Sciences

• **Statistics**
  B.S. in Statistics
  M.S. in Statistics
  Ph.D. in Statistics
  Ph.D. in Statistics and Public Policy (jointly with the H. John Heinz III School of Public Policy and Management)

**Computational Biology**
M.S. in Computational Biology

**Entertainment Technology Center**
M. of Entertainment Technology

**The H. John Heinz III School of Public Policy and Management**
M.S. in Educational Technology Management
M.S. in Health Care Policy and Management
M.S. in Information Security Management
M.S. in Public Policy and Management
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
Ph.D. in Public Policy and Management
Ph.D. in Economics and Public Policy (jointly with the Tepper School of Business)

**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.S. in Information Technology
M.S. in Information Technology - Information Security and Assurance
M.S. in Information Technology - Information Technology Management
M.S. in Information Technology - Software Design and Management
M. of Information Systems Management

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

• **Biological Sciences**
  B.A. in Biological Sciences (and a discipline in the Humanities and Social Sciences)
  B.S. in Biological Sciences
  B.S. in Biological Sciences and Psychology (jointly with the College of Humanities and Social Sciences)
  B.S. in Computational Biology
  M.S. in Biological Sciences
  Ph.D. in Biological Sciences
  Ph.D. in Biological Sciences/Biophysics and Biochemistry

• **Chemistry**
  B.A. in Chemistry
  B.S. in Chemistry
  B.S. in Chemistry/Computer Science Track
  M.S. in Chemistry
  M.S. in Polymer Science
  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
  B.S. in Mathematical and Statistical Sciences (jointly with the College of Humanities and Social Sciences)
  M.S. in Computational Finance (jointly with the Tepper School of Business)
  M.S. in Algorithms, Combinatorics, and Optimization
  M.S. in Mathematical Sciences
  D.A. in Mathematical Sciences
  Ph.D. in Algorithms, Combinatorics, and Optimization
  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**
B.S. in Computer Science
M.S. in Algorithms, Combinatorics and Optimization
M.S. in Computational Finance (offered jointly with the Tepper School of Business and College of Humanities and Social Sciences)
M.S. in Computer Science
M.S. in Computer Science (5th Year Scholars Program only)
M.S. in Human-Computer Interaction
M.S. in Information Technology
M.S. in Information Technology - Robotics Technology
M.S. in Knowledge Discovery and Data Mining
M.S. in Language Technologies
M.S. in Robotics
M.S. in Software Engineering
M. of Human-Computer Interaction
M. of Software Engineering
Ph.D. in Algorithms, Combinatorics and Optimization
Ph.D. in Computational and Statistical Learning
Ph.D. in Computation, Organizations and Society
Ph.D. in Computer Science
Ph.D. in Human-Computer Interaction
Ph.D. in Language Technologies
Ph.D. in Robotics
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)

David A. Tepper School of Business
B.S. in Business Administration
M.B.A. in Industrial Administration
M.S. in Accounting
M.S. in Algorithms, Combinatorics, and Optimization (jointly with the School of Computer Science)
M.S. in Civil Engineering and Management (jointly with the Carnegie Institute of Technology)
M.S. in Computational Finance (jointly with the College of Humanities and Social Sciences, Mellon College of Science, and School of Computer Science)
M.S. in Economics
M.S. in Financial Economics
M.S. in Information Networking (jointly with the Carnegie Institute of Technology and the School of Computer Science)
M.S. in Management, Manufacturing: Automation
M.S. in Manufacturing and Operations Systems
M.S. in Marketing
M.S. in Operations Research
M.S. in Organizational Psychology and Theory
M.S. in Quantitative Economics
M.S. in Software Engineering and Business Management (jointly with 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 Financial Economics
Ph.D. in Manufacturing and Operations Systems
Ph.D. in Marketing
Ph.D. in Operations Research
Ph.D. in Organizational Psychology and Theory
Application as a Freshman

Applicants As Individuals
Evaluating the talented and bright students who apply to Carnegie Mellon, each year is a challenging and exciting process. Each year, Carnegie Mellon enrolls the most qualified freshman class possible. 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 while contributing to and enriching the campus community.

Determinants of Success
Our admission process is designed to identify students who will be successful at Carnegie Mellon. 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.

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

Carnegie Mellon is an exciting campus because of the positive qualities and experiences our students bring with them. For this reason, we’re interested in the kinds of things students do beyond the classroom, whether they participate in extracurricular activities, work part-time or pursue hobbies. Knowing what students like to do on their own time gives us a feeling for each student’s personality, motivation and sense of responsibility. All of this is an important part of the admission process.

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

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

Admission to the Schools of Drama and Music is based primarily on an audition or portfolio showing. Applicants to the Schools of Art and Design will be evaluated not only on the basis of their portfolio but also on their academic performance. Students applying to the School of Architecture will have to complete an online essay and have the option to submit creative work for review, in addition to 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 Supplement.

1. Apply for admission to the specific college(s) in which you are interested.
   - Indicate college by checking proper box on Carnegie Mellon Supplement.
   - Write the name of the major or program that interests you.

2. If applying to more than one college or program, please rank your choices on the line provided.
   - You do not have to submit two applications, and there is no additional cost. Simply indicate on the Carnegie Mellon Supplement the colleges to which you are applying.
   - Make sure to meet the admission requirements for each college or department.

3. 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 “Intercollege Degree Programs”
   - Bachelor of Science and Arts (BSA) – see “Intercollege Degree Programs”

We strongly urge you to indicate a program preference at the time you apply. 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.)
4. Enclose with your application the non-refundable $65 application fee (and audition fees if applicable) as specified in our application packet.

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 music or drama, the additional audition fee is $50, and only payable online, at the time of registration. Please see www.cmu.edu/admission/finearts for more details.

5. Plan to visit our campus or interview with a Carnegie Mellon admissions counselor, if possible. (See section on “Experience Carnegie Mellon.”)

6. Send all of your high school transcripts to the Office of Admission. An updated transcript, which includes senior year courses and midyear grades, must be submitted as close to February 1 as possible. The Office of Admission does not acknowledge receipt of these items. We do not confirm fax or FedEx materials for up to 48 hours during our peak times. However, after March 1 we will let students know if something is missing.

7. Take the SAT Reasoning Test or ACT with Writing preferably by December. In certain disciplines, you must also take SAT Subject Tests by 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 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.

8. 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 and your SAT Critical Reading score is less than 600. Carnegie Mellon requires CBT TOEFL scores of 250 or better, IBT TOEFL score of 100 or better and IELTS scores of 7 and above.

9. If you are applying to the College of Fine Art’s Schools of Architecture, Art, Design, Drama or Music, you must complete the portfolio, essay or audition requirements. Before you can arrange an audition or review at <www.cmu.edu/admission/finearts>, your application and supplement must be submitted by December 1 (November 1 for Early Decision).

10. You must sign the “Confidentiality Statement” on the Personal Evaluation Form and give it to your secondary school counselor for completion. Your counselor should return this form, along with the application for admission, directly to the Office of Admission, as soon as possible.

11. Complete Part I of the Teacher Recommendation Form and give it to a teacher to complete. You should also provide your teacher with an addressed, stamped envelope to return the form to Carnegie Mellon’s Office of Admission by January 1.

12. The application deadline is January 1. The student or counselor should be sure to return the application and supplement, Personal Evaluation Form and complete transcripts by this date.

   IMPORTANT: Carnegie Mellon prefers that all forms and documents be submitted at the same time. If they must be sent separately, student should be sure to print full name and social security number at the top of each document.

13. If you are applying for financial aid, request a Free Application for Federal Student Aid (FAFSA) from your secondary school counselor. Complete the form and return it to the appropriate federal processor listed in the FAFSA instructions. Send a copy of your completed FAFSA directly to Carnegie Mellon. Carnegie Mellon’s Title IV code is 003242. You must also complete a Carnegie Mellon Financial Aid Application, 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 decisions by April 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 appropriate deadlines.

If you are offered admission and wish to enroll at Carnegie Mellon, you are required to pay a $600 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 through our Early Decision plans. Under these plans, applicants are notified of our admission decision early in the senior year. If you are accepted Early Decision, we expect you to enroll at Carnegie Mellon. If you are not admitted under Early Decision, your application will either be rejected or deferred to our Regular Decision process and we will re-evaluate it in the spring.

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 drama or BHA/BSA. Early Decision II is available to all programs, with the exception of architecture, art, design, drama or BHA/BSA. If you’d like to apply through an Early Decision plan:

1. Check the appropriate box on the application supplement.

2. If you are applying under Early Decision I, submit your application by November 1 of your senior year. (Please note there is no Early Decision option for Drama or BHA/BSA.

3. If you are applying under Early Decision II, submit your
application by December 1 of your senior year. (This option is not available to fine arts applicants or BHA/BSA.)

4. Submit all forms and credentials that are available (high school transcript, SAT Reasoning Test or ACT with Writing results, SAT Subject Test results), preferably by November 1 of your senior year (for Early Decision I) or by December 1 (for Early Decision II) of your senior year.

5. Arrange to have a campus visit that includes a group information session or an interview with a member of the admission staff, if possible.

6. Fulfill the portfolio, audition or essay requirements if applying to the College of Fine Arts.

Early Decision applicants will be notified of our admission decision by December 15 (Early Decision I) or January 15 (Early Decision II).

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 $600 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). 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.

### Secondary School Preparation and Required Tests

<table>
<thead>
<tr>
<th>College</th>
<th>High School Preparation</th>
<th>Tests&lt;sup&gt;5&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnegie Institute of Technology (CIT)</td>
<td>4 years English</td>
<td>SAT Reasoning Test or ACT with Writing</td>
</tr>
<tr>
<td></td>
<td>4 years Mathematics&lt;sup&gt;1&lt;/sup&gt;</td>
<td>SAT Subject Tests (2)</td>
</tr>
<tr>
<td>Mellon College of Science (MCS)</td>
<td>1 year Chemistry</td>
<td>Math Level I, Ic or Iic</td>
</tr>
<tr>
<td>School of Computer Science (SCS)</td>
<td>1 year Physics</td>
<td>Physics, Chemistry or Biology&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>David A. Tepper School of Business (Tepper)</td>
<td>1 year Biology</td>
<td>Prospective business students may take any second test, but preferably a science.</td>
</tr>
<tr>
<td>2 years Foreign Language</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 electives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College of Humanities and Social Sciences (H&amp;SS)</td>
<td>4 years English</td>
<td>SAT Reasoning Test or ACT with Writing</td>
</tr>
<tr>
<td>Information Systems (IS)</td>
<td>3 years Mathematics&lt;sup&gt;2&lt;/sup&gt; - H&amp;SS applicants</td>
<td>SAT Subject Tests (2)</td>
</tr>
<tr>
<td></td>
<td>4 years Mathematics&lt;sup&gt;1&lt;/sup&gt; - IS applicants</td>
<td>Math Level I, Ic or Iic</td>
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<tr>
<td></td>
<td>1 year Science (2 or more years preferred)</td>
<td>One additional test</td>
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<tr>
<td></td>
<td>2 years Foreign Language</td>
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<tr>
<td></td>
<td>6 electives</td>
<td></td>
</tr>
<tr>
<td>School of Architecture</td>
<td>4 years English</td>
<td>SAT Reasoning Test or ACT with Writing</td>
</tr>
<tr>
<td></td>
<td>3 years Mathematics&lt;sup&gt;1&lt;/sup&gt;</td>
<td>SAT Subject Tests (2)</td>
</tr>
<tr>
<td></td>
<td>1 year Physics</td>
<td>Math Level I, Ic or Iic</td>
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<tr>
<td></td>
<td>2 years Foreign Language</td>
<td>Physics or Chemistry</td>
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<tr>
<td></td>
<td>5 electives</td>
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</tr>
<tr>
<td>School of Art</td>
<td>4 years English</td>
<td>SAT Reasoning Test or ACT with Writing</td>
</tr>
<tr>
<td>School of Drama</td>
<td>2 years Foreign Language</td>
<td></td>
</tr>
<tr>
<td>School of Music</td>
<td>10 electives&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>School of Design</td>
<td>4 years English</td>
<td>SAT Reasoning Test or ACT with Writing</td>
</tr>
<tr>
<td></td>
<td>2 years Mathematics</td>
<td></td>
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<td></td>
<td>2 years Science</td>
<td></td>
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<tr>
<td></td>
<td>2 years Foreign Language (preferred)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 electives</td>
<td></td>
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</tbody>
</table>

<sup>1</sup> The four years of mathematics should include, at least, algebra, geometry, trigonometry, analytic geometry and elementary functions (pre-calculus).

<sup>2</sup> For H&SS applicants, three years should include at least algebra, geometry and trigonometry.

<sup>3</sup> For School of Music applicants, some prior solfege is helpful.

<sup>4</sup> The Biology SAT Subject Test is not acceptable for CIT applicants.

<sup>5</sup> Only junior or senior year test results are acceptable.
While a high school diploma is not required for admission to Carnegie Mellon, it is to your advantage to make arrangements to eventually receive one. Consult your high school for more advice, or for special arrangements, contact your state Board of Education for information about the General Education Diploma (GED).

**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.

**Transfer Applicants**

Transfer students are admitted to Carnegie Mellon under policies which vary from college to college. In order to transfer to the Carnegie Institute of Technology, the School of Computer Science, the Mellon College of Science or the Tepper School of Business there must be space available in the particular department to which you are applying. 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).

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, SCS and Tepper:
     - Fall transfer possible if space is available
     - Spring transfer extremely limited and unlikely
     - No external transfers accepted into BHA/BSA

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

2. Enclose a non-refundable fee of $65 (and audition fees if applicable). This application fee is required, except in extenuating family financial circumstances. To request a waiver, student should send us a letter from a college advisor or dean requesting an application fee waiver in place of the application fee. Make all checks or money orders payable to Carnegie Mellon University. Do not send cash.

   If applying to music or drama, the additional audition fee is $50. Submit all fees with your application.

3. Send all transcripts that reflect secondary school and college/university studies to the Office of Admission. Include a catalog (labeled with your name) and highlight course descriptions from each college/university attended.

   **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 the portfolio, essay or audition requirements. You must complete the application for admission by December 1.

5. Sign the "Confidentiality Statement" on the Personal Evaluation Form. 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: November 1
   - Fall transfer: March 1 (December 1 for CFA applicants)

7. If you are applying for financial aid, request a Free Application for Federal Student Aid (FAFSA) from your current college Financial Aid Office. Complete the form and return it to the appropriate federal processor listed in the FAFSA instructions. Send a copy of your completed FAFSA directly to Carnegie Mellon. Carnegie Mellon’s Title IV code is 003242.

   If planning on:

   - Spring transfer:
     - File FAFSA by this date:
       - Fall transfer (CFA): November 1
       - Fall transfer (all other colleges): 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 $600 by May 1, even if you are receiving financial aid.

If you are offered admission to CIT, H&SS, IS, MCS, SCS or TEPPER for the fall semester, you must pay a non-refundable $600 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, SCS or Tepper 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, SCS or Tepper 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 pervious 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 and return it to the Office of Admission. Because Carnegie Mellon does not offer financial aid to international students, we use this application to verify each student’s ability to pay for a Carnegie Mellon education. If you have access to the Web, you can find the Preliminary Application online. International students are not eligible for application fee waivers.**

- **If your native language is not English and your SAT Critical Reading Test score is less than 600, 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 TOEFL scores of 250 or better on the CBT TOEFL, 600 or better on the paper TOEFL, 100 or better on the IBT TOEFL or an IELTS score of 7 and above. Please arrange to have these scores sent no later than January 1.**

- **Financial aid and installment payment plans are unavailable to international students.**

### Intercollege Degree Programs

**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 Musical Theatre, Acting or Voice majors. Not all students admitted to both colleges are selected for the BHA program. In addition, you must include with your application a statement of intent (essay) describing your interdisciplinary goals in both the fine arts and humanities/social sciences and how the BHA program would provide the opportunity and frame work for you to accomplish these objectives. This essay is a central component in the selection process. The BHA 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. This program is not available under Early Decision.

**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 the CFA box and MCS box on page 3 of the supplement). This program is not open to Musical Theatre, Acting or Voice majors. Not all students admitted to both colleges are selected for the BSA program. In addition, you must include with your application a statement of intent (essay) describing your interdisciplinary goals in both the fine arts and natural sciences/ mathematics and how the BSA program would provide the opportunity and framework for you to accomplish these objectives. This essay is a central component in the selection process. The BSA statement of intent fulfills the essay requirement on the supplement. You do not need to complete another supplement essay. If you are selected for this program, you will be notified in your admission decision letter. This program is not available under Early Decision.

### College of Fine Arts Requirements

If you are applying to the Schools of Architecture, Art, Design, Drama or Music within the College of Fine Arts:

- **You must submit your application and supplement by December 1 (November 1 for architecture, art, design and music Early Decision applicants).**

- **You must go to www.cmu.edu/admission/finearts and H&SS box on the supplement). This program is not open to Musical Theatre, Acting or Voice majors. Not all students admitted to both colleges are selected for the BHA program. In addition, you must include with your application a statement of intent (essay) describing your interdisciplinary goals in both the fine arts and humanities/social sciences and how the BHA program would provide the opportunity and frame work for you to accomplish these objectives. This essay is a central component in the selection process. The BSA 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. This program is not available under Early Decision.**

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**School of Architecture Admission Procedure**

The study of architecture at Carnegie Mellon is an exciting, multidisciplinary activity that synthesizes design creativity, social responsibility, historical perspective, technical competence and global environmental consciousness. The five-year curriculum leads to an accredited professional Bachelor of Architecture (B.Arch) degree and a broad range of career opportunities.
TheSchoolofArchitectureisseekingstudentswithdiverse
backgrounds,interestsandcreativepotential,aswellasadistinctpassionforarchitectureinallavemanyfaces.Wehave
foundthatsuccessfularchitecturestudentshaveavarietyof
qualifications, including:

- Academic Record - as demonstrated by secondary school
  transcript, class rank, SAT Reasoning Test or ACT with
  Writing scores, and two SAT Subject Tests, including Math,
  and either Physics or Chemistry.

- Creative Ability - as demonstrated by a portfolio of creative
  work (see following details), as well as other artistic
  endeavors based on innovation and synthesis.

- Interpersonal and Leadership Skills - as demonstrated by
  awards and honors, extracurricular activities, letters of
  recommendation, service and a personal statement.

Since thepossibilitiesofstudyingarchitectureinhishigh
canbe limited, we encourage all applicants to make every effort
todevelopanunderstandingofwhatitmeanstostudyarchitecture-
quire how architecture is different from engineering, art and
other fields, and seek to understand the unique strengths of
Carnegie Mellon’s architecture program. To determine your
sincere interest in architecture, and to measure the potential for
success in the School of Architecture, we encourage you to:

- Participate in one of the many summer programs offered by
  schools of architecture in the United States and abroad.
  Carnegie Mellon offers a summer pre-college program that
  introduces and tests your interest and ability in
  architecture. The Pre-College program offers opportunities
to socialize with students from around the country, become
familiar with the campus and city, and experience first-hand
the life and studies of an architecture student. For more
information about our Pre-College program, visit our website
at www.cmu.edu/enrollment/pre-college.

- Visit architecture schools (while courses are in session) at
every college you are seriously considering. Be sure to visit
the design studios and talk to enrolled students and faculty
to understand both the nature of the academic program and
the unique life of an architecture student. Seek to
understand the unique strengths and character of each
program.

- Pursue a variety of rigorous architectural and artistic
  opportunities while in high school such as working in an
  architect’s office, on a construction site, or in a planning
  office; attend art classes and read about historical as well as
  contemporary architecture.

- Take the highest-level courses available at your high school
  in: art (a variety of media); history (courses in western and
  non-western history); English (advanced literature);
  mathematics (calculus) and science (Physics).

Portfolio of Creative Work
In addition to completing the admission application and
supplement, and required online essays, students are highly
encouraged to submit a portfolio of creative work to the School
of Architecture as a first option. Moreover, an on-campus review
of your portfolio of creative work is the preferred option and most
highly recommended.

The School of Architecture believes in the value of personal
contact to ensure the success of admission decisions. In general,
everyone is best served by an on-campus visit or review of your
portfolio of creative work, or both, so you can get to know the
university and the School of Architecture, as well as faculty and
students. After completing the required online essay for the
School of Architecture, we recommend that you choose either an
on-campus review of your portfolio or mail-in your portfolio.
If you are unable to submit a portfolio or arrange personal contact
with the School of Architecture, your admission application will be
reviewed along with the other applicants, without prejudice.

For more information and details about the options provided by
the School of Architecture, visit www.cmu.edu/admission/finearts.

You can sign up for an on-campus review of your portfolio of
creative work at www.cmu.edu/admission/finearts. Generally, on-
campus reviews are held in January and February, but Early
Decision applicants have a session reserved for mid-November.

Portfolio Objectives
We are interested in understanding your creativity in all its
facets: compositions, creations and inventions. As a result, we
encourage you to submit a variety of creative works that
demonstrate your innovative ideas, spatial reasoning, visual
thinking and your desire to make and build things. Your portfolio
is intended to expose your ability to analyze, problem-solve, think
critically, and synthesize. We are interested in determining your
commitment and motivation to study architecture. Keep in mind
that the architecture professors who will review your portfolio are
much more interested in understanding your creativity intent and
design process than your mastery of specific skills or techniques.
For this reason, you should avoid submitting drafting work as part of
your portfolio of creative work.

Assembling Your Portfolio
We suggest that you think strategically about how you
communicate and present your potential success as a student
of architecture. We advise you to consider the process of
assembling and submitting your creative work as a design
project: how can you best present your abilities, interests and
passion through your creative work? Arrange your work to tell a
good story about yourself. Select projects that show a range of
media and subject matter while still emphasizing your strongest
work. Please submit final and completed works for review, not
works in progress.

For more information on assembling your creative work, visit
www.cmu.edu/admission/finearts.

Portfolio Format
Your 14-page portfolio must be well organized and conform to the
following standards:

Size: Fixed dimensions of 8.5” x 11” single-sided pages, all
vertically oriented or all horizontally oriented.

Quality: All work must be high quality photographs, photocopies,
or prints. DO NOT MAIL ORIGINAL WORK.

Page 1: Cover page including your name, address, email and
telephone number(s).

Page 2: Contents page includes for each of the 12 works a title,
original date, media and maximum 20 word description. Indicate
whether the work was done for a class, collaboratively, or
independently.

Pages 3-5: Three single works of freehand drawing such as a
self-portrait, shoe, still life, etc. These must be original works
from life or your imagination, therefore, no reproductions.
Sketchbook pages scanned to one or more pages is strongly
recommended.

Pages 6-8: Three single works of 2-D design such as collage,
digital work, graphics, painting, photography, printmaking, etc.
Work should not be copied from an image you found, nor should
they be simply an assignment in a technical drafting class.

Pages 9-11: Three single works of 3-D design such as
architectural models, ceramics, furniture, textiles, metalwork,
sculpture, woodwork, etc. Use proper lighting techniques to
document and present your 3-D work.

Pages 12-14: Three single works of your choice such as music,
literature, (poetry, prose, script) performance, etc. If you wish to
show digitally - or time-based work such as animation, interactive
website or dramatic art, include a CD as one page.

On-Campus Review of Your Work
An on-campus review of your portfolio of creative work is not
required, and we do offer a mailed option for those who cannot
come to campus, but our ability to judge your creative abilities in
absentia is limited. We strongly recommend that you present
your portfolio of creative work in person by scheduling an on-
campus review at www.cmu.edu/admission/finearts. The
impressions that faculty form by talking with you and watching
you present your work are an integral part of the admission
process. Generally, portfolio review sessions are held in January
and February, but Early Decision applicants have a session
reserved for mid-November. If you cannot attend an on-campus review session, you should follow the mail-in process (see below) but you are still required to register at www.cmu.edu/admission/finearts.

Mail-In Option
The mail-in option is for students who are unable to attend one of the on-campus reviews. A committee of faculty members will review your portfolio of creative work. If additional information is needed, a faculty member may contact you for a phone interview.

When and Where to Mail Your Portfolio of Creative Work
Mail your portfolio to the address below with sufficient time for it to arrive by December 1 (November 1 for Early Decision applicants). Write your name on all materials. If you want us to return your material, please include a self-addressed, postage-paid envelope or container.

Send all materials to:
School of Architecture, Creative Work Review
College of Fine Arts 201
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

Contact
If you have any questions about the architecture admission process, the online essay or the submission of creative work, please contact the Senior Academic Advisor in the School of Architecture, haw5@cmu.edu.

Transfer Students
Transfer applicants to the School of Architecture are classified as freshmen.

School of Art Admission Procedure
The Carnegie Mellon School of Art is seeking students with a wide range of talents, aptitudes and backgrounds. Artistic ability, academic performance and leadership capabilities are all important factors. These capabilities are evaluated through a review of a portfolio of creative work, high school grades, standardized test scores, extracurricular activities, recommendations and personal statements. All applicants are considered for fall semester admission only.

Transfer applicants must complete all admission requirements, including the portfolio review. Transfer students should expect to have freshman status for at least the first semester at Carnegie Mellon School of Art. Transfer credit is evaluated after the applicant has studied at Carnegie Mellon School of Art for a period of time.

The Art Portfolio
Art portfolios may be reviewed at an On-Campus Carnegie Mellon Review Day or by mail.

The Carnegie Mellon School of Art faculty is more interested in seeing an applicant's creative potential than a demonstration of technical skills. The portfolio should reveal the full scope of the applicant’s talent and enthusiasm, with works that engage with the ideas, media and materials of the culture. It should reveal an ability to work on a wide range of artistic concerns, and to work in depth or in sequence on a single topic. The portfolio should feature work done independently, that is, outside of classroom assignments. The Art Portfolio is only one part of the application, thus the score of the portfolio review is not disclosed to the applicant. Applicants receive notification of the status of their overall application after all components have been evaluated and the admission decision has been made.

The portfolio should include pieces from as many of the following categories as appropriate:
- Work that changes with time, such as kinetic sculpture, animation, installation, performance and digital media, including live action video and interactive work or other time-based works

Tips for Portfolio Presentation
- The work should be photographed so that the image fills the frame.
- A neutral background is recommended so that it does not conflict with the work.
- If several exposures of each piece are taken with different camera settings, the applicant will be able to select the best one for use in the portfolio.
- It is better to arrange a slide sheet as a composition by organizing the works in coherent visual groups than to put slides in chronological order. Works can be grouped by media, theme, visual motifs, etc.
- Matting and mounting of works is not necessary.
- It is highly recommended to apply fixative to works that smudge.

The On-Campus Portfolio Review
Applicants may bring their portfolio to campus on one of the Sunday On-Campus Portfolio Review Days. On-Campus Portfolio Review Days offer an opportunity to attend group information sessions, meet individually with an art faculty member, and take a tour of School of Art facilities.

In order to attend an on-campus portfolio review, applicants must submit their application and supplement by: November 1, (early decision) or December 1, (regular decision and transfer students)

The Office of Admission makes all arrangements for attending the On-Campus Portfolio Review Days. You must register for a portfolio review online in order to be considered for admission to the School of Art. Please go to www.cmu.edu/admission/finearts for dates and availability. We honor review appointments on a first-come, first-serve basis. Please register as soon as possible to secure a review appointment. The Office of Admission will send you a confirmation email when you register online. If the confirmation does not arrive two weeks prior to your review, the applicant should call the Office of Admission at 412-268-2082 to confirm.

What To Bring For The On-Campus Art Portfolio Review
Applicants should bring 15-20 recent art works to their On-Campus Portfolio Review Day. If attending an On-Campus Portfolio Review Day, an applicant should not submit a portfolio by mail. Applicants can bring any of the following works for the on-campus review:
- Actual two-dimensional work (drawings, paintings, prints, etc.)
- Actual three-dimensional work (sculpture, ceramics, glass, textiles, etc.)
- A sketchbook, illustrated journal, etc. (each of these is considered one item)
- A photograph, slide or other documentation of work, which because of its size, weight or other circumstances, cannot be transported to the review. Examples: a large sculpture, a mural or other piece permanently installed, a work no longer owned by the applicant, or a piece under consideration for an award
- Digital work submitted on a CD or DVD. Examples: a) Computer graphics: JPEG or TIFF format, 1024x768 maximum image size
- Time-based work: video on DVD video or VHS videocassette; Animations must be composited to play on video, DVD or as a Quicktime movie
- Interactive work. Must run as a stand-alone application, without requiring the installation of additional software
- Web site

What To Submit In An Art Portfolio By Mail
Applicants submitting a portfolio by mail should not also attend an On-Campus Portfolio Review Day.

As with on-campus reviews, all by-mail portfolio items are evaluated by art faculty.

While an on-campus portfolio review brings obvious advantages to the applicant, there is no penalty for submitting a portfolio by mail.
The by-mail art portfolio must contain the four items listed below:

1. Documentation of 15-20 recent art works submitted as follows:
   a) Paintings, prints, drawings, sculpture (still work): 35 mm slide images in a standard 9x11" slide sheet or JPEG or TIFF format images on CD-R or as a DVD Slide Show-1024x768 maximum image size.
   b) Time-based work (video/animation) on DVD video or VHS videocassette
   c) Animation, video, interactive work or a Website on a CD-R or DVD-R. Animations must be composited to play on video, DVD or as a Quicktime movie. Interactive work must run as a stand-alone application, without requiring the installation of additional software.

2. A numbered list of all items describing size, type of material and dates.

3. A one-page statement about the portfolio, the applicant's art-related experiences, training and background.


The Art Portfolio must be mailed to the following address by January 15 (November 1 for Early Decision applicants):

Office of Admission — Art Portfolio
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

Important
- NO original slides or documentation should be mailed, only copies
- ALL items in the by-mail portfolio (each slide, CD, DVD, etc.) must be labeled with the applicant’s full name and social security number. Also specify the orientation of the slide (“top”)

Off-Campus Portfolio Critiques/National Portfolio Days
Carnegie Mellon participates in National Portfolio Days throughout the United States. Art faculty attending selected National Portfolio Days will provide informal portfolio critiques for those considering application. Please see www.cmu.edu/admission/finearts for dates and locations. A National Portfolio Day critique does not satisfy the formal portfolio review process required for admission.

School of Design Admission Procedure
The School of Design is seeking a class of students with a wide range of backgrounds, creative talents and interests. We have found that successful design students have a variety of qualifications. We look closely at students’ qualifications in the following three categories:

- Academics: academic performance and curriculum, SAT Reasoning Test or ACT with Writing scores
- Visual and design ability: portfolio and design project (see details below)
- Interpersonal skills: as demonstrated through extracurricular activities and letters of recommendation.

Submitting Your Portfolio (Work) for Review
The School of Design offers two ways for your work to be reviewed - an on-campus review or a mail-in review. Choose one or the other, but not both.

There are on-campus portfolio reviews during the months of November, January and February. Once you have submitted your application, you must register for a portfolio review online to be reviewed by the School of Design. Please visit <www.cmu.edu/admission/finearts> for dates and availability. We honor review appointments on a first-come, first-serve basis. Please register as soon as possible to secure a review appointment.

Our design faculty is an integral part of the admission process in determining incoming classes. The faculty gain a deeper understanding of portfolio work and the applicant from an interview with a design faculty member. We strongly emphasize the importance of an on-campus review.

On-Campus Portfolio Options
The School of Design provides three options for presenting your work on campus. With each option a faculty committee will independently review your portfolio and a faculty member will conduct a brief interview with you. The options are:

- Traditional Portfolio: An organized presentation of original work. Work may include: sketchbooks, drawings, 2-D and 3-D work, examples of color work and supplemental work. If the scale of your work is too large to transport, then a good quality photo is permissible. This on-campus option typically provides faculty the greatest insight to the quality of your work, your thinking and developmental process.

- Digital Portfolios and Work: We will review work presented in digital formats. This work should not be a duplication of work already presented (i.e. accompanying slides, prints, or actual work). To have this work reviewed you must bring a laptop computer with the work already prepared for showing. Otherwise it cannot be reviewed. Also keep in mind that a presentation of final work alone is not helpful in understanding your thinking and development processes. Inclusion of process work/sketches is important.

- Design Project: offered as an option for applicants who have a limited portfolio or none at all.

Mail-in Portfolio Options
The School of Design provides two options for presenting your work through the mail. With each option a faculty committee will review your portfolio and a faculty member may conduct a phone interview with you. In the case of a phone interview, you will be notified in advance of the call. The options are:

- Slide portfolio: An organized presentation of work. Sample sketches, drawings, 2-D and 3-D work, examples of color work and supplemental work are helpful to include. In addition, a slide key containing a short description of corresponding pieces must be included. Slides should be shot with proper lighting so as to depict subtle details in your work.

- Digital portfolios and work: We will review work presented in digital formats. The work must be submitted in CD or DVD format. This work should not be a duplication of work already presented (i.e. accompanying slides, prints, or actual work). Also keep in mind that a presentation of final work alone is not helpful in understanding your design process.

Mail your portfolio to the address below no later than January 15 (November 1 for Early Decision applicants):

Office of Admission — Design Portfolio
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

General Portfolio Guidelines

1. Actual work, rather than photographs of work, is preferred for on-campus reviews.

2. Attempt to limit your portfolio through careful editing to 15-20 items (a sketchbook counts as one item).

3. Projects should be as varied as possible, while emphasizing the strongest work. Acceptable work includes, but is not limited to, 2-D and 3-D design, drawing, painting, sculpture, digital and inventions. Design faculty encourages all applicants to include examples of drawing. Drawings can be from life or from the imagination, but they should not be copied from a photo or other two-dimensional image. Matting and mounting of works is not necessary. Applying fixative to works that smudge is highly recommended.

Mail-in Portfolio Guidelines

1. If submitting slides the format is 35mm. Slides should be numbered and sequenced in a standard 9x12" clear plastic page.
2. A slide key containing a short description of corresponding items must be included. Slides should be shot with proper lighting so as to depict the details in your work.

3. If submitting digital media, the format is CD or DVD. Test your data to ensure its ability to be opened and reviewed.

4. Do not mail original work (drawings, paintings, 3D, etc.) or sketchbooks.

5. Place your name on all materials.

6. Include a self-addressed and postage-paid envelope to return your materials.

Design Project
If you have limited work in your portfolio, the Design Project is an option to supplement that work. If you have no portfolio or work, the Design Project will serve to satisfy the portfolio requirement. Download the project from the Design Web site, www.design.cmu.edu. There you will click on “Admission”, “Undergraduate” and “Portfolio” and scroll down to the “Design Project” Link.

Complete the project and bring it with you to your scheduled on-campus faculty interview. Or, if you choose the mail-in option, return it by mail along with your slides or digital portfolio.

Please visit the School of Design’s Web site www.design.cmu.edu for specific program information and the most current updates.

National Portfolio Days
Carnegie Mellon participates in National Portfolio Days throughout the United States. Design faculty attending selected National Portfolio Days will provide informal portfolio critiques for those considering application. Please see www.cmu.edu/admission/finearts for specific program information and the most current updates.

Transfer Into Design
Whether you are transferring from another university or from one of Carnegie Mellon’s other colleges, you will be classified as a freshman in the School of Design unless you have completed a program equivalent to our freshman year. If you would like to be considered for advanced standing, indicate the level of entry on your Common Application Supplement in the space provided. You must also interview with a member of the design faculty and submit a portfolio to qualify for advanced standing consideration; we will determine your standing through the portfolio review, in addition to the $65 application fee (all checks payable to Carnegie Mellon University).

• You will receive an email confirmation of the time and date of your audition/portfolio review shortly after registering.
• Allow at least four hours for your audition and one hour for your portfolio review.
• Transfers follow same procedures as freshman applicants.
• Transfer students in Acting and Music Theatre will be classified as freshmen within the program.
• There are no auditions by mail for domestic students. International applicants must make arrangements for submitting a videotape of their audition by contacting the School of Drama at 412-268-2392.
• Drama Design applicants, particularly international candidates, may submit a portfolio by mail. Please contact the School of Drama to make arrangements.

Acting Option
If you’re applying to the Acting Option, you must fulfill an audition requirement, which is the main basis for admission. Pay close attention to these audition guidelines:

• You’ll be required to perform two contrasting monologues.
• Each monologue should be no longer than two minutes.
• One monologue should be from a play written before 1900 with an emphasis on language (e.g. Shakespeare, Shaw, the Greeks, etc.), the other a more contemporary piece written in the 20th or 21st century.
• Both pieces should be within your natural age range.
• Be sure you’ve read the entire play, so you can demonstrate an understanding of the character and situation involved.
• You should not have been coached as coaching often obscures natural ability and instinct. We do not recommend it.
• You may use hand props but not costumes.
• Be prepared to perform a third monologue if asked.
• Bring a resume and recent photograph to leave with the audition team. Some contemporary pieces have become overserved and we urge you not to audition with pieces from the following plays: Slow Dance on the Killing Ground, I Hate Hamlet, Star Spangled Girl, Runaways, Nuts, A My Name is Alice, Talking With, Identity Crisis and Quilters.

Music Theatre Option
If you’re applying to the Music Theatre Option, you must fulfill the audition requirement, which is the main basis for admission to the program. See audition dates below. During your audition you will:

• Perform two contrasting songs - one ballad and one “up tempo” song. You will need to bring your own music (an accompanist is provided).
• Learn and perform two dance combinations taught by a faculty member (wear appropriate dance attire).
• Perform two contrasting monologues - see “Acting Option” section for guidelines.

Drama Design Option
If you’re applying to the Drama Design Option, you must demonstrate basic proficiency in drawing, painting and design by submitting a portfolio of your work. The portfolio should include about 15 items of work in several art media and techniques. Not all samples of your work have to pertain to the theatre. We’d like to see examples of:

• Use of Color
• Line Drawing
• Drafting

Also, please send two letters of recommendation from people capable of describing your work and evaluating your professional.
promise.*

Dramaturgy Option
Students who wish to be admitted into the Dramaturgy Option will need to demonstrate research and writing skills commensurate with the level of expertise necessary to successfully complete the rigorous curriculum. In addition to the regular procedures for admission into the College of Fine Arts, the following materials must be included:

- A resume or curriculum vitae.
- A letter written by the applicant describing theatre experience and ambitions in the theatre.
- Two letters by people (preferably teachers) familiar with the applicant’s writing and research skills.
- A sample of original research writing by the applicant of 1,000 words or longer; this document must conform to current MLA or APA citation protocols.
- The $50 additional audition fee required by the School of Drama is waived for Dramaturgy applicants unless they are also applying for admission in another School of Drama Option.

Transfers in Dramaturgy
Admission process is identical for transfer students and incoming freshmen. Whether you are transferring from another university or from one of Carnegie Mellon’s other colleges, you will be classified as a freshman in the Dramaturgy Option, unless you can demonstrate you have completed a program equivalent to the Dramaturgy Option’s freshman year.

Production Technology & Management Option
If you’re applying to the Production Technology and Management Option, you should already have practical experience in the theatre, as well as some background in mathematics and physics, organization and management, or both. You must demonstrate basic proficiency in project planning and execution by submitting a portfolio of your work. The portfolio should include up to 15 examples of work. Not all samples of your work have to pertain directly to the theatre.

We’d like to see examples of:
- Evidence of your thought process for technical or management solutions
- Drafting, drawing or CAD
- Paperwork you’ve used/developed for schedules, reports, budgets, estimates, etc.
- Photos of work both finished and in process

We expect you to also submit:
- A resume
- A letter describing your training, experience and ambitions in theatre
- Two letters of recommendation from people capable of describing your work and evaluating your professional promise*

* Ask those who write letters of recommendation for you to send them by February 1, directly to:

Office of Admission - Design/Production
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
Fax 412-268-7838

Directing Option
To apply to the Directing Option, follow the audition guidelines outlined in the “Acting Option” with one major change—plan to perform only one monologue. Bring to the audition a statement describing why you are pursuing this line of study, explaining your choice of monologue and including a critical analysis of the play. Bring any director’s scripts, design portfolio, dramatic writing, photography or any other evidence of your creative life.

School Of Music Admission Procedure
To apply to the School of Music, complete the following steps by December 1:
- Complete and submit the Common Application and Carnegie Mellon Supplement, in addition to all required supporting materials, to the Office of Admission.
- Indicate your curriculum preference on page 3 of the Carnegie Mellon Supplement: Instrumental, Voice or Composition.
- Go to www.cmu.edu/admission/finearts and click the link to the School of Music web site.
- Complete and submit the Music School Application. Be certain to use an email address that will be accessible and active throughout the application and audition process, as this will be the School of Music’s primary means of communication.
- Upon submission of the application, you will be prompted to pay your $50 fee. If you are unable to pay by credit card, call the School of Music admission office at 412-268-4118 for further instructions.
- After submitting the audition fee, you will be promoted to reserve a date, time and location for your audition.
- Expect a confirmation email one week before the scheduled date of your audition.

Auditions
All applicants to the School of Music are required to undergo an audition. Applicants may meet the audition requirement through one of three means:
1. Audition in person and on-campus before the specific studio faculty.
2. Audition in person before a non-performance area faculty member of the School of Music at one of the regional locations. Regional auditions are recorded, and the recordings are reviewed and judged by the studio faculty. The regional audition option is not open to applicants of the percussion, double bass, composition and flute studios.
3. Audition by recording:
   a. High-quality DVD or CD recordings are the only acceptable medium.
   b. Pieces must be separated by tracks.
   c. Recording and case must be marked with the applicant’s name, the instrument or performance area, the repertoire and the words “audition recording.”
   d. Applicants must meet the specific performance area audition requirements.
   e. Recordings need to be received at the following address by January 10:
      Carnegie Mellon School of Music
      Music Recruitment and Enrollment, CFA 108
      5000 Forbes Avenue
      Pittsburgh, PA 15213-3890

Auditions are held in Pittsburgh and in regional locations between January 20 and February 18. Available dates, times and locations for auditions are listed on the School of Music web site. Candidates have the freedom to choose the most convenient location, date and time to hold their audition.

The School of Music is sensitive to your need for advanced travel arrangements for most applicants. Even so, audition appointments are subject to minor change until about two weeks before the designated date. You will be notified in advance if such a change is necessitated, and the School of Music will make every effort to collaborate on a feasible alternative date and time to cause minimal disruption. Final audition confirmations will be forwarded to you via email one week prior to the scheduled audition date.

Flute and Voice audition reservations will only be confirmed and honored for those candidates who perform favorably after pre-screening.

The audition process requires approximately four hours. You will have an adequate warm-up time prior to your audition and will participate in various music placement tests on the audition date. Applicants are notified of the result of the audition, in writing, by February 28. If the audition result is favorable, the School of Music will recommend acceptance to the Office of Admission, and the Office of Admission will determine of the student’s academic records meet the standards of Carnegie Mellon. If the audition result is not favorable, the applicant will not be admitted to the
School of Music, but could be admitted to Carnegie Mellon through an existing application to another school of study.

**Audition Requirements**

**Bagpipes:** All applicants to the bagpipe studio are expected to prepare and to meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

**Bassoon:** All applicants to the bassoon studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

**Clarinet:** All applicants to the clarinet studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

**Cello:** All applicants to the cello studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

**Composition:** All applicants to the composition program are required to submit, by December 1, preliminary audition materials consisting of:
- Three manuscripts of original compositions showing a range of genres.
- A CD recording of a live performance of each of these pieces. If a live performance is not possible, an electronically generated CD will be acceptable.

**Materials should be forwarded to:**
Carnegie Mellon School of Music
Music Recruitment and Enrollment, CFA 108
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

**IMPORTANT:** Recordings and manuscripts will not be returned.

All applicants to the composition program are invited to audition for the composition faculty. The submission of manuscripts and recordings is not for the purpose of pre-screening applicants. Composition faculty will review submitted materials in preparation for the live audition, which will consist of an interview between the composition applicant and the composition faculty. During the interview, you should be prepared to discuss personal composition processes, background and future goals. It will not be necessary for you to perform excerpts either vocally or instrumentally, of your works during the audition/interview. Copies of manuscripts and recordings may be brought to the interview, but are not required. Although arrangements of works by other composers are welcome, they will be considered supplementary to the basic requirement for three original works.

**Double Bass:** All applicants to the double bass studio are expected to prepare and to meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. An etude or equivalent technical exercise.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.

**IMPORTANT:** Double Bass auditions are held in the Pittsburgh venue only.

**Euphonium:** All applicants to the euphonium studio are expected to prepare and to meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

**Flute:** All flute candidates applying to the School of Music are required to submit a CD that will serve as a preliminary round for admittance. Your CD must be received by December 1.

**Preliminary CD Guideline:**
1. This CD recording must be entirely without piano accompaniment.
2. Recording must be high-quality audio CD, .DAT, mini-disk or cassette will not be accepted.
3. Please make sure that your CD is labeled with your name, major program and a track listing of selected repertoire.
4. Required Repertoire:
   a. Mozart: Concerto in G or D major - 1st and 2nd movements (exposition only)
   b. Orchestral Excerpts:
      - Beethoven Lenore Overture No. 3 - measures 328-360
      - Brahms Symphony No. 4, movement IV - measures 93-105
      - Mendelssohn A Midsummers Nights Dream, Scherzo - measures before P to the end
      - Debussy Prelude l’apres-midi d’un faune - rehearsal no. 2-3

   All of the above excerpts can be found in *Orchestral Excerpts for Flute* (Baxtresser/Rearick), published by Theodore Presser.

5. Please send your CD to:
   Carnegie Mellon School of Music
   Music Recruitment and Enrollment, CFA 108
   5000 Forbes Avenue
   Pittsburgh, PA 15213-3890

**IMPORTANT:** The preliminary audition CD will not be returned.

The flute faculty will convene the first week of December to review the preliminary CDs, and decisions will be made regarding which applicants will be invited to a live audition the second week of December. Applicants will be notified of the results of the pre-screening by December 22.

Candidates invited to a live audition will be expected to prepare and meet the following performance requirements:
1. Mozart Concerto - complete.
2. One 20th century work.
3. One etude and major and minor scales.
4. Four orchestral excerpts of contrasting styles.

**IMPORTANT:** Live auditions for flute candidates are held in the Pittsburgh venue only.

**Guitar:** Entering freshmen guitarist should have at least one year of study on the classical guitar. They should be familiar with basic right hand techniques and should be able to read music on the guitar up to seventh position. All applicants to the guitar studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. Chords: any major, minor or dominant seventh chord as requested.
3. An etude of your choice.
4. Two or three pieces from the suggested repertoire below:
   - Leo Brouwer, *Etudes Simples* (1-20)
   - Andrew York, *Eight Discernment and Eight Dreamscapes*
   - Gerald Garcia, *25 Esquisses*
Two contrasting works: one classical and one by a 20th century composer, such as an etude from Bach-Grandjany Etudes for Harp and Natra Sonatine.

Two orchestral excerpts, including the harp cadenza from Waltz of the Flowers by Tchaikovsky.

Harp: All applicants to the harp studio are expected to prepare and meet the following performance requirements for auditions:
1. Etude No. 1, from cinquante Etudes, Op. 34, Book 1, by Boscha.
2. Two contrasting works: one classical and one by a 20th century composer, such as an etude from Bach-Grandjany Etudes for Harp and Natra Sonatine.
3. Two orchestral excerpts, including the harp cadenza from Waltz of the Flowers by Tchaikovsky.

Percussion: Those auditioning for the percussion department are expected to demonstrate superior ability in one of the six categories listed below. All students are required to play from categories I, II, and V for admission into the percussion department. Competency in one additional category must be demonstrated. Auditions in all categories are not required.

1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

Oboe: All applicants to the oboe studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

Organ: The organ audition consists of three parts:
1. One of the Eight Little Preludes and Fugues* by Bach.
2. A movement of an organ sonata by Mendelssohn.*
3. An elementary composition to be read at sight. *This selection must be played from memory.

Piano: The piano audition consists of four parts:
1. A suite or a Prelude and Fugue by Bach* (selected contrasting movements of a suite are acceptable).
2. Piano sonata by Haydn, Mozart or Beethoven* (one or more contrasting movements).
3. A Romantic, Impressionistic, or Twentieth-century composition.*
4. An elementary composition to be read at sight. *This selection must be played from memory.

Saxophone: All applicants to the saxophone studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

Trombone: All applicants to the trombone studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

Tuba: All applicants to the tuba studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scales as requested.
2. A technical etude.
3. A solo composition of the applicant’s choice that will demonstrate the musical and technical level of achievement on the particular instrument.
4. Two or three orchestral excerpts of the player’s choice.

Viola: All applicants to the viola studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scale in three octaves as requested.
2. One etude by Bruni, Kreutzer, Campagnoli or Mazas’ Brilliant Studies.
3. A movement of a concerto or sonata by Bach or Telemann or a representative work of the Romantic or Contemporary period.

Violin: All applicants to the violin studio are expected to prepare and meet the following performance requirements for auditions:
1. Scales: any major or minor scale in three octaves as requested.
2. One etude by Mazas, Kreutzer or Fiorillo.
3. A movement of a concerto or sonata by Bach, or a representative work of the Romantic or Contemporary period.

Voice: Candidates are expected to have a voice with professional potential and some experience in solo singing. Note that the Voice Performance program in the School of Music is separate from the Music Theater program in the School of Drama, and application to one program does not provide immediate consideration in the other.
determine if a live audition is appropriate. The reserved audition appointment will only be confirmed and honored for applicants who have a favorable response following the pre-screening process. Applicants who do not participate in the pre-screening process cannot be considered for the vocal performance program.

All candidates must submit a high quality CD recording that meets the following requirements:
1. Three selections, separated by tracks, on a CD recording. No other recorded media type will be accepted.
2. All selections must be in the Classical style. Music Theater selections will not be accepted.
3. The first selection must be performed in English.
4. The second selection must be performed in Italian.
5. The third selection may be performed in any language of choice.
6. CD and CD case must be labeled with your name, your degree program, your voice and a track listing of your selected repertoire.
7. CD recordings must be received in the Music Admission office by December 1.
8. CDs should be forwarded to:
   Carnegie Mellon School of Music
   Recruitment and Enrollment, CFA 108
   5000 Forbes Avenue
   Pittsburgh, PA 15213-3890

The voice faculty will convene the first week of December to review the CDs, and decisions will be made regarding which applicants will be invited to a live audition the second week of December. Applicants will be notified of the results of the pre-screening by December 22.

Candidates who proceed to the live audition will be expected to perform the three selections from the pre-screening CD. Some sight-singing may be required as well. Those who require the services of a School of Music accompanist must forward copies of the music to the pre-screening address by January 10. Music must be single-sided, non-stapled, separated by paperclip, labeled with the applicants name, in the desired key and with clearly designated marks for cuts, etc. Accompanists are provided only in the Pittsburgh, New York and Boston audition venues.

Intercollege Degree Programs Admission Procedure

Bachelor of Humanities and Arts (BHA)
- You must apply and be admitted to the College of Fine Arts. Please follow requirements for the particular CFA school of interest
- You must also apply and be admitted to the College of Humanities and Social Sciences
- You must complete a BHA Statement of Interdisciplinary Intent
- Not all students admitted to both colleges are selected for the BHA program
- Students selected for this program will receive notification in their admission decision letter

Bachelor of Science and Arts (BSA)
- You must apply and be admitted to the College of Fine Arts. Please follow requirements for the particular CFA school of interest
- You must also apply and be admitted to the Mellon College of Science
- You must complete a BSA Statement of Multidisciplinary Intent
- Not all students admitted to both colleges are selected for the BSA program
- Students selected for this program will receive notification in their admission decision letter. Application components vary somewhat for BHA and BSA. Can di dates depend on your intended focus in the College of Fine Arts. You must complete the specific application requirements (portfolio review or audition) for your particular CFA focus.

Please note: Students interested in Drama may select from three options in the School of Drama: Directing, Design or Production Technology and Management. There is no Acting or Musical Theatre option for the BHA/BSA Program. Students interested in Music may select from two options in the School of Music: performance (instrumental, piano, organ) or composition. There is no vocal performance option for the BHA/BSA Program. If an audition or portfolio review is necessary for your BHA/BSA Program focus in the College of Fine Arts, please go to www.cmu.edu/admission/finearts to register for an audition or portfolio review.

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. Students should plan to spend about four hours on campus during these events.

Campus Tours

Campus tours are conducted by student admission assistants 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. Saturday tours and group sessions are held during the fall. 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 call the Office of Admission.
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
- eat at the dining facilities

There are four Sleeping Bag Weekends in the fall and winter. If you are on our mailing list, you should receive an invitation in the early fall. To reserve a place at a Sleeping Bag Weekend, email cmssw@andrew.cmu.edu, call us at 412-268-2082 or visit www.cmu.edu/admission.

Information Sessions
Each fall, the Admission staff travels across the country, meeting with groups of students and parents. We discuss the college selection process, admission requirements and financial aid. Prior to the event, you should receive an invitation stating the time and location of the program. Reservations are preferred, and we encourage students and parents to attend.

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
Carnegie Mellon’s campus is:
- located approximately five miles east of downtown Pittsburgh in the Oakland neighborhood
- accessible by ground, rail, or air transportation

To listen to a recorded message of directions to campus, please call (412) 268-8343.

Driving from the East:
- Take the Pennsylvania Turnpike West to Exit 57, Pittsburgh/ Monroeville
- Follow Interstate 79 West to Exit 7, Edgewood/Swissvale
- Turn right onto Braddock Avenue (at the end of the ramp)
- Continue to the Forbes Avenue intersection (Frick Park will be on the left)
- Turn left onto Forbes Avenue and follow Forbes Avenue approximately three miles to campus.
- Immediately after crossing the intersection of Forbes Avenue and Beeler Street, turn left into the East Campus Garage.

Driving from the West/North:
- Take the Pennsylvania Turnpike East to Exit 28, Perry Highway
- Follow Interstate 79 South to 279 South (Exit 72)
- Stay on 279 South toward Pittsburgh
- As you near the city, follow signs for 579 South and the Veterans Bridge
- After crossing the bridge, watch on the right for the 376 East/Oakland exit ramp
- Bear right onto this ramp, which will place you on the Boulevard of the Allies
- Continue on the Boulevard of the Allies
- Do not bear right at the 376 East/Monroeville ramp
- Stay on the Boulevard and exit at the Forbes Avenue off ramp, which will be marked with a small green sign
- Stay in right-hand lanes, following Forbes Avenue 1.3 miles through the Oakland business district to campus
- Pass the intersection of Forbes Avenue and Morewood Avenue and the Garage entrance will be on your right.

Driving from the South:
- Take Interstate 79 North to 279 North (Pittsburgh)
- Follow 279 North toward Pittsburgh through the Fort Pitt Tunnel and onto the Fort Pitt Bridge
- Once on the bridge, stay in the far right lanes and follow signs for 376 East/ Monroeville
- Take 376 East to Exit 2A, Forbes Avenue/ Oakland
- Stay in the right hand lanes, following Forbes 1.3 miles through the Oakland business district to campus
- Pass the intersection of Forbes Avenue and Morewood Avenue and the Garage entrance will be on your right.
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. Seven such programs are offered during the summer for high school students: the Pre-College Programs in the Fine Arts (Architecture, Art, Design, 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 206

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 freshman would take. The program is designed for mature, motivated students who seek to gain advanced placement credit and who are eager to sample college life early by living in a residence hall and participating in educational, social, and recreational activities.

The faculty teaches courses in biology, calculus, chemistry, engineering, computer science, philosophy, business, economics, modern mathematics, physics, history and writing during the six week program, and additional classes are added each year. Resident students are required to take two courses during the summer program. The two-course load is slightly less demanding than the typical five-course load during the regular semester; however, it remains close enough for a student to measure his ability to meet the pressure of college life.

All APEA classes 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. The program makes available tutorials in the more technical subjects.

Students who do exceptionally well in the APEA Program and who meet current admission standards are sometimes invited to apply for early admission to Carnegie Mellon if space is available. Carnegie Mellon is always interested in academically talented high school juniors who have the academic ability to skip their senior year entirely and accept early admission to college. This is especially true for capable students whose academic and career goals are clear. Students must take two courses in order to be considered for early admission to Carnegie Mellon. Depending on their academic interests, credentials, and space available, these students may enroll in the Carnegie Institute of Technology (engineering), Mellon College of Science, School of Computer Science, Tepper School of Business, or the College of Humanities and Social Sciences. Students who are accepted have the option of omitting their senior year and coming to campus in the fall as full-time students. It should be emphasized that space can be especially tight in engineering, and in particular Electrical and Computer Engineering and Computer Science. Participation in the APEA program does not guarantee early admission or even regular admission to Carnegie Mellon.

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 advanced placement credit at other universities. In order not to prejudice any application for admission in the future, no record of marginal or failing work is kept, much less released. In this regard, APEA is risk free.

Applications are also encouraged from very adventurous young students who are years away from college (ninth graders, for example) and reside in the Pittsburgh area. 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.

Tutorials are available as a part of the program. However, students should be aware that the calculus course assumes a knowledge of algebra, trigonometry, and geometry; that the physics course assumes a high school physics course has been taken, and recommends concurrent registration in calculus; and that the chemistry and biology courses assume a high school course in chemistry and/or biology has been taken.

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 of study is divided into two parts which occupy the entire day. In the morning, students have a free-hand drawing course which attempts to strengthen their abilities. The course assumes no prior student experience. In the afternoon, the design studio meets and tackles the problems at hand.

Lectures will be presented by faculty members in the School of Architecture and local practitioners. These lectures will cover such areas as design process and methodology, architectural history, technology, environment concerns, urban problems, professional registration and practice. Field trips will be to local construction sites in the Pittsburgh area. Design problems will range in length from one-hour models, group discussion, individual criticism and faculty review.

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

The summer Pre-College Art Program gives interested and talented high school students an opportunity to discover whether they have the necessary aptitudes for studying art at the college level.

When we make art, we not only satisfy human need for personal discovery and communication, but we also engage in the privilege to question, to be different, to challenge the status quo as an exercise in self-expression and free speech.

Students will be able to choose three specific art studios to study in three-week modules during the program. The areas include two-dimensional (painting, drawing, computer animation/graphics and printmaking), and three-dimensional (sculpture, installation and materials) and includes art history and concept studio.

A written evaluation of each student’s work is made at the conclusion of the six-week session. Students who intend to apply for admission to Carnegie Mellon for freshman admission to the department may schedule an interview with the Office of Admission. Students may request a portfolio review for admission or an informal critique during the last week of the program.

Pre-College Design Program

Design has an important influence on contemporary life. Nearly everything that has been manufactured or printed—packages, appliances, furniture, books, cars, magazines, etc. — has been influenced by a designer sensitive to social, aesthetic, technical and economic principles.

Full-time design faculty provide not only an integrated study program of graphic design, product design, drawing, photography and computer graphics, but also professional career counseling and guidance appropriate to students. A final positive review of individual student work by all faculty can fulfill the portfolio requirement for admission as freshmen to the department.

The six-week program consists of three-hour classes each morning and afternoon and includes homework assignments. During the registration period, all students will receive a list of required materials. Students may either bring materials from home or purchase them at the campus art store. Special activities could include visiting lectures or field trips to professional design studios. A written evaluation of each student’s work will be sent to the parents at the completion of the program.

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
Enrollment Services

Linda Anderson - Director of Enrollment Services and Director of Student Financial Assistance and Services
John Papinchak - Director of Enrollment Services and University Registrar
Warner Hall A-19
5000 Forbes Avenue Pittsburgh, PA 15213-3890
Phone (412) 268-8186
Fax (412) 268-8084
thehub@andrew.cmu.edu
www.cmu.edu/hub

The HUB

The HUB is Enrollment Services’ student service center. The Assistant Directors of Enrollment Services are available in The HUB Monday, Wednesday and Friday from 8:30 a.m. until 4:30 p.m., and Tuesday and Thursday from 10:30 a.m. until 4:30 p.m. to assist students with enrollment matters including registration, financial assistance, student accounts and PlaidCa$h. Parents and students are encouraged to contact the Assistant Directors by visiting The HUB, Warner Hall A-19.

Carnegie Mellon Card Office

The staff members of the Carnegie Mellon Card Office are available to assist you with all of your ID+ Card production needs. Card Office hours are from 8:30 p.m. to 4:30 p.m., Monday through Friday.

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 is available on The HUB Website. Registration and payment deadlines are listed on the Official Academic Calendar, located in the appendix section of this catalog as well as on The HUB Website.

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). OLR can identify your advisor and facilitate contact with your advisor via e-mail as part of the automatic registration process.

Registration for most entering freshmen is accomplished with the assistance of Associate Deans and department heads during the summer. 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. Failed and lower-level courses are to be given priority in planning a schedule.

Students enrolled in any curriculum leading to a degree who fail any required course more than once will not be permitted to re-register in that course without the approval of the Dean of their college, the head of their department and the head of the department offering the course in question.

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.

Availability of Required Courses

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

Change in Schedule (Add/Drop)

To add or drop a course after Registration Week, follow the OLR instructions for Adding/Dropping a course.

Scheduling changes must be made within the period 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,” located in the University Policies section of this catalog for more information).

Undergraduate students at Carnegie Mellon may drop a course by following the instructions for dropping a course in 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. 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 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 the School. If a student requests to add a course after the add period, the student must complete the Late Add Form and submit it to the Assistant Directors of Enrollment Services as soon as possible.

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.

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.

**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 mins 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 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.

There are nine approved PCHE Institutions in the Pittsburgh area:

- Carlow College (412-578-6084), Chatham College (412-365-1121), CCAC (412-237-2555), Duquesne University (412-396-6230), LaRoche College (412-367-9300), Pittsburgh Theological Seminary (412-362-5610), Point Park College (412-392-3861), Robert Morris College (412-262-8256), University of Pittsburgh (412-624-7600)

1. Each college or university accepts registration from the other institutions; however, first priority is given to students of the Host Institution, and not all departments or schools in all institutions are able to participate in this program. "PCHE Cross Registration Request" forms are available from The HUB.

2. In each case of a student cross-registration, the approval of the Dean or a designated individual from the home college or university must be obtained prior to registration.

3. In addition, the student's advisor or Dean is responsible for assuring the student's eligibility for the course in which he/she intends to enroll.

4. Full credit and grades for cross registered courses will be transferred to the appropriate institution; the academic regulations of the host university will prevail.

5. The academic honesty code and other rules of conduct of the institution providing instruction apply with respect to its courses and behavior on its campus. That institution also determines whether its rules have or have not been violated. The student's own institution will impose such penalties as it considers proper when violations are reported to it.

6. Cross-registrants do not thereby acquire the status of students in the institutions in which they are receiving instruction (e.g., for purposes of participation in student activities, insurance programs, etc.). They do receive library privileges at the host institution and may purchase course texts at the host bookstore.

7. Each qualified student normally may enroll in no more than one course off campus in any one term or semester under this program. Students wishing to cross register for more than one course in a term must have approval from the appropriate academic offices at both schools.

8. No additional tuition charge is made to students who are participating in this program; however, the student who cross registers is responsible for paying any course or laboratory fees to the host.

9. Cross-registration does not apply to summer sessions or intersessions at any of the institutions.

10. Adding or dropping a course after the home institution's deadline date requires permission from the home institution; adding or dropping a course after the host institution's deadline date requires permission from the host institution.

11. Students enrolled in approved joint co-op programs between two PCHE institutions are exempt from the requirement of being full-time at either school in order to cross register. Students are bound by the requirements of that program.

12. Carnegie Mellon students may not cross register for required courses that are normally available at Carnegie Mellon. Exceptions may be made if courses are unavailable or legitimate schedule conflicts seriously hinder completion of degree requirements within the prescribed timeframe.

13. Students should not cross register in the semester in which they are graduating.
Finances

2006-2007 Cost of Attendance

Estimated educational expenses at Carnegie Mellon for the 2006-2007 academic year are as follows:

Freshmen - Fall 2006

Per-Unit Tuition Rate $440

<table>
<thead>
<tr>
<th>Resident</th>
<th>Commuter</th>
<th>Non-Resident</th>
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</thead>
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<tr>
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<td>$34,180</td>
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<tr>
<td>Activity Fee</td>
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<td>168</td>
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<tr>
<td>Port Authority Fee</td>
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<td>70</td>
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<tr>
<td>Media Fee</td>
<td>10</td>
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<tr>
<td>Technology Fee</td>
<td>150</td>
<td>150</td>
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<tr>
<td>Room &amp; Fees</td>
<td>5,440</td>
<td>0</td>
</tr>
<tr>
<td>Dining</td>
<td>3,840</td>
<td>1,400</td>
</tr>
<tr>
<td>Books &amp; Supplies</td>
<td>945</td>
<td>945</td>
</tr>
<tr>
<td>Personal/Misc.</td>
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<td>1,315</td>
</tr>
<tr>
<td>Transporation*</td>
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Totals $46,308 $39,028

Undergraduate Students Who Entered

Fall 2003 - Fall 2004 - Fall 2005

<table>
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<tr>
<th>Resident</th>
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<td>168</td>
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<tr>
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<tr>
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<td>10</td>
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<tr>
<td>Technology Fee</td>
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<td>150</td>
</tr>
<tr>
<td>Room &amp; Fees</td>
<td>5,440</td>
<td>0</td>
</tr>
<tr>
<td>Dining</td>
<td>3,530</td>
<td>1,400</td>
</tr>
<tr>
<td>Books &amp; Supplies</td>
<td>945</td>
<td>945</td>
</tr>
<tr>
<td>Personal/Misc.</td>
<td>1,315</td>
<td>1,315</td>
</tr>
<tr>
<td>Transporation*</td>
<td>Variable</td>
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</table>

Totals $44,678 $37,708 $44,178

Undergraduate Students Who Entered

Prior to Fall 2003

Per-Unit Tuition Rate $433

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<thead>
<tr>
<th>Resident</th>
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<tr>
<td>Port Authority Fee</td>
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<tr>
<td>Media Fee</td>
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<tr>
<td>Technology Fee</td>
<td>150</td>
<td>150</td>
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<td>Room &amp; Fees</td>
<td>5,440</td>
<td>0</td>
</tr>
<tr>
<td>Dining</td>
<td>3,530</td>
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<tr>
<td>Books &amp; Supplies</td>
<td>945</td>
<td>945</td>
</tr>
<tr>
<td>Personal/Misc.</td>
<td>1,315</td>
<td>1,315</td>
</tr>
<tr>
<td>Transporation*</td>
<td>Variable</td>
<td>600</td>
</tr>
</tbody>
</table>

Totals $44,188 $37,218 $43,688

The three budgets depicted above 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.

1 Based upon the cost of a standard double room. Your actual cost may differ.
2 The commuter dining amount is based upon a 10 meals plus $8 DineXtra per two weeks.
3 Design & Architecture students add an additional $490 for books/supplies.
4 These expenses will not appear on your Student Account Invoice. 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 $870 per 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 $1,806 per 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.

Student Fee Information

Activity Fee - $84 per semester - Charged to all students registered for a minimum of 18 units. This fee covers the cost of student activities and events.

Orientation Fee - $190 - Charged to all first-time undergraduate students (fall semester only!)

Port Authority (PAT) Fee - $35 per semester - Charged to all degree-seeking students enrolled for at least one course. This permits full access to the Port Authority Transit System.

Health Insurance Fee - $870 annually - Minimal health insurance coverage is required at a cost of $870 per year, unless a waiver is granted by Health Services, because you are covered under your family’s health plan.

Technology Fee - $75 per semester - Charged to all students who are eligible to enroll. This includes distance education, non-degree and exchange students. This does not include Study Abroad students. This fee is nonrefundable.

Media Fee - $5 per semester

Billing Information

Payment of Charges

All charges and credits incurred at the university are reflected on your student account and invoice. This invoice includes tuition and fees; and may include housing, meal plan, sorority or fraternity charges, health insurance, PlaidCa$h, DineXtra and any miscellaneous charges incurred. Miscellaneous charges could include but are not limited to music lessons, library fines, parking fines, pharmacy fees or emergency loans.

Note: The information on the invoice is accurate as of the day of printing.

A student account invoice is mailed in July for the fall semester and in November for the spring semester. Payment is due on or before August 18, 2006 and January 5, 2007 for the 2006-2007 academic year. Balances not paid in full on or before the Monday prior to the start of classes will be assessed a Late Enrollment fee of $150.

Your account can be paid via personal check, cash, wire transfer, scholarships or loan proceeds. You may also contract a payment plan through Tuition Management Services (TMS) - see the following page for additional information. Enrolled students may pay by e-check via Student Information On-Line (www.cmuhub.cmu.edu).

E-Refund:

Enrollment Services encourages all students to authorize direct deposit of their student account credit balances into a checking or savings account. Taking advantage of this opportunity eliminates the need to stand in line at The HUB to pick up a refund check. To register for E-Refund, visit the Aid/Account Page within Student Information On-Line, and click the E-Pay/E-Refund button.
Payment Options

E-Pay with E-Check:

Electronic check payment is available to currently enrolled students at Carnegie Mellon. This electronic check payment process allows a student to pay the current semester and future semester account balances via an automatic direct debit to a U.S. checking or savings account. This authorization will be made from a secure student account payment website within Student Information On-Line on the Aid/Account Page. Enrollment takes one day to set-up.

You will need the following information in order to complete the E-Pay Enrollment Process:

- Account Type and Number (checking or savings)
- Transit routing number

Check and Electronic Check Payments

Enrolled students may make their student account payments from a checking or savings account via electronic check. To access E-Pay, log into Student Information On-Line and click on the Aid/Account button. Note: You must register with the E-Pay system prior to making your first E-Check payment.

Students and parents may make payments in person at The HUB, using cash or a check. Check should be made payable to Carnegie Mellon, payments may be mailed to our lockbox:

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

When paying by check, write the student’s name on the memo line of your check. If you send a check to this address, DO NOT attach any additional information to your invoice.

Wire Transfer Payments

The following information is required when sending a wire transfer payment:

Mellon Bank, 500 Ross St., Pittsburgh, PA 15262
Routing Number: 043-000-261
Carnegie Mellon Account Number: 197-9003
SWIFT Number: MELNUS3P
Student Name and ID Number

Carnegie Mellon is not responsible for wire transfer payments that are not properly identified. Allow at least 10-14 business days for processing.

Tuition Management Systems Monthly Payment Plan

The Tuition Management Systems Interest-Free Monthly Payment Plan allows you to maximize your savings and income by spreading your education expenses over 10 interest-free monthly payments beginning in July. Your only cost is an annual enrollment fee of $55.

The Carnegie Mellon Tuition Payment Plan includes life insurance coverage, personal account service and counseling, automated account information 24 hours a day and access to your account through their website, www.afford.com.

If you have already set up a monthly payment plan with TMS, one half of your contracted amount will be credited to your fall invoice, the remainder to the other semesters contracted. If you still have a balance due once your contracted amount is credited on the invoice and after deducting the amount of your approved loans, you either need to increase your contract with TMS, OR send the amount due to Carnegie Mellon.

Visit www.afford.com for more information on payment options, Carnegie Mellon education loans, free education payment counseling and the many payment options we offer to help you afford a Carnegie Mellon education. You may also contact a TMS Education Payment Counselor at 1-800-895-9061 Monday-Friday, 8:00 a.m. to 10:00 p.m. and Saturday, 9:00 a.m. to 3:00 p.m. (EST).

Monthly payment plan overpayments will be refunded in April.

Financial Assistance

Prospective Students: Office of Admission, Warner Hall 101
Current Students: The HUB, Warner Hall A-19

Financial Assistance Principles

Carnegie Mellon allocates resources carefully and judiciously to the benefit of the high-quality students we seek to enroll in the university. Financial aid, viewed by many as an entitlement when federal resources were much more plentiful, is now awarded by institutions who must balance resources, goals and priorities while attracting the highest quality students. Like many other colleges and universities, we use an increasingly larger share of our limited resources to help families cover the cost of enrollment. Federal and state financial aid resources, awarded on the basis of financial need, are distributed under federal and state guidelines.

Our merit-based financial aid strategy is aimed at rewarding the highest quality students. It aids high-quality students from middle-income families who may not have qualified for financial aid if it were awarded solely on the basis of financial need.

Applying for Financial Assistance

Carnegie Mellon follows a need-blind admission policy, which means we do not admit students based on their families’ ability to pay for their education. Applying for financial aid will have no affect on your chances for regular admission. It may have an affect; however, on those students we are able to admit from the waiting list. We will determine your eligibility to receive a financial aid package – a combination of federal, state and Carnegie Mellon funds.

To apply for financial aid, follow these steps:

1. Prior to completing the FAFSA or Renewal FAFSA on the web, you need to request a Personal Identification Number (PIN) from the Department of Education. If you are a dependent, undergraduate student, your parent must also request a PIN in order to electronically sign your FAFSA or Renewal FAFSA. Request a PIN by visiting http://pin.ed.gov. If you already have a PIN, you do not need to request a new one. If you have lost or forgotten your PIN, you need to request that it be sent to you again. If you think someone knows your PIN, select the Change PIN option to request a new PIN combination.

2. Complete a Free Application for Federal Student Aid (FAFSA). The FAFSA is available on-line at www.fafsa.ed.gov. This document is necessary if you wish to be considered for any student aid.

3. Complete the Carnegie Mellon Financial Aid Application. There are two options for completing this form:

   - On line - You must have an Andrew UserID and password to complete this application.
   - PDF version - You may download this form from The HUB Website.

   Additional information is published on The HUB Website, including specific instructions and required documents.

4. Parent(s)/U.S. Federal Income Tax Return or Foreign Tax Return and W-2 Wage and Tax Statement(s)

   Please send us a signed copy of your parent(s)’ actual Federal Income Tax Return, pages 1 and 2 only. We will not accept a tax preparer’s stamp in place of any signature(s). We will accept a tax preparer’s signature. We also require legible copies of all parental W-2 Wage and Tax Statement(s). Print your name and Student ID Number in the upper right corner of each tax document. Do not submit a copy of their prior year or an estimated tax return. If you file electronically, you are required to submit to us a signed copy of your electronic tax return. All documents listed above are due to us on or before April 15.
If your parent(s) are required to file a Federal Income Tax Return in a country other than the United States, you must provide us with a copy of their foreign tax return and provide tax information translated into U.S. dollars on a U.S. Federal Income Tax Return. This document must be signed by your parent(s) and a tax accountant.

5. Student’s/Spouse’s U.S. Federal Income Tax Return or Foreign Tax Return

We also require a signed copy of your actual Federal Income Tax Return. We will not accept a tax preparer’s stamp in place of any signature(s). We will accept a tax preparer’s signature. Do not submit a copy of the prior year or an estimated tax return. If you file electronically, you are required to submit to us a signed copy of your electronic tax return. All documents listed above are due to us on or before April 15.

If you are required to file a Federal Income Tax Return in a country other than the United States, you must provide us with a copy of your foreign tax return and provide tax information translated into U.S. dollars on a U.S. Federal Income Tax Return. This document must be signed by you and a tax accountant.

Award Notification Letter

The Office of Admission or Enrollment Services will mail an award notification letter to the applicant which indicates the types and amounts of aid offered. If additional information is required, a tracking letter may also be mailed to the applicant.

Financial Aid Award Package

To help meet your financial need, we offer you a combination of awards called a financial aid award package. There are two components to most financial aid packages: gift aid and self-help. Gift aid awards include grants and scholarships and are monies given to you that you do not have to repay. Self-help awards are monies you must apply for and either repay (student loans) or work for (student employment).

Financial aid award packages are structured to meet the particular needs of our students. The amount of financial aid may vary with need as the student progresses through the undergraduate program. Returning students financial aid award packages are evaluated and renewed by the Assistant Directors in The HUB annually upon proper resubmission of application materials by April 15, continued evidence of financial need, and satisfactory academic progress.

Note: If your EFC is greater than the cost of attendance, you will not be offered need-based financial aid. You or your parent(s) may still apply for non-need-based aid, such as the Federal PLUS Loan and the unsubsidized Federal Stafford Loan.

Satisfactory Academic Progress


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 Tepper and Heinz) must pass 80 percent of all cumulative units attempted at Carnegie Mellon and have a 2.00 cumulative QPA.

Carnegie Mellon Academic Scholarships - Institutional Academic Scholarships are awards that you do not have to repay. The Carnegie Mellon Institutional Academic Scholarships are awarded to students when they enter as freshmen and are renewed annually if the student meets the cumulative 2.0 QPA requirement. These scholarships are renewable for eight semesters of undergraduate education (ten semesters for Architecture students), provided satisfactory academic performance is maintained and the student is assessed Carnegie Mellon tuition.

Appeal Process - Carnegie Mellon realizes that extenuating circumstances may contribute to a student’s inability to achieve satisfactory academic progress, and thus we encourage students to appeal after receipt of progress failure notification. Appeal examples include; extended illness, changes in major, difficult transition to first-year in college (academically and socially), recent diagnosis of learning disability or a recent death of a close family member.

For More Information

An excellent, detailed source of information regarding financial assistance programs available at Carnegie Mellon is the Undergraduate Student Financial Assistance Guide for the current academic year. This publication is available on The HUB Website.

Types of Financial Assistance Available

Grants

Grants are awards you do not have to repay. All federal, state and other institutional grants and scholarships are awards based upon financial need.

Federal Pell Grant

A Federal Pell Grant is a grant awarded by the federal government to students with high financial need. The projected maximum grant awarded for the 2006-07 academic year is $4,050. If you become eligible for a Federal Pell Grant after your financial aid package is determined, a dollar-for-dollar reduction to your Carnegie Mellon need-based grant funds will occur.

Federal Supplemental Educational Opportunity Grant (Federal SEOG)

A Federal SEOG is a grant for undergraduates with exceptional financial need. Carnegie Mellon usually awards these grants to students who receive a Federal Pell Grant. If there is a change in your Federal SEOG eligibility, a dollar-for-dollar adjustment to your Carnegie Mellon need based grant funds will occur.

State Grants

Some states provide educational grants to their residents who demonstrate financial need.

If you are eligible for grant assistance from your state but you do not apply, Carnegie Mellon will not provide additional grant assistance to replace your lost state grant funds. In addition, if you do not apply on time for State Grant assistance and you are a Pennsylvania resident, we will reduce your eligibility for the Carnegie Mellon Undergraduate Grant by $1,000 if you would have been eligible for a PHEAA State Grant. This is the amount of institutional grant assistance Carnegie Mellon would have received from the Pennsylvania Higher Education Assistance Agency (PHEAA) if you had applied on time.

If you are awarded a state grant after your financial aid package is determined, a dollar-for-dollar reduction to your Carnegie Mellon need based grant funds will occur.

Carnegie Mellon Undergraduate Grant

A Carnegie Mellon Undergraduate Grant is a grant awarded by Carnegie Mellon to students who have financial need. Once you complete the Carnegie Mellon financial aid process, you are considered for this grant. Note: This grant is not automatically renewed each year.

Scholarships

Scholarships are awards that you do not have to repay. The Carnegie Mellon Institutional Academic Scholarships are awarded to students when they enter as freshmen and are renewed annually if the student meets the cumulative 2.0 QPA requirement.
Carnegie Mellon Academic Scholarship Program

Carnegie Mellon offers several academic scholarships to incoming freshmen. The scholarships are designed to recognize and reward outstanding academic, artistic and personal achievement. Final need is not a requirement. These scholarships are renewable for eight semesters of undergraduate education (ten semesters for Architecture students), provided satisfactory academic performance is maintained and you are assessed Carnegie Mellon tuition. Academic scholarships are only awarded to incoming freshmen during the admission process. These scholarships include: Judith Resnik Challenger Scholarship, Andrew Carnegie Scholarship and Presidential Scholarship. Recipients do not have to file a FAFSA to renew these scholarships unless they wish to apply for need-based financial aid. If your parent is a Carnegie Mellon employee who qualifies for tuition remission, you will not be eligible for a Carnegie Mellon Academic Scholarship.

Student Loans

Student loans are self-help awards which must be repaid.

Federal Perkins Loan

A Federal Perkins Loan is a low-interest (5 percent) federal loan administered by Carnegie Mellon. Carnegie Mellon offers this loan to students who have exceptional financial need as determined by Federal Methodology and Carnegie Mellon. You receive consideration for a Federal Perkins Loan if you complete a FAFSA and a Carnegie Mellon Financial Aid Application. There is no separate application for this loan. Enrollment Services will automatically credit the loan to your student account (one-half in the fall, one-half in the spring). If you are offered a Federal Perkins Loan, Enrollment Services will mail you a Promissory Note in mid to late summer. You must sign and return your Promissory Note to Enrollment Services. If you do not return a signed Promissory Note, your Federal Perkins Loan will be canceled.

Repayment of both principal and interest does not begin until nine months after you graduate or are no longer enrolled at least half-time (18 units per semester). No interest accrues on the loan until you begin repayment.

Federal Stafford Loan

A Federal Stafford Loan (FSL) is a loan given by a private lender (e.g., bank, credit union, or other financial institution) to students. The interest rate is fixed at 6.8%, as of July 1, 2006. There are two types of Federal Stafford Loans — subsidized and unsubsidized.

You may borrow up to the following annual loan limits (subsidized and unsubsidized FSL combined) based upon your year of study:
- first-year students $2,625;
- sophomores $3,500;
- juniors, seniors and fifth-year students $5,500.

The maximum is $23,000 for undergraduate study.

To apply for an FSL, you must complete and submit the following:
- FAFSA;
- Carnegie Mellon Financial Aid Application;
- Signed copy of your parent(s)’ Federal Income Tax Return or Foreign Income Tax Return;
- Your parents’ W-2 Wage and Tax Statements;
- Signed copy of your Federal Income Tax Return or Foreign Income Tax Return.

You must complete a Stafford Master Promissory Note (MPN). If you previously borrowed a Federal Stafford Loan (FSL) and completed a Master Promissory Note, you do not need to complete another MPN for each subsequent academic year. Your FAFSA will serve as your application.

If you are a first-time borrower at Carnegie Mellon, you must complete a Stafford MPN on-line by visiting the American Education Services (AES) website: www.aessuccess.org. Complete instructions are available on The HUB website: www.cmu.edu/hub/mpn.html.

In most cases, your FSL funds will be electronically deposited into your student account at Carnegie Mellon on or about September 2 for the fall semester, and on or about January 2 for the spring semester. In some cases, you may be required to sign your FSL check in The HUB before the loan proceeds can be credited to your student account. You should subtract approximately one-half of your annual FSL from the balance due appearing on your Fall and Spring Invoices.

No fees will be deducted from your loan if you are borrowing from a KeystoneBEST Lender. Our preferred Keystone Best Lenders are PNC Bank and Citizens Bank.

Subsidized Federal Stafford Loan

A subsidized Federal Stafford Loan (FSL) is a loan given by a private lender (e.g., bank, credit union or other financial institution) to students with financial need. You begin repaying the loan six months after you either graduate or cease to be enrolled at least half-time (18 units per semester). The interest on a subsidized FSL is paid by the federal government while you remain enrolled at least half-time and during your six-month grace period. You have up to 10 years to repay your loan.

Unsubsidized Federal Stafford Loan

An unsubsidized Federal Stafford Loan (FSL) is available to students who do not qualify, in whole or in part, for a subsidized Federal Stafford Loan. It is not based on financial need. Unlike the subsidized FSL, you are required to pay the interest that accumulates on the unsubsidized FSL every three months while you are in school. It is possible to have the interest capitalized (instead of paying the interest every three months, it is added back to the principal). This will increase the amount you have to repay. We suggest you pay the interest as it accumulates, as you’ll repay less in the long run.

You may be eligible for additional unsubsidized FSL funds (beyond the limits stated above) if your parent(s) apply for a Federal PLUS Loan and are denied. If this is the case, the maximum you may borrow annually in additional unsubsidized FSL funds based upon your year of study is as follows:
- first-year students $4,000; sophomores $4,000;
- juniors, seniors and fifth-year students $5,000.

The aggregate total (subsidized, unsubsidized and additional unsubsidized FSL combined) is $46,000 for undergraduate study; however, only $23,000 of this total can be in subsidized FSL funds.

Federal Entrance Loan Counseling

Federal regulations require that all first-time federal student loan borrowers complete an entrance counseling session prior to their Federal Student Loan funds being credited to their student accounts. During the entrance counseling session, you will be informed of your rights and responsibilities as a borrower.

CARNegie mellON will NOT process your federal Stafford loan uNTil you Complete the entrance counseling session.

Complete the loan counseling requirements electronically on our Federal Entrance Loan Counseling Website www.cmu.edu/hub. Follow the instructions, answer the questions and complete the appropriate electronic submission form. We recommend that you print a copy of the “Rights and Responsibilities Checklist.”

Prior to the form appearing in the browser, you will need to log into the server by entering your Andrew UserID and Password. Use Netscape Navigator version 4.0 or newer or Microsoft Internet Explorer version 4.0 or newer. America Online's browser will not work. If you have questions regarding your account information, please contact Computing Services at 412-268-4357.

Federal PLUS Loan

A Federal PLUS Loan is a non-need-based loan given by a private lender (e.g., bank, credit union or other financial institution) to creditworthy parent(s). The interest rate is variable and is set annually on July 1. The interest rate cannot exceed 9 percent. Repayment of principal and interest begins 60 days after the last disbursement for the loan period and the maximum repayment period is 10 years.

Parent(s) may apply for a Federal PLUS Loan for up to the annual cost of attendance minus any financial aid. Approval for this loan and the amount a parent is eligible to borrow is determined by the lender. If the Federal PLUS Loan is not approved by the lender, the student may borrow additional unsubsidized FSL funds (see Unsubsidized Federal Stafford Loan).
If the Federal PLUS Loan is approved by the lender, insurance and guarantee fees (2 to 3 percent) are deducted from the loan proceeds each semester before being sent to Carnegie Mellon. The proceeds will be sent to us via electronic funds transfer (EFT) or by check. If the funds are disbursed via EFT, they will be electronically deposited into your student account at Carnegie Mellon. If the funds are sent to us by check (made co-payable to your parent and Carnegie Mellon), Enrollment Services will send the check to your parent to be endorsed and returned to Enrollment Services to be deposited into your student account at Carnegie Mellon.

All parents wishing to borrow a Federal PLUS Loan for the first time are required to complete a Federal PLUS Master Promissory Note (MPN). If the parent who will be a first-time borrower of a Federal PLUS Loan has a U.S. Department of Education PIN, he or she may complete the Federal PLUS MPN online by visiting the AES Website www.aessuccess.org. Additional Information is available at www.cmu.edu/hub/plus_mpn.html.

Parents who previously borrowed through the Federal PLUS Loan Program and wish to reapply must complete the Federal PLUS pre-approval process at www.aessuccess.org.

Carnegie Mellon Gate Student Loan

Our Carnegie Mellon Gate Student Loan Program offers you a low interest rate, requires no payments during enrollment, and has a graduated repayment schedule. It is a supplemental student loan program. You are the borrower and you are not required to have a cosigner. You may be eligible to borrow an annual maximum of $10,000. You may access the information regarding the Carnegie Mellon Gate Student Loan Program on The HUB Website. Before considering the Carnegie Mellon Gate Loan, we encourage you and your parents to investigate borrowing through the subsidized and unsubsidized Federal Stafford Loan Programs and Federal PLUS Loan Program.

Student Employment

There are many student employment opportunities on campus, both need-based and non-need-based.

Federal Work-Study (FWS) is a need-based self-help award. If you have been awarded FWS, your FWS award is the total that you can earn during the academic year as a work-study student. Funds earned in the Federal Work Study Program are not credited to your student account.

If you have not been awarded FWS and wish to work on campus, there are positions available. Both need-based and non-need-based student employment positions are advertised on the Career Center’s web page: www.studentaffairs.cmu.edu/career.

All undergraduates who are employed by Carnegie Mellon complete timecards and are paid by check on a bi-weekly basis. Students have the option to have their pay direct deposited into a local checking or savings account.

Reserve Officer Training Corps (ROTC) Scholarships

Air Force ROTC

Type I Award: covers full tuition and fees. Type II Award: $15,000 annually. Type VIII Award: 80% of tuition. There is a book allowance of $510, and a monthly stipend ($250 - freshmen; $300 - sophomores; $350 - juniors; $400 - seniors). Stipends are calculated for 9 months for the Air Force because they use the University of Pittsburgh academic calendar.

Students on scholarship are required to attend AFROTC courses (for more information see page 82).

Army ROTC

Army ROTC offers four, three and two year full tuition and fee scholarships with additional annual allowances of $900 for books and a monthly stipend ($300 - freshmen; $350 - sophomores; $450 - juniors; $500 - seniors). Army stipends are calculated for 8 months using Aug. 30 to April 26.

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) 624-6197/6198/6199 (for more information see page 82).

Navy-Marine Corps ROTC

The NROTC offers four-, three- and two-year scholarships based on competitive national selection. The Navy pays for tuition and fees. There is an annual book allowance of $750, and a monthly stipend ($250 - freshmen; $300 - sophomores; $350 - juniors; $400 - seniors) with an additional transportation allowance. In addition, NROTC midshipmen receive full active duty pay and benefits while on summer training cruises. Navy stipends are based upon 9 months using the Carnegie Mellon calendar.

Special scholarships are available to minority students and students who are interested in careers as nuclear power officers. These special scholarships are available to students who have completed at least one term of academic college course work. See page 83 for more information.

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 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.

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 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 Scholarship and/or a State or Federal Grant

Outside scholarships do not affect Carnegie Mellon academic scholarships unless the total amount of grants and scholarships exceeds the total amount of tuition, fees, standard room and standard dining.

In the case of federal and state grants that were not included in our initial award, a dollar-for-dollar reduction of the need based institutional grant/scholarship funds will occur.

The first $6,000 you receive in outside grants/scholarships will not reduce your Carnegie Mellon gift aid. In some cases, self-help aid (loans and work study) will be adjusted. If you receive more than $6,000 annually in outside grants/scholarships, your need based Carnegie Mellon grants/scholarships will be reduced by one-half the value that exceeds $6,000.

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.

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.

Other Sources for Enrollment-Related Information

The HUB Website contains the most up-to-date enrollment related information for Carnegie Mellon students. It is accessible 24-hours a day at www.cmu.edu/hub.

Additionally, Enrollment Services publishes many different guides and brochures throughout the academic year in order to provide detailed information pertaining to financial assistance, student accounts and registration.

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. Extended hours may be offered during orientation week, and will be announced on The HUB Website.
University Policies

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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).
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, x8-5865.

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 $50 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, x8-2157.

Free Speech and Assembly and Controversial Speakers

Free Speech and Assembly Policy
Carnegie Mellon University, a private university chartered under the corporation laws of the Commonwealth of Pennsylvania, encourages freedom of speech, assembly and exchange of ideas. As a university sincerely espousing the philosophy of academic freedom, the university urges and supports its community’s desires and efforts to pursue these rights. All persons may distribute printed material, offer petitions for signature, make speeches and conduct other similar activities outside university buildings.

The only limits on these activities, within the law, are the rights of the members of the university community and the maintenance of the normal functioning of the university. To ensure this, any protest or demonstration must be of an orderly nature so that no acts or credible threats of violence occur and the normal, orderly operation of the university is not impeded; the protest or demonstration shall not infringe upon the rights or privileges of individuals not in sympathy with it. No activities that harm individuals, damage or deface property, block access to university buildings or disrupt classes will be permitted. The enforcement of these restrictions will not depend in any way on any subject matter involved in a protest or demonstration.

If such activity on this campus were to occur that is not responsibly conducted and is therefore disruptive, the university will attempt to deal with the disruption by internal means if at all possible. If such activity becomes destructive of property or threatens life or limb, the university may have to request immediate assistance from law enforcement officials outside the university.

Controversial Speakers
The following statement, abridged from a resolution by the Pittsburgh Council on Higher Education and adopted by the university Board of Trustees, establishes the principle governing the right of the university to invite speakers to address the campus community.

If men and women are to value freedom, they must experience it. If they are to learn to choose wisely, they must know what the choices are; and they must learn in an environment where no idea is unthink-able and where no alternative is withheld from their consideration.

The assumptions of freedom are that men and women will more often than not choose wisely from among the alternatives available to them and that the range of alternatives and their implications can be known fully only if men and women can express their thoughts freely.

When, as they will, speakers from within or from outside the campus challenge the moral, spiritual, economic or political consensus of the community, people are uneasy, disturbed and at times outraged. In times of crisis, this is particularly true. But freedom of thought and freedom of expression cannot be influenced by circumstances. They exist only if they are inviolable. They are not matters of convenience but of necessity. This is a part of the price of freedom.

For their part, colleges and universities must hold vital the students’ right to know. When so-called controversial speakers are invited to the campus by a recognized campus organization, they speak not because they have a right to be heard but because the students have a right to hear. It is the students’ right to hear that the university must defend if it is to serve its high function in society.

Contact
Questions about this policy or its intent should be directed to: Michael Murphy, Dean of Student Affairs, x8-2075.
• 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, x8-2157.

Related Policies and Procedures
The university complies with OSHA regulations regarding occupational exposure to blood-borne pathogens. Questions concerning these regulations should be directed to Environmental Health & Safety, x8-8182.

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 meaningfully assess risks, 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" of external use of major 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.

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 work. 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 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
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 courseware 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, unless 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 originally owns intellectual property created with 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 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 the 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 that contract or agreement either does not specify either 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 the 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:

1. 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.

2. 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 expertise 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. Amendments to this policy that constitutionally require a 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 for Enrollment, Carnegie Mellon University, 610 Warner Hall, Pittsburgh, PA 15213. The university will schedule a hearing no later than 45 days after your request.

How will the hearing be conducted?

• A university officer appointed by the Vice President for Enrollment, who is not affiliated with your enrolled college will conduct the hearing.
• You can 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,
• 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,
• degrees 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 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 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.

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 in violation of federal, state, or local laws or executive orders. However, in the judgment of the Carnegie Mellon Human Relations Commission, the Department of Defense 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 enrollment, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone (412) 268-2056.
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Student Activities Fee
By action of the Board of Trustees, a required Student Activities Fee in addition to tuition is charged to all undergraduate 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 bulletin board official.cmune-news.

Contact
Questions concerning this policy or its intent should be directed to the Office of the President, extension x8-2200.

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 TSB 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: TheHub, x8-8186.

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: TheHub, x88186.

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:

- Permanent grades assigned by the instructor will be recorded, after the last day of classes.
• 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 PlaidCa$h 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, x88186.

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 followed 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, x88186.

Financial Aid Policy Statement (See page 34)

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.

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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.

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.

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 www.cmu.edu/hub. 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 curriculums 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.

Statement on 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

Carnegie Mellon does not rank students by 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 will no longer 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.”

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, Incompletes 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/Withdraw 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).

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 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 only 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 online 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 TSB 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.
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 3.75) 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.

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 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.

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 beliefs 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:

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.

Any graduate student who has returned from leave of absence, or will return in the future, will be subject to the 4.33-point grading scale for all future semesters. These students will not have their past semester quality point averages recalculated at the time of their return.

* Subject to the below exception.

Contact

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

**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.

**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.

**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

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 School/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).
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.

**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, 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.
- 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.

**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 enrollment, 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 enrollment or his designate.

**Contact**

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

**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 GPA. 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.

**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:
Non-Native English Speakers

Level of English Fluency Needed for Non-Native English Speakers

To be successful at Carnegie Mellon University, students who are non-native 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 Tademy, Director (412) 268-2012
et19@andrew.cmu.edu

Larry Powell, EOS Manager (412) 268-2013
lpowell@andrew.cmu.edu,

Courtney Bryant, EOS Administrative Coordinator (412) 268-2013 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.

Leadership Development

CMARC seeks to prepare students to make a long term, positive impact in their communities and workplaces. Advisors provide a variety of experiences that educate and train students in decision making and effective leadership principles. Service learning opportunities are also available.

Community Building

CMARC sponsors a host of activities that bring students together across all classes, disciplines, and cultures. This programming helps students personalize their experience and ties them into the fabric of Carnegie Mellon University. They also enable newcomers to acquire useful, informal networks with upper-class students. A prime example of CMARC’s community building efforts is Origins, a two day off-campus pre-orientation program for incoming first year students.

Computing Services

Joel Smith, Vice Provost Computing Services
Cyert Hall 283, x8-2649
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, public computer clusters, a computer repair shop and a computer store. 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 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/documentation/index_policies.html

Software and Account Services

Use the Carnegie Mellon web portal at http://my.cmu.edu to easily access 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 Council

The Student Advisory Council (SAC) meets monthly 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 their web site.
The Help Center
Cyert Hall 119, x8-HELP
www.cmu.edu/computing/support/
The Help Center technical staff answers questions related to computing at Carnegie Mellon. Consultants are available weekdays from 9:00 a.m. to 5:00 p.m. by phone, in person, or by sending e-mail to advisor@andrew.cmu.edu. The Help Center also handles computer account issues; a complete account directory is available at www.cmu.edu/directory/.

Information Security Office
Cyert Hall, x8-8556
www.cmu.edu/computing/security/
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
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 Multime-dia Studio located in the College of Fine Arts building. The Multimedia Studio provides students with the multime-dia 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, x8-6500
www.cmu.edu/computing/telecom/
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.

Computer Store
University Center lower level, in the Bookstore x8-2636
www.cmu.edu/computing/store/
The Computer Store offers a variety of hardware and software with a focus on the needs and requirements of the university computing environment. Hardware and educational software is available to faculty, staff, and students with a valid Carnegie Mellon ID card. The store also maintains a stock of computing peripherals supplies, and they can order other supplies for you. The store accepts check, cash, departmental charge, Campus Express, MasterCard and Visa.

Computer Maintenance Group
Cyert Hall A-101, x8-2661
www.cmu.edu/computing/cmg/
The Computer Maintenance Group (CMG) offers computer repair services for desktops, laptops and a wide range of other products. CMG accepts check, cash, department charge, MasterCard or Visa.

For More Information
A comprehensive collection of computing documentation is available on line at www.cmu.edu/computing/ documentation/.

Division of Student Affairs
Michael C. Murphy, Dean of Student Affairs
Warner Hall 301
The Division of Student Affairs coordinates student services and orchestrates the metacurricular life of the campus. The operation is focused on a broad-based system focusing on the intellectual, occupational, emotional, spiritual, physical and cultural growth and nurturing of students.

With primary emphasis on the development of the entire student, the division includes the following departments:

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

Departments within the division strive not only to meet specific student needs, but to provide general student direction and guidance, including referral to resources available both within and outside the university. The division places particular emphasis on developing community and integrating various constituencies to expedite student growth, including faculty, staff, alumni, parents, trustees, and members of the broader local, national and international communities.

The division holds as its ambition that each student reaches his or her highest potential in the areas of intellectual and artistic endeavor, personal and professional skill development, leadership development, and contribution to the larger community.

The staff throughout the division are here to help undergraduate and graduate students. We care about you, your studies, your social growth, your well-being and your future. We want to help you enjoy a great Carnegie Mellon experience.

Career Center
Paul Fowler, Director and Associate Dean of Student Affairs
University Center Lower Level, 8-2064
The thoughtful selection of a satisfying career path and the subsequent preparation needed to attain this goal are two prime concerns for most of today’s students during their university experience. Therefore, it becomes a key responsibility for institutions of higher learning to be responsive to this and to offer career development and job-search programs which are of the highest quality, comprehensive in their scope, and uniquely designed to meet the needs of their students. Carnegie Mellon has long demonstrated the importance of this segment of a young person’s development by maintaining an office charged with that responsibility since the earliest years of the university.

The range of services currently offered by the Career Center includes workshops and seminars designed to equip students with important career exploration and career decision making skills, individual advising and the availability of state of the art interactive computer based career interest inventory and other professionally administered techniques to aid in this process. A career consultant works with the students and faculty in each college to provide targeted programming and individual advising that meet the specific needs of students within each college.

A very important resource available in the Career Center is the career library collection which features an extensive assortment of electronic and paper materials on career planning and career choice, occupational monographs, job vacancy listings, business and professional directories, graduate study directories and employer information featuring the leading firms in the nation. Students regularly use this information as they consider their choice of an occupation, career or profession or as they are actively engaged in the search for summer internships, part time campus employment or that first job after graduation.

Because the name of Carnegie Mellon has come to be regarded as synonymous with the highest qualities of scholarship, research and artistic endeavor, employers of all types see the university as the source of some of the most able and talented graduates in the nation. During the past year, approximately 600 firms sent...
representatives to the campus to meet with interested internship and full-time job candidates. This represents over 1500 interview schedules and approximately 10,000 individual interviews over the course of the academic year. Average starting salaries offered to Carnegie Mellon graduates in most fields consistently rank above national norms.

**Recruiting Policy**
All organizations are given equal access to recruit on campus by the Career Center. Organizations are advised of Carnegie Mellon’s Statement of Assurance and are required to submit a copy of their non-discrimination policy. They are also required to complete a Career Center information form that includes questions about the organization’s hiring policies pertaining to citizenship requirements, drug testing and sexual orientation.

**Counseling and Psychological Services**
Cynthia Valley, Director
Morewood Gardens E-Tower, x8-2922

Counseling provides students with an opportunity to talk about personal, career or academic concerns. Students go to the Counseling Center for a variety of reasons: problems with friends, family or school; confusion about future goals; feelings of stress, low self-esteem, anxiety, depression or loneliness; substance abuse and eating disorders. Counselors at the center are good people to talk to when you have any kind of concern. The center offers individual and group psychotherapy, crisis intervention, and psychiatric consultation.

Counseling sessions are free and confidential. Students who have personal concerns or concerns about others are encouraged to contact the center for assistance. The Counseling and Psychological Services center office is open weekdays, and there is a professional on call for emergencies during evenings and on weekends.

**Health Services**
Anita Barkin, Director
Morewood Gardens E101, x8-2157

Health Services provides general medical care, gynecological care and contraception, allergy injections, first aid and on-site pharmaceuticals. Appointments to see the physician, nurse practitioners and registered nurses can be scheduled by calling the office Monday through Saturday during normal operating hours. Walk-in emergency appointments are also provided.

Examinations for illness and injury are free of charge, however, fees for laboratory tests, diagnostic procedures and referral to the emergency room or specialists are the responsibility of the student. There may be a fee for medication. Entering students are asked to submit the health history form found in the admission packet. Immunization must be completed on the back of the form. Several immunizations are required for full matriculation to the university. If a student has a medical emergency when the office is closed, he/she can call campus security at x8-2323 for transport to an emergency room, or call the Health Services to page the physician on call.

**Health Insurance**
The university requires students to carry adequate medical insurance. All students are charged for basic coverage under the university plan. Students are required to take one of three actions: 1) pay for the basic plan as charged on the student account or 2) enroll in one of the enhanced benefit options or 3) complete the waiver form indicating that the student is already covered under another plan. In order to qualify for a waiver from the student insurance program, the student must be listed as the principle, spouse or dependent in a government or employer-sponsored plan that meets certain criteria for coverage. The charge for the basic plan will be removed if, and only if, the plan qualifies. Individually purchased plans are not accepted. Questions can be addressed to shinsure@andrew.cmu.edu

**Office of the Dean of Student Affairs**
Michael Murphy, Dean of Student Affairs
Warner Hall 301, x8-2075

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. The Office of the Dean of Student Affairs provides central guidance and direction of student services at Carnegie Mellon by coordinating divisional and student life assessment efforts and facilitating interdepartmental interaction. Staff in the office of the dean serve as housefellows to five residential areas and coordinate specific initiatives that promote leadership development; multicultural, gender, and GLBT awareness; and promote community involvement.

While students are encouraged to seek out any member of the division for help, you may also meet with the dean or associate dean directly by contacting 268-2075 and scheduling an appointment at your convenience.

**Office of the Assistant Dean**
Wendy S. Hermann, Associate Dean of Student Affairs
Morewood Gardens A-Tower, B-9510

The Office of the Assistant Dean works in partnership with multiple offices in and out of the Division of Student Affairs to serve and support the international experience of Carnegie Mellon students. The focus of the office centers on being a residential liaison through the participation in the Housefellow Program as well as a non-residential liaison in terms of student organization advising. Other key areas include, service learning and community partnerships, initiatives in artistic and intellectual development and programs designed for personal and professional development.

Programs housed in the Office of the Assistant Dean include:
- The University Lecture Series
- Arts Pass Program
- Alternative Spring Break
- Dimensions Workshops

Contacts in the Office of the Assistant Dean include:
- Housefellows for Morewood A&B, C&D, E-Tower
- Advising for SDC
- Advising for Underground Programming
- Advising for the First Year Service Initiative (FYSI)

**Office of International Education**
Lisa Krien, Director of International Education
Warner Hall, 3rd Floor, x8-5231

The Office of International Education (OIE) serves three main groups: foreign students, foreign scholars, and all students who would like to study abroad. OIE also plays a prime role in Carnegie Mellon’s effort to internationalize the campus.

**Service to Foreign Students**
- Advising for the First Year Service Initiative (FYSI)
- Advising for SDC
- Advising for Underground Programming
- Advising for the First Year Service Initiative (FYSI)

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**Service to Foreign Scholars**
- Advising for the First Year Service Initiative (FYSI)
- Advising for SDC
- Advising for Underground Programming
- Advising for the First Year Service Initiative (FYSI)

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Study Abroad
www.cmu.edu/studyabroad

OIE offers information and support to all students interested in studying abroad. Students start the process by learning about their options at an information session or individual appointment. Once a student has identified a program, they will work closely with their academic advisor to make sure the study abroad program suits their curricular needs. Most applications are due the semester before a student plan to go abroad. Once accepted, students attend a pre-departure orientation to receive important information on registering for study abroad, health and safety and crossing cultures. OIE welcomes students back from their study abroad experience with a reception in the fall and an information welcome-back orientation each semester. For more detailed information on Carnegie Mellon’s study abroad program, see the "Undergraduate Options" section of this catalog.

Office of Orientation and First Year Programs
Anne R. Witchner, Assistant Dean of Student Affairs
Morewood Gardens 1B8, 8-4887

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, parent’s programming such as Family Weekend, freshman programming series, and special event planning.

Office of Student Activities
John Hannon, Director of Student Activities
University Center 103, x8-8704

The Division of Student Affairs centers its support of campus activities through the Office of Student Activities in the University Center. Students are encouraged to pursue extracurricular interests which will give them an opportunity to meet other students, become familiar with the university, have fun, learn a skill or make the campus and the community a better place.

Student Activities is committed to assisting student-run organizations on campus and provides advising, support, and leadership training for the student organizations that exist at Carnegie Mellon. The Office of Student Activities also works to ensure that students have an opportunity to broaden their social, spiritual, physical, intellectual, and cultural understanding by means of an extensive series of programs designed to complement curricular learning opportunities.

The student activities fee, administered by the Student Government, provides funding for a wide range of extracurricular activities. The Activities Board is responsible for bringing a variety of programs to campus, including concerts, lectures, films, as well as planning coffeeshouses and dances. Students using the resources provided by the student activities fee have sponsored many activities including ultimate frisbee, a robotics club, an art gallery, a newspaper and an FM radio station. Students have also formed special interest groups dealing with leisure recreation activities as varied as skiing, amateur exploring, karate and ham radio. Still other student-designed activities provide for the needs and interests of the student body.

The university has always encouraged the formation of new student organizations, clubs or activities to meet newly identified needs. Student Government has been eager to support both financially and with its organizational resources a wide variety of experiences important to the self-development of students.

Student Life Office
Renee Camerlengo, Director of Student Life
Office: Morewood Gardens, A-Tower, x8-2142

The Student Life Office strives to foster the development of residential communities that offer meaningful and diverse experiences in support of students achieving their full academic, personal and professional potential at Carnegie Mellon and beyond. In collaboration with other divisional staff, Student Life is responsible for the resident advisors and community advisors that lead the house communities and can connect students with the team responsible for their specific living area.

Carnegie Mellon is proud to have 13 national fraternities, four national sororities, one private sorority and four colonies as part of our community which is advised by Student Life. Carnegie Mellon Greek organizations are dedicated to academic achievement, service to the community, leadership development, and the cultivation of friendships. Membership in each chapter reflects the diversity on our campus as Greeks have a variety of majors and interests, and come from all geographic locations.

The Student Life Office also coordinates the community standard process. Working with individual students, groups and all of our buildings have ethernet or broadband service for fast data connectivity. Items such as pillows, linens, area rugs, telephones, etc., are the student’s responsibility.

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, telephones, etc., are the student's responsibility.

Room Rates

Room rates include utilities, maintenance, campus and local phone service, a cable TV jack and Ethernet/broadband connection in each room, apartment, or house. Students pay separately for room and public area damages and for toll and long distance telephone usage. (Campus and local calls - within the immediate area - are free. Students pay for all other calls by using their personal authorization code provided by the MobileSphere program.)

Residence Hall Rooms

Room Types

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

**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. Financial Aid budgets are based on standard double room rates. It is important for those who are not assigned to this type accommodation to be aware of this fact. 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.

**Community Housing**
The Office of Housing and Dining Services in Morewood Gardens provides an off-campus housing registry service. This community housing 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 services are also offered that assist customers in finding a new home and provide guidance through all the processes that accompany it.

Since accommodations in the campus residence system 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.housing.cmu.edu/](http://www.housing.cmu.edu/).

**Housing Reservations**
**Returning Student Room Selection (Room Draw)**
Each spring returning resident students will have an opportunity to reserve spaces in university housing on a seniority basis through the Room Draw process that takes place in 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 unless their dates of deposit are too far apart.

Room assignments for first-year students will be 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.

**Roommate Matching Procedures**
A number of factors are taken into account when we make roommate assignments, including preference for a special residential program, specific hall or room type, smoking status, a 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**
Students are required to complete, sign and return the Housing License Agreement with their housing application. The Housing License Agreement states the terms and conditions of occupancy by which the student and the university intend to be legally bound. Housing and Dining Services advises students, parents and guardians to read the agreement thoroughly before being signed and returned. The Housing License Agreement is for two full terms, beginning with the fall semester.

The upper-class student submission and signing of the Housing License Agreement takes place online and involves an electronic signature via university email authentication. Should a returning student decide to select a room for any year past the first year living on campus, the student’s official signature from their first-year Housing License Agreement will be kept on file.

**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 Terms and Conditions**
The Housing License Agreement is a binding document and 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 University advises the student and parents or guardians to read the Agreement carefully before signing and returning it to the Office of Housing and Dining Services. THE HOUSING LICENSE AGREEMENT IS FOR TWO FULL TERMS, BEGINNING WITH THE FALL SEMESTER.

**Housing Charges**
The housing room charge is billed in three separate amounts. After charging and crediting the housing deposit, the University bills students for the balance of their academic year housing charges in two separate amounts, one each semester.
Refund Policy: As a rule, a student who signs a Housing License Agreement for the academic year may not receive any refund for withdrawing from university housing before the end of the entire two-term period or other dates specified in the agreement, except for reasons of marriage, verified departure from the university or the application of special provisions and refund amounts based on sorority or fraternity membership (based upon negotiated leases). 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.

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.housing.cmu.edu.

Dining Services
Carnegie Mellon Housing and Dining Services offers students a medley of campus dining choices. Several components are combined to provide the highest quality of food, service and convenience to our students.

Casual Dining Program
The following dining locations are available to our students throughout the campus.

Andy's Estery (University Center, Lower Level) - Specialty wraps, coffee and coffee drinks, large selection of fresh fruit smoothies and a variety of breakfast treats.

Asiana (Newell-Simon Atrium) - Asiana offers Chinese and Pacific Rim entrees and soups, from fresh hot foods to fresh ready-to-go items.

Barista Cafe (University Center, Upper Level) - Coffee brewed from freshly ground beans, tea, juices, fresh pastries baked in house daily and other breakfast items.

Bento Bowl (University Center, Upper Level) - Our unique Bento Bowl offers traditional Asian cuisine prepared by our chefs with authentic sauces and oils.

East Street Deli (University Center, Upper Level) - Freshly sliced deli meats, cheeses, and freshly prepared vegetarian selections on fresh-baked breads and rolls.

Ginger’s Deli (Baker Hall, Posner Hall and Purnell Center) - Custom deli sandwiches and salads, soups and hot entrees.

Kosher Korner (University Center, Upper Level) - Carnegie Mellon teams up with Hillel and the Jewish Association in Aging to provide kosher meals each as certified by the Vaad Horabanim of Greater Pittsburgh. A variety of entrees, snacks and a complete kosher salad bar are available each day.

La Prima Espresso (Wean Hall) - Espresso, cappuccino, Italian pastries, focaccia bread, soups and sandwiches are the delights you will find at La Prima.

Mitchell’s Mainstreet Marketplace (Newell-Simon Atrium) Coffees, soups, salads, sandwiches, pizza and hot entrees.

On-the-Go (University Center, Upper Level) - The main dining gallery coolers contain fresh salads, vegetarian meals, sandwiches, bottles beverages, convenience items and nutritious snacks, all ready to purchase and take with you on-the-go.

Penne’s International Market (University Center, Upper Level) - International specialty items, salads, soups, and home-style cooking that range from Middle-Eastern, to Asian, to home-style American favorites all in one day.

Pepperazzi (University Center, Upper Level) - The ultimate in fresh-dough pizza and pasta, prepared each day with the finest ingredients using classic Italian recipes. Don’t forget to sample our hot-roasted, farm-sourced vegetables. All of these items are made fresh every day for our guests.

Schatz Dining Room (University Center, Upper Level) - The Schatz Dining Room offers a full service all-you-can-eat breakfast buffet for the campus community Monday through Friday, an all-you-can-eat brunch on Saturday and Sunday, and an all-you-can-eat dinner Monday through Thursday. Schatz offers gourmet meals in block and a la carte form, a salad bar, daily grill features and many special theme dinners throughout the academic year.

Showcase Salads (University Center, Upper Level)
The Farm-source program is the basis for our showcase salads. This salad bar is stocked full with a vast variety of fresh vegetables (including organic where appropriate), fruits, and other delectable ingredients to top off any salad. Our chefs have created an extensive collection of enticing entreé salads that are sure to please you. To complement your salad is a selection of homemade hot soups and fresh-baked breads.

SI Senor (University Level, Main Floor)
Made-to-order Mexican cuisine, wraps, tacos, and quesadillas.

Skibo Coffeehouse (University Center, Upper Level)
Come check out the coolest hangout on campus! House specialties include a variety of coffee, espresso, sundaes, gourmet sandwiches and a large selection of vegan products. Skibo coffeehouse offers weekly entertainment including band night and open-mic nights.

Sushi Two (University Center, Upper Level)
Fresh sushi is created daily by our expert sushi chef. Sushi-to-go is also offered in the cooler at On-the-Go.

Taste of India (Resnik House)
Indian cuisine including Tandoori chicken and other traditional favorites.

The Underground (Morewood Gardens)
The Underground is located beneath the Cyert Center for Early Education in the Morewood Gardens complex. Follow the stairs down to The Underground for a great meal, some pool or pinball, or catch the latest sports on the big screen TV. Food is provided by Gullifty’s, known throughout the Pittsburgh area for their great soups, sandwiches and desserts.

The Zebra Lounge (College of Fine Arts) - The coffeehouse shares space with an art gallery, with shows changing regularly. The Zebra Lounge is an excellent space to show off your artistic talents, vocally, musically or theatrically. This unique coffeehouse is great for a quick snack or to settle in and study for the afternoon. The Zebra Lounge features fair trade and organic coffees and teas.

Vending Services
Vending Services occupy a number of locations on campus. From this 24-hour service, students may choose entrees, “Healthy Choice” lunch meals, soup, coffee, assorted beverages and snacks.

Dining Plans
A variety of dining plan options are offered to the students. Participation in the Carnegie Mellon dining Plan offers convenience, value and variety. All dining plans are encoded on the Carnegie Mellon ID+ Card. Contact Housing and Dining Services at 412-268-2139 or platedandrew.cmu.edu.
Academic Support Services

Academic Development Center
Linda Hooper, Director
Old Student Center 212, x-86878

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.

Major programs and services offered through Academic Development include:

- **Peer Tutoring** – Subject-specific tutoring geared primarily (but not exclusively) to introductory courses is available on both a walk-in and individual basis at select times.

- **Study Skills Instruction** – Students can register for group workshops or make one-on-one appointments to receive instruction on topics such as time management, test preparation, etc.

- **Supplemental Instruction (SI)** – The SI Program offers weekly review sessions that supplement regular course content for traditionally difficult subjects.

- **First Year Success Series** – This on-line series provides practical advice from Carnegie Mellon students and faculty about many of the new challenges that first-year students face during their first few weeks of college.

- **Fast Facts** - These pamphlets cover a variety of topics related to academic success ranging from fighting test anxiety to preparing for exams.

Teaching Certification

Carnegie Mellon students interested in secondary school teaching 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 College to earn the MAT and Pennsylvania Teacher Certification. To make this program possible, interested undergraduate students should plan to cross register at Chatham for 72 units of required courses, using elective spaces in their schedule.

Criteria for admission or the MAT program includes: An overall GPA of 3.0, and completion of three pre-professional Praxis exams in Reading, Writing and Mathematics. All candidates for initial certification in Pennsylvania must have earned at least a baccalaureate degree, completed an approved program of teacher education, and passed The Praxis content tests for their certification area. For more information about Praxis exams, www.ets.org/praxis.

To plan early, contact Judith Hallinen, Director, Center for School Outreach, 8-1498.

Intercultural Communication Center
Peggy Heidish, Director
Office: Warner Hall 308, 412-268-4979
eshelp@andrew.cmu.edu

The Intercultural Communication Center is a support service offering 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**: Designed to help students with their academic writing assignments -- this includes support with reading and interpreting source texts
- **Seminars and Workshops**: such as Presentation Skills, Citing Sources, Improving Scientific Writing and Reading Strategies
- **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 nonnative English speaker (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

Fellowship Resource Advising Center
Stephanie Wallach, Director
Judy Zang, Scholarship Coordinator
www.cmu.edu/frac

Students at Carnegie Mellon are encouraged to apply for a number of prestigious national and international fellowships. Each of these provides an opportunity to become part of a new community of scholars and opens doors throughout your career. The Morrise K. Udall Foundation Scholarships. The Harry S. Truman Scholarship, the Barry M. Goldwater Scholarship, the Rhodes Scholarship, the Marshall Scholarship and the Fulbright Grant are examples of these prestigious awards.

The Fellowship Resource Advising Center also provides information about other scholarships of all kinds, and works closely with students and faculty to help put together a truly competitive application.

Visit the FRAC website to receive information and updates about scholarships and fellowships that are relevant to you. The website also contains links to many other resources which provide 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 and one program (College of Humanities and Social Sciences, Mellon College of Science, School of Computer Science, and Bachelor of Humanities and Arts program) 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 249 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.

The society’s name is formed by the first letters of the phrase Philosophy 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.
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 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 Krateito Photon, “Let the love of wisdom rule humanity.” Phi Kappa Phi recognizes and honors persons of good character who have excelled in scholarship, in any field. 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 percent of their class and juniors must be in the top five percent. Graduate students, alumni, faculty and staff are also eligible for nomination. The chapter inducts new members twice a year and provides information to its members on all sorts of opportunities, including study abroad, internships, and national scholarships, recognition and awards.

Undergraduate Research Office
Stephanie Wallach, Director
Lisa Everett, Program Manager
www.cmu.edu/uro

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. In addition to the programs listed in this brochure, the Office provides one-on-one advising and information services, from help with locating faculty mentors to reviewing grant proposals and applying to professional conferences.

All undergraduate students conducting research with a faculty advisor are eligible to participate in the Undergraduate Research Office. The term ‘research’ is defined broadly to mean "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.

Advising and Information Services
The Director of the Undergraduate Research Office is available to help students locate faculty advisors, discuss project ideas, locate possible funding sources, and generally facilitate the research process. The Office also maintains the electronic b'board "official.research.undergrad" and a website (www.cmu.edu/uro) with information about how to apply for grants, abstracts of current and previous undergraduate research, and links to helpful resources.

Small Undergraduate Research Grants
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. 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 in March for the Summer and Fall grant periods and October for the Spring grant period.

Undergraduate Research Symposium
The Undergraduate Research Symposium provides an opportunity for students to share the findings of their research projects through poster, oral and artistic presentations. This “Meeting of the Minds” is held annually on the spring reading day during finals.

Undergraduate Research Seminar Series
This series provides students with timely information and discussion opportunities on topics such as “Ethics in Research,” “Preparing for a Presentation” and “Intellectual Property Rights.”

Summer Fellowship Program
Summer Fellowships provide full stipend support for students conducting research on campus during the summer months in close collaboration with a faculty advisor. Fellowships provide a $3,000 stipend for ten weeks of full-time research. Students may also apply for a SURG grant to cover the costs of materials and supplies. The deadline for submission of proposals coincides with the regular SURG grant deadline in mid-March.

Presentation Awards
Students whose work has been accepted for presentation at an academic conference are eligible to apply for a Presentation Award. Awards are made each semester on a first-come basis to help defray the costs of conference registration, transportation, and accommodations. Students may apply for up to 75% (to a maximum of $350) of the total cost of attending the conference.

Intel First Year Research Experience (IFYRE)
Work-study eligible first year students in technical disciplines can be placed in faculty labs to get an early taste of the excitement and benefits of undergraduate research.

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 on a full NCAA basketball court (or play volleyball!)• 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 and cross-country ski machines
• Take an aerobics class—there are plenty to choose from.
If you overdo it, the locker rooms have jacuzzis to soothe those muscles.

Eating at the University Center
We’ve brought in several outside vendors to offer a variety of dining options:

• Andy’s Eatery
• Barista Cafe
• Bento Bowl
• East Street Deli
• Kosher Korner
• On-the-Go
• Penne’s International Market
• Pepperazzi
• Schatz Dining Room
• Si Senor
• Skibo Coffeehouse
• Sushi Two

Shopping at the University Center
Carnegie Mellon’s retail stores are in the University Center. These include the Art Supply Store, the Textbook Shoppe, the University Shoppe, a multi-level retail facility for art/engineering supplies and tools, books, clothing and memorabilia and Entropy, a convenience store.

The building houses student organization offices, activity space and a gameroom. The first floor of the building includes staff offices, a gallery/exhibit area, a multi-denominational chapel and an alumni lounge, which is open to all members of the university community.

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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: Chief Creig W. Doyle
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. 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 www.library.cmu.edu/.

Services in each of the libraries enable you to locate, obtain and use information. Reference service helps you to select resources and find the information you need. If you need materials that we do not own, interlibrary loan service will help you to obtain them. Circulation service helps you to borrow and renew materials, and to use course reserves (items that faculty have set aside in the library for their classes to use).

The University Libraries also house several unique collections, including the Architecture Archives (architecture in the western Pennsylvania region), the H. John Heinz III Archives, the Allen Newell Collection, the Herbert Simon Collection, and the University Archives (history of the university). The Fine and Rare Books collection includes exceptional materials in literature, the arts, the history of science and other subjects. The Posner Center, located between the College of Fine Arts and Tepper School of Business, houses the Posner Family Collection of rare books and artifacts.

Library Catalog and Other Online Access
The library catalog (Cameo) provides access to all of the Carnegie Mellon library collections. Use Cameo to find out where materials are located in libraries on campus, and whether they are checked out, on reserve, or available to be borrowed. Cameo’s self service features are also handy. For example, click “User Self Service” and “Library Account Information” to see a list of the items that you have checked out and whether you owe any fines. Click “User Self Service” and “Renew Items” to extend your loans and avoid overdue fines.

You can access many resources and services from the University Libraries’ home page. For instance:

- "Databases” index and describe specific information located in various sources. Some databases include full-text.
- "Full-text Collections” put articles, proceedings, archives and media on your desktop 24/7.
- "Ask A Librarian” (chat, email or phone) is an interactive reference service staffed by Carnegie Mellon librarians.
- "Research Help” pages direct you to key resources in your subject area, including the Carnegie Mellon librarian who is a subject specialist for your field.
- "What’s New” items inform you about new library resources, events, and workshops.

From our home page, you can also use the 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 request courier service to deliver items to campus, or you can get library cards and borrow directly from these nearby libraries.

Instruction and Help
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 when you are in the library, reference staff also can show you how to use online resources effectively from outside the library.

If you need specialized reference help, contact the librarian for your subject area. Librarians work directly with the faculty and students in each school, department and institute at Carnegie Mellon to build useful collections and assist 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 the library job opportunities for student assistants at www.library.cmu.edu and apply.
# Undergraduate Options

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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 Mellon University 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 courses 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 School of Public Policy and Management

The Heinz School'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, TSB offers an accelerated B.S./M.S. program in Economics.

Health Professions Program

Director: Amy L. Burkert, 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
   03-130 Biology of Organisms
   03-124 Modern Biology Lab
   or:
   03-343 Experimental Genetics and Molecular Biology

2. One year of general chemistry with lab.
   This is typically fulfilled by the following Carnegie Mellon courses:
   09-105 Introduction to Modern Chemistry
   09-106 Modern Chemistry II
   09-221 Lab I: Introduction to Chemical Analysis

3. One year of organic chemistry with lab.
   This is typically fulfilled by the following Carnegie Mellon courses:
   09-217 Organic Chemistry I
   09-218 Organic Chemistry II
   09-222 Lab II: Organic Synthesis and Analysis

4. One year of physics with lab.
   This is typically fulfilled by the following Carnegie Mellon courses:
   33-106/111 Physics I (for science or engineering students)
   33-106/112 Physics II (for science or engineering students)
   33-100 Basic Experimental Physics

5. One year of English.
   This is typically fulfilled by the following Carnegie Mellon courses:
   76-101 Interpretation and Argument
   76-xxx English course of the student's choice, typically 200-level or higher
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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 School of Public Policy and Management

The Heinz School’s Accelerated Masters program allows qualified undergraduates 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, TSB offers an accelerated B.S./M.S. program in Economics.

Health Professions Program

Director: Amy L. Burkert, 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
03-130 Biology of Organisms
03-124 Modern Biology Lab
or
03-343 Experimental Genetics and Molecular Biology

2. One year of general chemistry with lab.
This is typically fulfilled by the following Carnegie Mellon courses:
09-106 Modern Chemistry II
09-221 Lab I: Introduction to Chemical Analysis

3. One year of organic chemistry with lab.
This is typically fulfilled by the following Carnegie Mellon courses:
09-217 Organic Chemistry I
09-218 Organic Chemistry II
09-222 Lab II: Organic Synthesis and Analysis

4. One year of physics with lab.
This is typically fulfilled by the following Carnegie Mellon courses:
33-106/111 Physics I (for science or engineering students)
33-106/112 Physics II (for science or engineering students)
33-100 Basic Experimental Physics

5. One year of English.
This is typically fulfilled by the following Carnegie Mellon courses:
76-101 Interpretation and Argument
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-meds," 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 symposia, community outreach activities, and preceptorship/internship experiences are all part of our program. The student pre-health organization on campus, the Doctors of Carnegie (DOCs), together with the Health Professions Program, provide students with many opportunities to learn, explore and prepare for their chosen area of interest.

The Health Professions Program has been successful in helping students 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**

The following minors offer a secondary focus to the student’s major area of study. Unless otherwise indicated, minors are generally open to all university 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 School of Public Policy and Management, 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:**

- 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
Office: H&SS Academic Advisory Center, Baker Hall A57

"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 alternatives that should be conscientiously and intelligently 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 who are contemplating or actively seeking to enter law school and careers in the law. 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 careers in the law, 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:

1. early identification of "pre-law" candidates;
2. 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, and also to engage 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;
3. timely direction in designing and executing a well-planned law school research, selection and application strategy;
4. 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 in, and graduates of, the University. These components include periodic workshops and seminars, a Pre-Law Handbook, a pre-law library, and linkage through the Program Director with law school admissions offices, the Law School Admissions Services, and associations (both regional and national) of pre-law advisers. 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 adviser before the end of their junior year.

Study Abroad

Carnegie Mellon students from every major can study in virtually any part of the world for a semester, year or summer. 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 year.

The Study Abroad Advisor provides general information sessions as well as individual advising to assist students in the study abroad process. The Office of International Education (OIE) has a library of over 3,000 available programs as well as useful web links to help students to 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 schemes for study abroad and maintained all scholarships, grants and financial aid.

More detailed information can be found at www.cm.edu/studyabroad

Carnegie Mellon Offers a variety of options for study abroad, including:

University Exchange Programs

Carnegie Mellon University has a number of university-wide undergraduate 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. Currently University Exchange programs are offered in Switzerland, Mexico, Japan, Singapore, Chile, Israel, China and Australia.

Departmental Exchanges

Art, Design, Chemical Engineering, Materials Science and Engineering, and Business offer departmental exchange programs. Students should contact the department for additional information. Departmental exchanges are set up in the same way as university exchanges; students pay Carnegie Mellon tuition and receive their normal financial aid package. Students are responsible for room, board, travel and miscellaneous expenses.

Sponsored Study Abroad

The university has designated a few study abroad programs administered by other organizations or universities as sponsored programs. On these programs, students will pay a university fee equivalent to current tuition, room and board charges, and retain their eligibility for all financial aid. Carnegie Mellon will pay the program costs to the study abroad sponsor. Where applicable, funds are distributed to the student for room, board, travel, and personal expenses. Applications and information are available in OIE.

Currently we have sponsored programs in Australia, Botswana, Canada, China, England, France, Germany, Ghana, Ireland, Italy, Japan, the Netherlands, South Africa, and Spain.

Non-Carnegie Mellon 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, the student may participate. 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 for the relevant and full-year programs available. Information may be obtained in OIE.

Examples of programs that Carnegie Mellon students have attended are: AIFS, Arcadia University, Boston University, Butler University, Council, Cornell University, Institute for the International Education of Students (IES), Syracuse University DIS, Semester at Sea; as well as direct enrollment to international universities.

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). 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 adviser before the end of their junior year.

The requirements for successful completion of a University Student-Defined Major include a student proposal approved by an advisor, relevant college(s), and the Provost, and successful completion of the approved course of study. In brief:

- A student interested in pursuing a university student-defined major must develop a proposal which outlines an intellectually coherent area of study (with degree title) and a plan of study (courses to be taken, pedagogical rationale, proposed schedule). The proposal should include an explanation of why it is not appropriate or possible to pursue such a program through the curriculum of any one of the colleges. It should outline a program of study for both general education (for example, the core requirements of one of the most relevant colleges or equivalent general education plan) and major requirements. The proposal should designate one of the participating colleges as the defacto "home college" for tracking and verification purposes.

- The student's proposal must be approved by a faculty advisor 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 ensure 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 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 (TSB).

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, Physical Education & Recreation

Dr. Susan Bassett, Director of Athletics
Office: 204 Gymnasium

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 75 conference championships and competed in over 80 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 Bruin, 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 18 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 14 conference championships, has a string of 27 consecutive winning seasons, and has appeared in the NCAA Division III Championship playoffs four times. In 1979, Carnegie Mellon was awarded the Lambert Trophy as the best small college team in the northeast. The men’s cross-country team holds the NCAA Division III record with 109 consecutive dual meet victories. Women’s cross-country won the 1998 conference and placed 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 women’s tennis team has recently produced national ranked players in the NCAA competition. Both men’s and women’s swimming and track teams annually qualify a number of athletes for the national championships. Swimming recently has produced a national champion.

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 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) 268-2211

Intramurals/Club Sports

Michael Mastroianni, Director
Office: 101 Gymnasium

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 some 6,000 students. Men and women, both graduate and undergraduate, compete in one or more of over 40 indoor and outdoor sports, ranging from flag football and basketball to table tennis, water polo, and ultimate frisbee.

The Intramural Department is under staff direction, but four student-run organizations (the Intramural Board, the Managers’ Club, the Women’s Representatives and the Officials’ Club) govern the events. 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.

The following is a listing of the intramural sports offered by season:

**Fall**
- Flag Football
- Tennis
- Golf
- Co-Rec Volleyball
- Cross-Country
- Water Polo
- Chess
- Soccer
- Volleyball
- Bowling
- Racquetball
- Team Table Tennis
- Darts
- 3-Person Volleyball
- Foosball
- Team Call Pool
- Floor Hockey
- Spades

**Spring**
- Basketball
- Table Tennis-Singles
- Faculty/Grad. Volleyball
- Pinocchio
- Individual Call Pool
- Swimming
- Indoor Soccer
- Softball
- Co-Rec Softball
- Fencing
- Co-Rec Kickball
- Ultimate Frisbee
- Track
- Water Basketball
- Co-Rec Badminton
- Team Badminton
- 3-on-3 Basketball
- Foul Shooting
- 3-Point Basketball
- Pickleball
- Euchre

For a complete listing of club sports offered by season, please see http://www.cmu.edu/athletic/im_club/club.htm

**Fitness**

Donna Morosky, Director
Office: 102A Gymnasium

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 Health division provides educational services, programs, workshops and seminars. Programs include cardiorespiratory fitness, muscular strength, blood pressure and stress reduction. Workshops include the topics of nutrition, weight control, stress management and lower back care and prevention.
Recreation
Dr. Susan Bassett, Director
Office: 204 Gymnasium

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. Hours for recreational use of all facilities are subject to change during varsity sports seasons.

The Gymnasium, which has facilities for basketball, volleyball, badminton, racquetball, weight lifting, stairmasters and aerobicycling, is open Monday through Friday, as well as weekends. Located within our newly constructed University Center are facilities for squash, basketball, racquetball, volleyball, badminton, a diving pool and a large swimming pool for lap swim, aerobic cycles, stairmasters, treadmills, Nordic Tracks, Cybex machines, dumbbells, a sauna and a whirlpool. 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) 268-2211.

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.

Physical Education
Dr. Susan Bassett, Director
Office: 204 Gymnasium

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 20 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, and aerobic fitness. Carnegie Mellon also provides courses for American Red Cross certification in the four levels of swimming (beginners, intermediate, swimmers, and lifeguarding), and First Aid and Cardiopulmonary Resuscitation (CPR). Instruction is also provided in several team sports.
Reserve Officers’ Training Corps (ROTC)

Department of Aerospace Studies
(Air Force ROTC)

David S. Gillette, 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 U.S. 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 years, and is 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: Beliefield 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 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
30-101 Introduction to Military Leadership Fall
30-102 Foundations of Leadership Spring

Sophomore Year
30-201 Leadership Dynamics & Application Fall
30-202 Applications in Leadership & Combat Power Spring

Junior Year
30-301 Basic Leader Planning & Combat Operations Fall
30-302 Advanced Leadership Planning & Combat Operations Spring

Leadership Development & Assessment Course
(six-week required summer camp)
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 Reserve 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 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.

Faculty

JOHN N. BENDER, Lieutenant Colonel, Professor of Military Science — M.S., Long Island University; Carnegie Mellon, 2004 —.
CALMER R. BEESON, Major, Assistant Professor of Military Science - BA, Moravian College; Carnegie Mellon, 2006 —.
ROY C. NICKERSON, Captain; Assistant Professor of Military Science — B.A., Western Kentucky University; Carnegie Mellon, 2004—.

Department of Naval Science
(Naval ROTC)

Keith P. Bowman, Captain, U.S. Navy
Office: 4615 Forbes Avenue

The Department of Naval Science was established 16 December 1987.

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, 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, 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

The three or two year scholarship programs provide full tuition, fees, $750 for textbooks per year, uniforms and a $250 per month tax-free subsistence allowance to students during their freshman year. This scholarship is targeted for Technical majors ONLY. This program allows a person who has never applied for a NROTC scholarship in the past to be nominated for this scholarship. The nominee will have an answer within 5 working days from submission. 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.

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, uniforms, and during their junior and senior years a tax-free subsistence allowance of $350 and $400 respectively, per month. 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 two years. 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 military drill, physical fitness, and leadership are emphasized.

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.

Faculty

KEITH BOWMAN, Professor of Naval Science — B.S., United States Naval Academy; M.B.A., Rollins College; Carnegie Mellon, 2006—.

CHRIS GIBSON, Associate Professor of Naval Science — B.A., University of Washington; M.A., U.S. Air Force Air Command and Staff College; Carnegie Mellon, 2005—.

KYLE LACEY, Assistant Professor of Naval Science — B.S., University of Wisconsin; Carnegie Mellon, 2005—.

JOSHUA PETERSON, Assistant Professor of Naval Science — B.S., United States Naval Academy; Carnegie Mellon, 2005—.

JOSEPH THOMPSON, Assistant Professor of Naval Science — B.S., United States Naval Academy; Carnegie Mellon, 2006—.

Naval Professional Academic Courses (Naval Science Courses)

<table>
<thead>
<tr>
<th>Course #</th>
<th>Title</th>
<th>Year Taken</th>
<th>Required of</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-101</td>
<td>Introduction to Naval Science</td>
<td>Freshman</td>
<td>All</td>
<td>6</td>
</tr>
<tr>
<td>32-102</td>
<td>Sea Power and Maritime Affairs</td>
<td>Freshman</td>
<td>All</td>
<td>6</td>
</tr>
<tr>
<td>32-201</td>
<td>Leadership and Management</td>
<td>Sophomore</td>
<td>All</td>
<td>9</td>
</tr>
<tr>
<td>32-212</td>
<td>Navigation</td>
<td>Sophomore</td>
<td>Navy Option</td>
<td>9</td>
</tr>
<tr>
<td>32-310</td>
<td>Evolution of Warfare</td>
<td>Junior</td>
<td>Marine Option</td>
<td>9</td>
</tr>
<tr>
<td>32-311</td>
<td>Engineering</td>
<td>Junior</td>
<td>Navy Option</td>
<td>9</td>
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<tr>
<td>32-312</td>
<td>Weapons Systems</td>
<td>Junior</td>
<td>Navy Option</td>
<td>9</td>
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<tr>
<td>32-402</td>
<td>Leadership and Ethics</td>
<td>Senior</td>
<td>All</td>
<td>6</td>
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<tr>
<td>32-410</td>
<td>Amphibious Warfare</td>
<td>Senior</td>
<td>Marine Option</td>
<td>9</td>
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<tr>
<td>32-411</td>
<td>Naval Operations and Seamanship</td>
<td>Senior</td>
<td>Navy Option</td>
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<tr>
<td>32-100-400 Naval Laboratory</td>
<td>All</td>
<td>All</td>
<td>3</td>
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</table>
Bachelor of Humanities and Arts Degree Program

Sponsored by the College of Humanities and Social Sciences and the College of Fine Arts
Office: Margaret Morrison Carnegie Hall, Room 107
www.cmu.edu/interdisciplinary

Carnegie Mellon University offers an interdisciplinary degree that combines the strengths of the College of Fine Arts (CFA) and the College of Humanities and Social Sciences (H&SS). The intercollege degree, called the Bachelor of Humanities and Arts (BHA), offers depth of study in both the fine arts and the humanities, social and behavioral sciences. The BHA Degree Program enables a student to receive broader exposure to the humanities and liberal arts than is generally possible through a Bachelor of Fine Arts degree in CFA, while obtaining deeper and more substantial training in the fine arts than is generally possible through a Bachelor of Arts or Bachelor of Science degree in 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 BHA and BSA Programs. The director and associate director of the BHA and BSA 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.

Senior Project Course Option

The BHA Program offers a senior project option. The creation and completion of such a project can be an important, integrative and fulfilling capstone. It can also provide an academic goal for BHA "sub-seniors," as well as influence the development of the BHA Program as a distinguished scholarly and creative undergraduate student community.

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 H. John Heinz III School of Public Policy and Management. 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.

<table>
<thead>
<tr>
<th>BHA Curriculum</th>
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<tbody>
<tr>
<td>I. BHA General Education</td>
<td>84 units</td>
</tr>
<tr>
<td>II. H&amp;SS Concentration</td>
<td>54 units</td>
</tr>
<tr>
<td>III. CFA Concentration</td>
<td>108 units</td>
</tr>
<tr>
<td>IV. Free Electives</td>
<td>114 units</td>
</tr>
<tr>
<td>BHA Degree Requirements</td>
<td>360 units</td>
</tr>
</tbody>
</table>

I. BHA General Education (GenEd)

(10 courses, 84 units minimum)

BHA students are required to fulfill the following General Education requirements, an interdisciplinary seminar requirement, and a computing skills workshop.

- 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)
- BHA & BSA Integrative Seminar (1 course, 9 units, 62-190 required)
- University Requirement: Computing Skills Workshop (1 mini-course, 3 units, to be completed in first semester)

Communicating: Language and Interpretations (3 courses, complete 27 units minimum)

Courses in this category give special attention to the study of language as interpretation, expression and argument within and across multiple discourses. Students examine language for its internal logics and structures.

76-101 Interpretation and Argument - REQUIRED

If a score of 5 is obtained on the either English Advanced Placement examination, approved English substitutions at the 200 and 300 level are available.

Modern Languages - REQUIRED to complete two courses taught in a language offered by the Modern Language Department. A wide selection of courses are offered in Chinese, French, German, Italian, Japanese, Russian, and Spanish. Students must complete two courses in the same language. Languages taught at other institutions are also acceptable (with advisor approval).

Reflecting: Societies and Cultures (1 course, complete 9 units minimum)

This category emphasizes the study of history, society, and culture from local and global perspectives.

79-104 Introduction to World History - REQUIRED
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 from the following course options:

Mathematics
21-110 Problem Solving in Recreational Mathematics
21-111 Calculus I
21-112 Calculus II*
21-120 Differential and Integral Calculus
21-121 Integration and Differential Equations*
21-122 Integration, Differential Equations and Approximation*
21-123 Calculus of Approximations (5 units)*
21-127 Concepts of Mathematics
21-256 Multivariate Analysis and Approximation*
80-110 Nature of Mathematical Reasoning
80-211 Argon and Inquiry
80-226 Revolution in Science

Natural Science
03-121 Modern Biology
03-122 Organismic Botany*
03-125 Evolution and the History of Life*
03-130 Biology of Organisms*
03-231/332 Biochemistry I & II*
03-310 Introduction to Computational Biology*
03-330 The Biology of the Brain*
09-101 Introduction to Experimental Chemistry (3 units)
09-103 Atoms, Molecules and Chemical Change
09-104 Fundamental Aspects of Organic Chemistry/
Organic Synthesis
09-105 Introduction of Modern Chemistry I
09-106 Modern Chemistry II*
09-217 Organic Chemistry I*
33-102 Concepts of Modern Physics (non-major)
33-106 Physics I for Engineering Students*
33-107 Physics II for Engineering Students*
33-111/112 Physics I & II for Science Students*
33-114 Physics of Musical Sound
33-115 Energy and Environmental Issues
33-124 Introduction to Astronomy
33-211 Physics III: Modern Essentials*
33-213 Mini-Courses in Special Relativity* (4 units)
33-224 Stars, Galaxies, and the Universe*
99-230 Environmental Geology

Other Courses
05-291 Human-Computer Interaction for Non-Majors
05-413 Human Factors
06-100 Introduction to Chemical Engineering
12-090 Technology and the Environment
05-291 Human-Computer Interaction for Non-Majors*
05-413 Human Factors
06-100 Introduction to Chemical Engineering*
12-100 Introduction to Civil and Environmental Engineering
15-100 Introductory/Intermediate Programming
15-105 Principles of Computation
15-111 Intermediate/Advanced Programming
15-200 Advanced Programming/Practicum*
18-100 Introduction to Electrical & Computer Engineering*
19-100 Introduction Engineering & Public Policy*
24-101 Introduction to Mechanical Engineering*
27-100 Engineering Materials of the Future*
36-202 Statistical Methods*
36-310 Fundamentals of Statistical Modeling*
36-350 Data Mining*
42-101 Introduction to Biomedical Engineering
79-333 History of Biomedical Research
80-110 Nature of Mathematical Reasoning
80-210 Logic and Proofs
80-211 Arguments and Inquiry
80-212 Logic and Philosophical Analysis
80-220 Philosophy of Science
80-222 Measurement and Methodology
80-225 Birth of Modern Science
80-226 Revolution in Science
80-312 Philosophy of Mathematics
80-322 Philosophy of Physics
80-324 Philosophy of Biology
85-412 Cognitive Modeling*
85-419 Introduction to Parallel Distributed Processing*
88-110 Experiments with Economic Principles
88-251 Empirical Research Methods*

* co-requisites and/or prerequisite

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 - REQUIRED

12-090 Technology and the Environment
36-303 Sampling Surveys and Society*
73-100 Principles of Economics
73-150 Principles of Economics with Calculus*
79-212 Religion in American Society
79-337 Educational Policy in Historical Perspective
79-348 Objects of Value
80-130 Introduction to Ethics
80-136 Ethics and Public Policy
80-238 Critical Thinking
80-272 Philosophy of Social Science
80-273 Ethical Theory
80-275 Political Philosophy
80-276 Philosophy and the Law
80-241 Ethical Judgments in Professional Life
80-242 Conflict, Dispute Resolution
80-244 Bioethics, Management, Environment and Ethics
80-245 Medical Ethics
80-247 Health, Development and Human Rights
80-270 Philosophy of Mind
80-271 Philosophy and Psychology
80-305 Rational Choice (CL 88-356)
80-321 Causation and Social Policy
80-330 Research Ethics
80-341 Computers and Ethics
80-346 Value, Fact, and Policy
85-102 Introduction to Psychology
85-211 Cognitive Psychology
85-213 Human Information Processing and Artificial Intelligence
85-219 Biological Foundations of Behavior
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Personality
85-252 Abnormal Psychology
88-104 Decision Processes in American Political Institutions
88-120 Reason, Passion, and Cognition
88-220 Policy Analysis
88-307 Principles of Individual and Collective Irrationality
88-324 Electoral Systems and Processes
88-330 Political Economy of Inequality and Redistribution
88-343 Economics of Technological Change*
88-358 Policy Making Institutions*

* Indicates co-requisites and/or prerequisites required.

Integrative Seminar (1 course, 9 units)

This interdisciplinary seminar is designed for BHA and BSA students to be taken in the fall semester of their freshman or sophomore year. If necessary, this seminar can be substituted with another approved interdisciplinary course. This course is designed to create an environment for interdisciplinary learning and collaboration. It provides a forum for BHA and BSA freshmen/sophomores to discuss their own projects and begin collaborations with other students. BHA & BSA Integrative Seminar begins the connection of students within BHA and BSA to the interdisciplinary culture at Carnegie Mellon and beyond.

62-190 BHA & BSA Integrative Seminar - REQUIRED
University Requirement
(1 mini-course, 3 units)
This is a mini-course, pass/no credit, to be completed in the 1st semester.

II. College of Humanities and Social Sciences Concentration
(6 courses, 54 units minimum)
Each student meets individually with a BHA H&SS Academic Advisor to design a 54-unit H&SS concentration based on existing H&SS majors/minors, or by creating a self-defined area of 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 units minimum)
BHA students choose one of the following concentrations:

- Architecture
- Art
- Design
- Drama
- Music

ARCHITECTURE CONCENTRATION
(108 units minimum)
Required Courses (54 units minimum)
48-100 Design Fundamentals 12 units
or
48-095 Architecture for Non-Majors 9 units
48-130 Architectural Drawing I: Tactile Foundation 9 units
48-135 Architectural Drawing II: Appearance 9 units
48-240 Survey of World Architecture & Urbanism 9 units
48-34x Architectural History Lecture (varying topics) 9 units
48-44x Architectural History Lecture (varying topics) 9 units

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

Elective Focus: General Education in Architecture
(54 units)
48-120 Computer Modeling I 9 units
48-210 Statics (prerequisite: 33-106) 9 units
48-215 Materials and Assembly (prerequisite: 48-210) 9 units
48-217 Structures I (prerequisite: 48-210) 9 units
48-230 Drawing III: Perspective (prerequisite: 48-135) 9 units
48-315 Environment I: Climate and Energy (prerequisite: 33-106) 9 units
48-351 Human Factors in Architecture 9 units
48-34x Architectural History Lecture (varying topics) 9 units
48-44x Architectural History Lecture (varying topics) 9 units
48-452 Real Estate Design and Development 9 units
48-453 Urban Design 9 units
48-551 Ethics and Decision Making in Architecture 9 units
48-5xx Departmental Elective (prerequisites vary) 9 units

Elective Focus: Architectural Technology
(Six varying topics, 54 units)
This sequence is intended to develop intellectual links to the technical aspects of the profession.
Prerequisite Courses:
21-120 Differential and Integral Calculus 10 units
33-106 Physics I for Engineering Students 12 units
or
48-115 Physics for Architecture 9 units

Elective Courses:
48-210 Statics (prerequisite: 33-106 or 48-115) 9 units
48-215 Materials and Assembly (prerequisite: 48-210) 9 units
48-217 Structures (prerequisite: 48-210) 9 units
48-315 Environment I: Climate and Energy (prerequisite: 33-106 or 48-115) 9 units
48-410 Environment II: Space, Sound, and Light (prerequisite: 33-106 or 48-115) 9 units
48-412 Environment III: Mechanical Systems 9 units
48-415 Advanced Building Systems (prerequisite: 48-315) 9 units
48-4xx Designated Departmental Technical Elective 9 units

Elective Focus: Architectural History
(six varying topics, 54 units)
48-34x/44x Architectural History 9 units
48-34x/44x Architectural History 9 units
48-34x/44x Architectural History 9 units
48-34x/44x Architectural History 9 units
48-34x/44x Architectural History 9 units

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 units
60-102 Concept Studio II 10 units
60-201 Concept Studio III 10 units
60-202 Concept Studio: EcoArt 10 units

Media Studios (3 courses, 30 units)
Complete three courses:
60-150 2-Dimensional Studio I 10 units
60-151 2-Dimensional Studio II 10 units
60-250 2-Dimensional Studio III 10 units
60-251 2-Dimensional Studio IV 10 units
60-130 3-Dimensional Studio I 10 units
60-230 3-Dimensional Studio II 10 units
60-110 Electronic Media Studio I 10 units
60-210 Electronic Media Studio II 10 units

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, PDP or SIS). They may take all courses in one media area if a focus is desired.
60-410-29 Advanced Electronic and Time-Based Work (ETB) 10 units
60-430-49 Advanced Sculpture, Installation and Site-Work (SIS) 10 units
60-450-98 Advanced Painting, Drawing and Printmaking (PDP) 10 units
60-499 Studio- Independent Study (one only) 10 units

Art History/Theory (2 courses, 18 units)
60-205 Modern Visual Culture: 1789-1945 9 units
60-206 Contemporary Visual Culture: 1945 to the Present 9 units

NOTE: To complete the full three-semester historical sequence, take 60-105, Pre-Industrial Visual Cultures, 9 units.

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)
60-400 Senior Review (Spring)
**DESIGN CONCENTRATION (108 units minimum)**

**PORTFOLIO REVIEW REQUIRED FOR ADMISSION**

**Design Required Courses (81 units)**

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>51-101</td>
<td>Design Studio I (Fall)</td>
<td>9</td>
</tr>
<tr>
<td>51-102</td>
<td>Design Studio II (Spring)</td>
<td>9</td>
</tr>
<tr>
<td>51-121</td>
<td>Design Drawing I (Fall)</td>
<td>9</td>
</tr>
<tr>
<td>51-122</td>
<td>Design Drawing II (Spring)</td>
<td>9</td>
</tr>
<tr>
<td>51-132</td>
<td>Introduction to Photo Design (Spring)</td>
<td>9</td>
</tr>
<tr>
<td>51-171</td>
<td>Human Experience in Design (Fall)</td>
<td>9</td>
</tr>
<tr>
<td>51-174</td>
<td>History of Objects and Images (Spring)</td>
<td>9</td>
</tr>
<tr>
<td>51-271</td>
<td>Design History I (Fall)</td>
<td>9</td>
</tr>
<tr>
<td>51-272</td>
<td>Design History II (Spring)</td>
<td>9</td>
</tr>
</tbody>
</table>

**Design Electives (27 units)**

Choose three (3) additional Design courses in consultation with the Design advisor.

NOTE: BHA Design students have 114 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)**

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

Options available in the following areas: 1) Production Technology and Management, 2) Dramaturgy, 3) Directing, 4) Design

There is no BHA/BSA acting or musical theatre option.

The BHA/BSA Drama candidate must choose from the four options offered by The School of Drama and successfully pass the audition/interview for Directing or Dramaturgy Options, or the portfolio review/interview for the Design or Production Technology and Management Options. All BHA/BSA students are required to take courses 54-177 and 54-179 Foundations of Drama I and II, 54-151 and 54-152 Stagecraft, and 54-175 and 54-176 Conservatory Hour in the freshman year, 54-259 or 54-262 Production Preparation II in one of the semesters of the sophomore year (4-8 weeks per term), and 54-281 and 54-282 Foundations of Drama III and IV during junior or senior year.

**Drama Required Courses: (46 units)**

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<tr>
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<th>Course Title</th>
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<tr>
<td>54-177</td>
<td>Foundations of Drama I and II</td>
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<tr>
<td>54-281</td>
<td>Foundations of Drama III and IV</td>
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<td>54-281</td>
<td>Foundations of Drama III and IV (taken anytime from sophomore to senior year, in sequence)</td>
<td>6-12</td>
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<tr>
<td>54-151</td>
<td>54-152 Stagecraft</td>
<td>12</td>
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<tr>
<td>54-175</td>
<td>Conservatory Hour</td>
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(Note: All Foundations courses are one-semester courses)

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<th>Course Title</th>
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<tr>
<td>54-181</td>
<td>Electronic and Computer Music</td>
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<tr>
<td>54-338</td>
<td>Sound Recording</td>
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<tr>
<td>54-339</td>
<td>Independent Study in Music Technology or Sound Recording</td>
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<th>Course Title</th>
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<tr>
<td>57-101</td>
<td>Introduction to Music Technology</td>
<td>6</td>
</tr>
<tr>
<td>57-438</td>
<td>Multitrack Recording</td>
<td>9</td>
</tr>
<tr>
<td>57-283</td>
<td>Music History I</td>
<td>9</td>
</tr>
<tr>
<td>57-284</td>
<td>Music History II</td>
<td>9</td>
</tr>
</tbody>
</table>

Choose 36 units from:

- 57-153 Harmony I
- 57-152 Harmony II
- 57-280 Repertoire and Listening for Musicians III*
- 57-289 Repertoire and Listening for Musicians IV*
- 57-399 Music – Cinema - Culture
- 57-400 Puccini’s Operas
- 57-401 String Quartet: a social history
- 57-181 Solfege I
- 57-182 Solfege II
- 57-183 Solfege III
- 57-184 Solfege IV

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

**MUSIC HISTORY AND CULTURE (108 units minimum)**

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

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

**Required Courses for All Concentration Options**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-152</td>
<td>Harmony I</td>
<td>6</td>
</tr>
<tr>
<td>57-173</td>
<td>Survey of Western Music History</td>
<td>9</td>
</tr>
<tr>
<td>57-189</td>
<td>Repertoire and Listening for Musicians I</td>
<td>3</td>
</tr>
</tbody>
</table>

**Music Required**:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-338</td>
<td>Sound Editing and Mastering</td>
<td>6</td>
</tr>
<tr>
<td>57-438</td>
<td>Multitrack Recording</td>
<td>9</td>
</tr>
<tr>
<td>57-283</td>
<td>Music History I</td>
<td>9</td>
</tr>
<tr>
<td>57-284</td>
<td>Music History II</td>
<td>9</td>
</tr>
<tr>
<td>57-290</td>
<td>Repertoire and Listening for Musicians III*</td>
<td>3</td>
</tr>
<tr>
<td>57-291</td>
<td>Repertoire and Listening for Musicians IV*</td>
<td>3</td>
</tr>
</tbody>
</table>

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

**MUSIC TECHNOLOGY (108 units minimum)**

**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 54 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 13 courses, 114 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
Sponsored by the Mellon College of Science and the College of Fine Arts
Office: Margaret Morrison Carnegie Hall, Room 107
www.cm.edu/interdisciplinary

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 BHA & BSA Programs. The director and associate director of the BHA and BSA 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.

Senior Research/Project Course Option
The BSA program offers a senior project option. The creation and completion of such a project can be an important integrative and fulfilling capstone. It can also provide an academic goal for BSA "sub-senior," as well as influence the development of the BSA program as a distinguished scholarly and creative undergraduate student community.

BSA Curriculum

<table>
<thead>
<tr>
<th>I. BSA Core</th>
<th>108 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>II. MCS Concentration</td>
<td>120-134 units</td>
</tr>
<tr>
<td>III. CFA Concentration</td>
<td>108 units</td>
</tr>
<tr>
<td>IV. BSA Free Electives</td>
<td>30-44 units</td>
</tr>
<tr>
<td>BSA Degree Requirements</td>
<td>380 units</td>
</tr>
</tbody>
</table>

I. BSA Core
(12 courses, 108 units minimum)
- Writing/Expression (1 course, 9 units, 76-101 required)
- BHA & BSA Integrative Seminar (1 course, 9 units, 62-190 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-xxx required)
- University Requirement: Computing Skills Workshop (1 mini-course, 3 units, to be completed in first semester)

Writing/Expression (1 course, 9 units)
Broadly considered, language is a tool used to communicate, as well as a way to organize non-visual and non-mathematical thinking. This requirement focuses on the social nature of language and the ways in which writing constitutes thinking.

76-101 Interpretation and Argument - REQUIRED

If a score of 5 is obtained on the either English Advanced Placement examination, approved English substitutions at the 200 and 300 level are available.

Integrative Seminar (1 course, 9 units)
This interdisciplinary seminar is designed for BHA and BSA students to be taken in the fall semester of their freshman or sophomore year. If necessary, this seminar can be substituted with another approved interdisciplinary course. This course is designed to create an environment for interdisciplinary learning and collaboration. It provides a forum for BHA and BSA freshmen/sophomores to discuss their own projects and begin collaborations with other students. BHA & BSA Integrative Seminar begins the connection of students within BHA and BSA to the interdisciplinary culture at Carnegie Mellon and beyond.

62-190 BHA & BSA Integrative Seminar - REQUIRED

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
66-250 Introduction to Religion
70-342 Managing Across Cultures
76-227 Comedy
76-232 African-American Studies
76-241 Introduction to Gender Studies
79-104 Introduction to World History
79-113 Culture and Identity in American Society
79-201 Introduction to Anthropology
79-204 Twentieth Century America
79-207 Development of European Culture
79-209 Theory and Practice in Anthropology
79-218 The Roots of Rock & Roll
79-241 African-American History I
79-242 African-American History II
79-270 Chinese Culture and Society
79-368 Poverty, Charity and Welfare
79-384 Medicine and Society
80-100 What Philosophy Is
80-151 God in the West
80-250 Ancient Philosophy
80-251 Modern Philosophy
80-253 Continental Philosophy
80-254 Analytical Philosophy
80-255 Pragmatism
80-261 Aesthetics of Mass Art
82-2xx Any 200 level or greater course from Modern Languages
**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, Surveys, and Society
- 70-332 Business and Society
- 70-420 Entrepreneurship for Scientists
- 73-100 Economic Principles
- 73-110 Experiments with Economic Principles
- 79-223 Protest and Dissent in American History
- 79-331 Crime and Punishment
- 79-335 Drug Use and Drug Policy
- 79-340 History of Modern Warfare
- 79-350 Theories of International Relations
- 79-384 Medicine and Society
- 80-135 Introduction to Political Philosophy
- 80-136 Ethics and Public Policy
- 80-235 Political Philosophy
- 80-236 Philosophy and the Law
- 80-243 Environment Management and Ethics
- 80-245 Mental Health
- 80-341 Computers, Society, and Ethics
- 88-104 Decision Processes in American Political Institutions
- 88-110 Experiments with Economic Principles
- 88-205 Comparative Politics
- 99-226 Rachel Carson: Her Work and Legacy
- 99-305 The Year is 1905: E=mc² Photons and Relativity

**Cognition, Choice, and Behavior**

This category uses model-based analysis to broaden understanding of human thinking, choices, and behavior on an individual basis across a variety of settings.

- 80-130 Introduction to Ethics
- 80-150 Nature of Reason
- 80-180 The Nature of Language
- 80-181 Language and Thought
- 80-220 Philosophy of Science
- 80-221 Philosophy of Social Science
- 80-230 Ethical Theory
- 80-241 Ethical Judgments in Professional Life
- 80-242 Conflict, Dispute Resolution
- 80-270 Philosophy of Mind
- 80-271 Philosophy and Psychology
- 85-100 Introduction to Intelligence in Humans, Animals and Machines
- 85-102 Introduction to Psychology
- 85-211 Cognitive Psychology
- 85-221 Principles of Child Development
- 85-241 Social Psychology
- 85-251 Personality
- 85-261 Abnormal Psychology
- 88-120 Reason, Passion, and Cognition

**Complete TWO additional courses from one of the following departments: English, History, Modern Languages, Philosophy, or Psychology**

(2 courses, complete 18 units minimum)

**Mathematics (2 courses, 20 units)**

Complete these two courses in Calculus:

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

**Science (3 courses, 31 units)**

Complete the following science courses:

- 03-121 Modern Biology
- 09-105 Introduction to Modern Chemistry
- 33-xxx Physics for Science Students I

**University Requirement**

(1 mini-course, 3 units)

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


**II. MCS Concentration**

(number of courses vary, 120-134 units)

BSA students choose one of the following concentrations:

- Biological Sciences 120 units
- Chemistry 122 units
- Mathematical Sciences 121 units
- Physics 134 units

**BIOLOGICAL SCIENCES CONCENTRATION**

(120-123 units minimum)

**Biology Required Courses (102 units)**

- 03-211 or 03-212 Biochemistry
- 03-240 Cell Biology
- 03-330 Genetics
- 03-124 or 03-343 Biology Laboratory
- 03-201 and/or 03-202 Undergraduate Colloquium
- 09-106 Modern Chemistry II
- 09-217 Organic Chemistry I
- 09-218 Organic Chemistry II
- 09-221 Chem Lab I
- 09-222 Chem Lab II
- 33-112 Physics for Science Students II

**Biology Electives (2 courses, 18 units)**

Must be selected from 03-3xx, excluding 03-445

**CHEMISTRY CONCENTRATION**

(122 units minimum)

**Required Courses (104 units)**

- 09-106 Modern Chemistry II
- 09-217 Organic Chemistry I
- 09-218 Organic Chemistry II
- 09-214, 344 or 345 Physical Chemistry
- 09-348 Inorganic Chemistry
- 09-221 Chem Lab I
- 09-222 Chem Lab II
- 09-226 Chem Lab III
- 09-204 Issues in Chemistry
- 09-201, 202 and 301 Undergraduate Seminars (1 unit each)
- 09-402 Undergraduate Seminar
- 33-112 Physics for Science Students II

**Chemistry Electives (2 courses, 18 units)**

May be any upper level chemistry course, 09-3xx or higher, or Biochemistry, 03-211 or 03-231.

**MATHEMATICAL SCIENCES CONCENTRATION**

(121 units minimum)

**Required Courses (85 units)**

(Reasonable changes within the core program will be accepted.)

- 21-127 Concepts of Mathematics
- 21-228 Discrete Mathematics
- 21-241 Matrix Algebra I (or 21-341 Linear Algebra)
- 21-259 Calculus in Three Dimensions
- 21-260 Differential Equations
- 22-350 Principles of Real Analysis I
- 22-373 Algebraic Structures
- 33-112 Physics for Science Students II
- 15-100 Introductory/Intermediate Programming

**Math Sciences Electives (2 courses, 18 units)**

Students with a music focus should take 21-372 (Partial Differential Equations).

**Math 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 (134 units minimum)**

**Required Courses (125 units)**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>33-112</td>
<td>Physics for Science Students II</td>
<td>12</td>
</tr>
<tr>
<td>33-104</td>
<td>Experimental Physics</td>
<td>9</td>
</tr>
<tr>
<td>33-211</td>
<td>Physics III</td>
<td>10</td>
</tr>
<tr>
<td>33-231</td>
<td>Physical Analysis</td>
<td>10</td>
</tr>
<tr>
<td>33-232</td>
<td>Mathematical Methods of Physics</td>
<td>9</td>
</tr>
<tr>
<td>33-234</td>
<td>Quantum Physics</td>
<td>10</td>
</tr>
<tr>
<td>33-331</td>
<td>Physical Mechanics I</td>
<td>10</td>
</tr>
<tr>
<td>33-338</td>
<td>Intermediate Electricity and Magnetism I</td>
<td>10</td>
</tr>
<tr>
<td>33-340</td>
<td>Modern Physics Lab</td>
<td>10</td>
</tr>
<tr>
<td>33-342</td>
<td>Thermodynamics</td>
<td>10</td>
</tr>
<tr>
<td>33-201</td>
<td>Physics Sophomore Colloquium I</td>
<td>2</td>
</tr>
<tr>
<td>33-202</td>
<td>Physics Sophomore Colloquium II</td>
<td>2</td>
</tr>
<tr>
<td>33-301</td>
<td>Physics Upper Class Colloquium I</td>
<td>2</td>
</tr>
<tr>
<td>33-302</td>
<td>Physics Upper Class Colloquium II</td>
<td>2</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
</tr>
</tbody>
</table>

**Technical Elective (1 course, 9 units)**

May be any physics or computer science course

(33-114 Physics of Musical Sound is highly recommended for students with a Music focus)

**III. College of Fine Arts Concentration**

(number of courses vary, 108 units minimum)

BSA students choose one of the following concentrations:

- Architecture
- Art
- Design
- Drama
- Music

**ARCHITECTURE CONCENTRATION (108 units minimum)**

**Required Courses (54 units minimum)**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-100</td>
<td>Design Fundamentals</td>
<td>12</td>
</tr>
<tr>
<td>48-095</td>
<td>Architecture for Non-Majors</td>
<td>9</td>
</tr>
<tr>
<td>48-130</td>
<td>Architectural Drawing I: Tactile Foundation</td>
<td>9</td>
</tr>
<tr>
<td>48-135</td>
<td>Architectural Drawing II: Appearance</td>
<td>9</td>
</tr>
<tr>
<td>48-240</td>
<td>Survey of World Architecture &amp; Urbanism</td>
<td>9</td>
</tr>
<tr>
<td>48-34x</td>
<td>Architectural History Lecture (varying topics)</td>
<td></td>
</tr>
<tr>
<td>48-44x</td>
<td>Architectural History Lecture (varying topics)</td>
<td></td>
</tr>
</tbody>
</table>

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

**Elective Focus: General Education in Architecture (54 units)**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-120</td>
<td>Computer Modeling I</td>
<td>9</td>
</tr>
<tr>
<td>48-210</td>
<td>Statics (prerequisite: 33-106)</td>
<td>9</td>
</tr>
<tr>
<td>48-215</td>
<td>Materials and Assembly (prerequisite: 48-210)</td>
<td>9</td>
</tr>
<tr>
<td>48-217</td>
<td>Structures I (prerequisite: 48-210)</td>
<td>9</td>
</tr>
<tr>
<td>48-230</td>
<td>Drawing III: Perspective (prerequisite: 48-135)</td>
<td>9</td>
</tr>
<tr>
<td>48-315</td>
<td>Environment I: Climate and Energy (prerequisite: 33-106)</td>
<td>9</td>
</tr>
<tr>
<td>48-351</td>
<td>Human Factors in Architecture</td>
<td>9</td>
</tr>
<tr>
<td>48-44x</td>
<td>Architectural History Lecture (varying topics)</td>
<td>9</td>
</tr>
<tr>
<td>48-45x</td>
<td>Real Estate Design and Development</td>
<td>9</td>
</tr>
<tr>
<td>48-453</td>
<td>Urban Design</td>
<td>9</td>
</tr>
<tr>
<td>48-551</td>
<td>Ethics and Decision Making in Architecture</td>
<td>9</td>
</tr>
<tr>
<td>48-5xx</td>
<td>Departmental Elective (prerequisites vary)</td>
<td>9</td>
</tr>
</tbody>
</table>

**Elective Focus: Architectural Representation and Visualization (54 units)**

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

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-120</td>
<td>Introduction to Digital Media I</td>
<td>9</td>
</tr>
<tr>
<td>48-125</td>
<td>Introduction to Digital Media II</td>
<td>9</td>
</tr>
<tr>
<td>48-230</td>
<td>Architectural Drawing III: Perspective (prerequisite: 48-135)</td>
<td>9</td>
</tr>
</tbody>
</table>

**48-563 Building Virtual Worlds**  9 units
**48-7xx Graduate Elective**  9 units
**48-7xx Graduate Elective**  9 units

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

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

**Prerequisite Courses:**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>33-106</td>
<td>Physics I for Engineering Students</td>
<td>12</td>
</tr>
<tr>
<td>48-115</td>
<td>Physics for Architecture</td>
<td>9</td>
</tr>
</tbody>
</table>

**Elective Courses:**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-210</td>
<td>Statics (prerequisite: 33-106 or 48-115)</td>
<td>9</td>
</tr>
<tr>
<td>48-215</td>
<td>Materials and Assembly (prerequisite: 48-210)</td>
<td>9</td>
</tr>
<tr>
<td>48-217</td>
<td>Structures (prerequisite: 48-210)</td>
<td>9</td>
</tr>
<tr>
<td>48-315</td>
<td>Environment I: Climate and Energy (prerequisite: 33-106 or 48-115)</td>
<td>9</td>
</tr>
<tr>
<td>48-410</td>
<td>Environment II: Space, Sound, and Light (prerequisite: 33-106 or 48-115)</td>
<td>9</td>
</tr>
<tr>
<td>48-412</td>
<td>Environment III: Mechanical Systems</td>
<td>9</td>
</tr>
<tr>
<td>48-415</td>
<td>Advanced Building Systems (prerequisite: 48-315)</td>
<td>9</td>
</tr>
<tr>
<td>48-4xx</td>
<td>Designated Departmental Technical Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48-34x/44x</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-34x/44x</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-34x/44x</td>
<td>Architectural History</td>
<td>9</td>
</tr>
<tr>
<td>48-34x/44x</td>
<td>Architectural History</td>
<td>9</td>
</tr>
</tbody>
</table>

**ART CONCENTRATION (108 units minimum)**

**PORTFOLIO REVIEW REQUIRED FOR ADMISSION**

**Concept Studios (2 courses, 20 units)**

Complete two courses:

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-101</td>
<td>Concept Studio I</td>
<td>10</td>
</tr>
<tr>
<td>60-102</td>
<td>Concept Studio II</td>
<td>10</td>
</tr>
<tr>
<td>60-201</td>
<td>Concept Studio III</td>
<td>10</td>
</tr>
</tbody>
</table>

**Media Studios (3 courses, 30 units)**

Complete three courses:

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-150</td>
<td>2-Dimensional Studio I</td>
<td>10</td>
</tr>
<tr>
<td>60-151</td>
<td>2-Dimensional Studio II</td>
<td>10</td>
</tr>
<tr>
<td>60-250</td>
<td>2-Dimensional Studio III</td>
<td>10</td>
</tr>
<tr>
<td>60-251</td>
<td>2-Dimensional Studio IV</td>
<td>10</td>
</tr>
<tr>
<td>60-130</td>
<td>3-Dimensional Studio I</td>
<td>10</td>
</tr>
<tr>
<td>60-230</td>
<td>3-Dimensional Studio II</td>
<td>10</td>
</tr>
<tr>
<td>60-110</td>
<td>Electronic Media Studio I</td>
<td>10</td>
</tr>
<tr>
<td>60-202</td>
<td>Concept Studio: EcoArt</td>
<td>10</td>
</tr>
</tbody>
</table>

**Advanced Studios (4 courses, 40 units)**

Complete four courses. Courses may be offered in the fall and/or spring. Students may take courses in any media area (ETB, PDP or SIS). They may take all courses in one media area if a focus is desired.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-410-29</td>
<td>Advanced Electronic and Time-Based Work (ETB)</td>
<td>10</td>
</tr>
<tr>
<td>60-430-49</td>
<td>Advanced Sculpture, Installation and Site-Work (SIS)</td>
<td>10</td>
</tr>
<tr>
<td>60-450-98</td>
<td>Advanced Painting, Drawing and Printmaking (PDP)</td>
<td>10</td>
</tr>
<tr>
<td>60-499</td>
<td>Studio- Independent Study (one only)</td>
<td>10</td>
</tr>
</tbody>
</table>

**Art History/Theory (2 courses, 18 units)**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-205</td>
<td>Modern Visual Culture: 1789-1945</td>
<td>9</td>
</tr>
<tr>
<td>60-206</td>
<td>Contemporary Visual Culture: 1945 to the Present</td>
<td>9</td>
</tr>
</tbody>
</table>

NOTE: To complete the full three-semester historical sequence, take 60-105, Pre-Industrial Visual Cultures, 9 units.
Review Requirement (Complete 2 required reviews, 0 units)
A review is required at the end of the sophomore and senior years. Pass/fail only.
50-200 Sophomore Review (Spring)
50-400 Senior Review (Spring)

DESIGN CONCENTRATION (108 units minimum)
PORTFOLIO REVIEW REQUIRED FOR ADMISSION

Design Required Courses (81 units)
51-101 Design Studio I (Fall) 9 units
51-102 Design Studio II (Spring) 9 units
51-112 Design Drawing I (Fall) 9 units
51-112 Design Drawing II (Spring) 9 units
51-132 Introduction to Photo Design (Spring) 9 units
51-171 Human Experience in Design (Fall) 9 units
51-174 History of Objects and Images (Spring) 9 units
51-271 Design History I (Fall) 9 units
51-272 Design History II (Spring) 9 units

Design Electives (27 units)
Choose three (3) additional Design courses in consultation with the Design advisor.

DRAMA CONCENTRATION (108 units minimum)
AUDITION/INTERVIEW REQUIRED FOR DIRECTING OR DRAMATURGY OPTIONS, PORTFOLIO REVIEW/INTERVIEW REQUIRED FOR DESIGN OR PRODUCTION TECHNOLOGY AND MANAGEMENT OPTIONS.
Options available in the following areas: 1) Production Technology and Management, 2) Dramaturgy, 3) Directing, 4) Design
There is no BHA/BSA acting or musical theatre option.
The BHA/BSA Drama candidate must choose from the four options offered by The School of Drama and successfully pass the audition/interview for Directing or Dramaturgy Options, or the portfolio review/interview for the Design or Production Technology and Management Options. All BHA/BSA students are required to take courses 54-177 and 54-179 Foundations of Drama I and II, 54-151 and 54-152 Stagecraft, and 54-175 and 54-176 Conservatory Hour in the freshman year, 54-259 or 54-262 Production Preparation II in one of the semesters of the sophomore year (4-8 weeks per term), and 54-281 and 54-282 Foundations of Drama III and IV during junior or senior year.
Drama Required Courses: (46 units)
54-177, 54-179 Foundations of Drama I and II
(freshman year, 6 units per semester) 12 units
54-281, 54-282 Foundations of Drama III and IV
(taken anytime from sophomore to senior year, in sequence, 6 units per semester) 12 units
(Note: All Foundations courses are one-semester courses)
54-151, 54-152 Stagecraft
(Includes work on production run-crews and a large classroom component. This is a time-intensive course. BHA/BSA students can modify this commitment in terms of hours and units in consultation with the Drama advisor. Minimum 5 units for classroom work, 6 units for production work. Taking the full 15 units in the fall and 11 units in the spring is recommended but not required.) 11 units minimum
54-259 or 54-262 Production Preparation II
(sophomore year, fall or spring semester) 9 units
54-175, 54-176 Conservatory Hour
(freshman year, 1 unit per semester, two semesters) 2 units

Drama Electives: (62 units)
Choose additional courses from the Drama catalogue 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)
AUDITION AND INTERVIEW REQUIRED FOR MUSIC CONCENTRATION OPTION. INTERVIEW REQUIRED FOR MUSIC HISTORY AND CULTURE OR MUSIC TECHNOLOGY CONCENTRATION OPTION.
Options available in the following areas: 1) Music (instrumental, piano, organ, composition, voice), 2) Music History and Culture, 3) Music Technology.

Required Courses for All Concentration Options
57-152 Harmony I 6 units
57-173 Survey of Western Music History 9 units
57-189 Repertoire and Listening for Musicians I 3 units

Music
Required:
57-xxx BHA/BSA Studio (4 semesters) 36 units
57-xxx Major Ensemble (4 semesters) 24 units
57-161 Eurhythmics I 3 units
57-181 Solfege I 3 units
Choose 24 units from:
57-153 Harmony II 6 units
57-283 Music History I 9 units
57-284 Music History II 9 units
57-289 Repertoire and Listening for Musicians III* 3 units
57-290 Repertoire and Listening for Musicians IV* 3 units
57-162 Eurhythmics II 3 units
57-163 Eurhythmics III 3 units
57-164 Eurhythmics IV 3 units
57-182 Solfege II 3 units
57-183 Solfege III 3 units
57-184 Solfege IV 3 units

Music History and Culture
Required:
57-283 Music History I 9 units
57-284 Music History II 9 units
57-289 Repertoire and Listening for Musicians III* 3 units
57-290 Repertoire and Listening for Musicians IV* 3 units
57-611 Independent Study in Music History 6 units
Choose 36 units from:
57-209 Beatles 9 units
57-405 Concerto: virtuosity and contrast 9 units
57-457 Jazz History I 6 units
57-458 Jazz History II 6 units
57-399 Music - Cinema - Culture 9 units
57-202 Opera History 9 units
57-409 Puccini’s Operas 9 units
57-404 String Quartet: a social history 9 units

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

Music Technology
Required:
57-181 Solfege I 3 units
57-101 Introduction to Music Technology 6 units
57-347 Electronic and Computer Music 6 units
57-337 Sound Recording 6 units
57-xxx Independent Study in Music Technology or Sound Recording 9 units
Choose 36 units from:
57-153 Harmony II 6 units
57-338 Sound Editing and Mastering 6 units
57-438 Multitrack Recording 9 units
57-283 Music History I 9 units
57-284 Music History II 9 units
57-289 Repertoire and Listening for Musicians III* 3 units
57-290 Repertoire and Listening for Musicians IV* 3 units
57-182 Solfege II 3 units
Choose 24 additional Music units in consultation with the Music advisor.

*co-requisite for Music History I and II

IV. Free Electives: 32-44 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 Science in Computational Finance

The Mellon College of Science, the Heinz School of Public Policy and Management and the Tepper School of Business jointly offer a degree uniquely designed to meet the quantitative needs of the finance industry. Modeled after the highly successful Carnegie Mellon Master of Science in Computational Finance, this degree allows students to develop a deep knowledge of mathematics, probability, statistics, and the applications of these disciplines to finance. Students who complete this degree may directly enter the finance industry, enter other industries where an applied mathematics training is appropriate, or pursue advanced degrees in economics, finance or the mathematical sciences. Students entering the work force upon completion of this degree may wish to later complement their undergraduate degree with a Master’s degree in Business Administration or other professional degree. Students who might eventually pursue doctoral degrees in mathematics, 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.

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 15-100 Introductory/Intermediate Programming.

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

- Physics I for Science Students
- Modern Biology
- Introduction to Modern Chemistry

Humanities, Social Sciences and 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:

- Interpretation and Argument
- Principles of Economics with Calculus
- Economic Theory

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.

Depth Electives

The detailed curriculum below includes three depth electives. These are to be chosen from among the following:

- Principles of Real Analysis I
- Projects in Applied Mathematics
- Partial Differential Equations
- Modern Regression
- Topic in Data Analysis
- Statistics Topic
- Financial Analysis and Securities Trading
- International Finance
- Investment Analysis
- Corporate Finance
- Options
- International Money and Finance
- Financial Economics
- Monetary Theory and Policy

Detailed Curriculum

What follows is the detailed curriculum for the degree Bachelor of Science in Computational Finance. The courses listed are required. The semesters in which the courses are to be taken are suggested.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Fall</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>15-100 Introductory/Intermediate Programming</td>
<td>10</td>
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<tr>
<td></td>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
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<tr>
<td></td>
<td>76-101 Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>99-101 Computing Skills Workshop</td>
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<td></td>
<td>xx-xxx Science Requirement</td>
<td>9-12</td>
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<tr>
<td></td>
<td>Spring</td>
<td>41-44</td>
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<tr>
<td></td>
<td>15-200 Advanced Programming/Pрактикум</td>
<td>9</td>
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<tr>
<td></td>
<td>21-122 Integration, Differential Equations and Approximation</td>
<td>10</td>
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<tr>
<td></td>
<td>73-150 Principles of Economics with Calculus</td>
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</tr>
<tr>
<td></td>
<td>xx-xxx Science Requirement</td>
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<td></td>
<td>xx-xxx Elective</td>
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<tr>
<td>Sophomore</td>
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<td>Fall</td>
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<td></td>
<td>21-241 Matrix Algebra (or 21-341 Linear Algebra I)</td>
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<tr>
<td></td>
<td>21-259 Calculus in Three Dimensions</td>
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<td></td>
<td>21-260 Differential Equations</td>
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</tr>
<tr>
<td></td>
<td>70-122 Introduction to Accounting</td>
<td>9</td>
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<tr>
<td></td>
<td>xx-xxx Humanities, Social Science or Fine Arts Elective</td>
<td>9</td>
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<tr>
<td></td>
<td>Spring</td>
<td>45</td>
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<tr>
<td></td>
<td>21-270 Introduction to Mathematical Finance</td>
<td>9</td>
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<tr>
<td></td>
<td>21-292 Operations Research I</td>
<td>9</td>
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<tr>
<td></td>
<td>21-369 Numerical Methods</td>
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<td></td>
<td>70-391 Finance</td>
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<tr>
<td></td>
<td>73-251 Economic Theory</td>
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<tr>
<td>Junior</td>
<td>45</td>
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<td></td>
<td>Fall</td>
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<tr>
<td></td>
<td>21-325 Probability</td>
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<td></td>
<td>21-370 Discrete-Time Finance</td>
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<td>73-200 Macroeconomics</td>
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<td>xx-xxx Depth Elective</td>
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<td>xx-xxx Elective</td>
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<td></td>
<td>Spring</td>
<td>45</td>
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<td></td>
<td>21-420 Continuous-Time Finance</td>
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<tr>
<td></td>
<td>36-226 Introduction to Probability and Statistics II</td>
<td>9</td>
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<td></td>
<td>36-410 Introduction to Probability Models</td>
<td>9</td>
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<td>xx-xxx Humanities, Social Science or Fine Arts Elective</td>
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<td></td>
<td>xx-xxx Elective</td>
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<tr>
<td>Senior</td>
<td>45-48</td>
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<td></td>
<td>Fall</td>
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<td></td>
<td>45-816 Studies in Financial Engineering</td>
<td>6</td>
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<tr>
<td></td>
<td>90-718 Professional Speaking</td>
<td>6</td>
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<tr>
<td></td>
<td>90-729 Organizational Design and Implementation</td>
<td>6</td>
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<tr>
<td></td>
<td>xx-xxx Depth Elective</td>
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<td></td>
<td>xx-xxx Humanities, Social Science or Fine Arts Elective</td>
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<td>xx-xxx Elective</td>
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<tr>
<td></td>
<td>Spring</td>
<td>42-48</td>
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<tr>
<td></td>
<td>xx-xxx Depth Elective</td>
<td>9</td>
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<tr>
<td></td>
<td>90-717 Professional Writing</td>
<td>6</td>
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<tr>
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<td>xx-xxx Humanities, Social Science or Fine Arts Elective</td>
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<td>xx-xxx Elective</td>
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<td>xx-xxx Elective</td>
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<td>xx-xxx Elective</td>
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</tbody>
</table>

The Computational Finance Minor

The requirements for the Computational Finance Minor are listed below. Beginning in Fall 2006, a student must satisfy one of the following requirements to declare a minor:

1. Completion of 21-270 Introduction to Mathematical Finance with a grade of A and an overall QPA of at least 3.2.
2. Completion of 21-270 Introduction to Mathematical Finance and 21-370 Discrete-Time Finance with an average grade of B and an overall QPA of at least 3.0.
When a student has met the necessary requirements, he or she may declare the minor by contacting the Associate Dean of the Mellon College of Science.

21-241 Matrix Algebra (or 21-341 Linear Algebra I)
21-259 Calculus in Three Dimensions (or 21-256 Multivariate Calculus)
21-260 Differential Equations
21-270 Introduction to Mathematical Finance
21-370* Discrete-Time Finance
21-420** Continuous-Time Finance

To avoid excessive double counting, Mathematical Sciences majors must also take 21-365 Projects in Applied Mathematics or an approved substitute.

*Pre-requisite for 21-370, 21-270 and either 21-256 or 21-259, and the co-requisite is 70-207, 21-325, 36-226 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 courses, e.g., 73-100, 73-150, 73-200 and 73-251.

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 invited 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 have the choice to live in a residential cluster that promotes the integration of academic and social interests. Beyond the first year, students continue to participate in occasions that foster their intellectual community. The program also 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 General Education Program

There are 14 requirements in the SHS General Education Program. The program is designed to expose students to a variety of subjects and methodologies that will not only make them better-informed citizens of the world, but also broaden their range of possible subsequent major choices. The SHS General Education Program is structured to provide a great deal of flexibility and independence in selecting courses to fulfill these requirements.

Mathematical Sciences (29 units)

1.21-120 Differential and Integral Calculus or 21-131 Analysis I
2.21-122 Integration, Differential Equations, and Approximation or
21-132 Analysis II
3.36-247 Statistics for Lab Sciences (or appropriate substitute)

Writing/Expression (9 units)

Broadly considered, language is a tool used to communicate, as well as a way to organize thinking. This requirement focuses on the social nature of language and the ways in which writing constitutes thinking.

4.76-101 Interpretation & Argument

Notes: This requirement should be completed in the first year. A student who received a 5 on either of the English AP exams may elect to take an advanced English course instead, selected from a list approved annually by the English department. In any event, the course taken to fulfill this requirement cannot be double-counted towards any other graduation requirement.

World Cultures (9 units)

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

5. 79-104 Introduction to World History

Freshman Seminar (6-9 units)

6. Choose one full-semester freshman seminar from H&SS, or two half-semester freshman seminars from MCS and/or H&SS.

Computational Reasoning (9-10 units)

7. Choose from the following courses
15-100 Introductory / Intermediate Programming
15-111 Intermediate / Advanced Programming
21-127 Concepts of Mathematics
80-210 Introduction to Logic
80-211 Arguments & Inquiry

Science Core (28 units)

8-10. Choose three of the following courses. Science majors must take at least two that are outside their major and in different departments.

03-121 Modern Biology
03-130 Biology of Organisms
09-105 Introduction to Modern Chemistry
09-106 Modern Chemistry II
33-111 Physics I for Science Students
33-112 Physics II for Science Students

Distribution Requirements (36 units)

11-14. Choose a minimum of four courses, minimum 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. Please see the SHS Director for approval.

Cognition, Choice, and Behavior

11. This category uses model-based analysis to broaden an understanding of human thinking, choices, and behavior on an individual basis across a variety of settings.

80-130 Introduction to Ethics
80-150 Nature of Reason
80-180 Nature of Language
80-181 Language and Thought
80-221 Philosophy of Social Science
80-230 Ethical Theory
80-241 Ethical Judgment in Professional Life
80-242 Conflict, Dispute Resolution
80-270 Philosophy of Mind
81-150 Philosophy and Psychology
85-100 Introduction to Intelligence in Humans, Animals and Machines
85-102 Introduction to Psychology
85-211 Cognitive Psychology
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Personality
85-261 Abnormal Psychology
88-120 Reason, Passion, and Cognition
Economic, Political, and Social Institutions

12. This category examines the ways in which institutions organize individual preferences and actions into collective outcomes using model-based reasoning.

- 36-303 Sampling, Surveys, and Society
- 70-332 Business and Society
- 73-100 Principles of Economics
- 79-223 Protest and Dissent in American History
- 79-331 Crime and Punishment
- 79-335 Drug Use and Drug Policy
- 79-345 American Environmental History: Critical Issues
- 79-350 Theories of International Relations
- 80-135 Introduction to Political Philosophy
- 80-136 Social Structure, Public Policy, and Ethical Dilemmas
- 80-235 Political Philosophy
- 80-236 Philosophy and the Law
- 80-243 Environment Management and Ethics
- 80-341 Computers, Society, and Ethics
- 88-104 Decision Processes in American Political Institutions
- 88-110 Experiments with Economic Principles
- 88-205 Comparative Politics

Creative Production and Reflection

13. This category is designed to encourage exploration of the artistic and intellectual creation of others while allowing for personal expression, and reflection upon the creative process.

- xx-xxx Any course from the College of Fine Arts
- 76-206 Introduction to Creative Writing
- 80-220 Reflections on Science
- 80-260 Philosophy and Art
- 82-1xx Any Elementary Modern Language course
- 82-2xx Any Intermediate Modern Language course

Cultural Analysis

14. 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.

- 57-173 Survey of Western Music History
- 66-250 Introduction to Religion
- 70-342 Managing Across Cultures
- 76-227 Comedy
- 76-232 African-American Studies
- 76-241 Introduction to Gender Studies
- 79-113 Culture and Identity in American Society
- 79-201 Introduction to Anthropology
- 79-206 Development of American Culture
- 79-207 Development of European Culture
- 79-209 Theory and Practice in Anthropology
- 79-218 The Roots of Rock & Roll
- 79-241 African-American History I
- 79-242 African-American History II
- 79-260 Mayan America
- 79-270 Chinese Culture and Society
- 79-368 Poverty, Charity, and Welfare
- 79-384 Medicine and Society
- 80-100 What Philosophy Is
- 80-151 God in the West
- 80-250 Ancient Philosophy
- 80-251 Modern Philosophy
- 80-253 Continental Philosophy
- 80-254 Analytical Philosophy
- 80-255 Pragmatism
- 80-261 Aesthetics of Mass Art
- 82-273 Introduction to Japanese Language & Culture
- 82-294 Topics in Russian Language and Culture
- 82-303 French Culture
- 82-304 Francophone World
- 82-325 Introduction to German Studies
- 82-333 Introduction to Chinese Language & Culture
- 82-342 Spain: Language and Culture
- 82-343 Latin America: Language and Culture
- 82-344 US Latinos: Language and Culture
- 82-345 Hispanic Literary and Cultural Studies

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) that 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
- 21-122 Integration, Differential Equations, and Approximation
- 21-127 Concepts of Mathematics
- 21-241 Matrix Algebra
- 21-259 Calculus in Three Dimensions
- 21-292 Operations Research I
- 21-355 Principles of Real Analysis I
- 21-369 Numerical Methods
- 21-xxx Mathematical Science Elective
- 21-xxx Mathematical Science Elective

Probability and Statistics: 36 Units

- 21-325 Probability
- 36-225 Introduction to Probability and Statistics I

Note: 21-325 Probability is preferred.

Data Analysis: 27 Units

- 36-247 Statistics for Laboratory Sciences
- 36-309 Experimental Design for Behavioral and Social Sciences
- 36-303 Surveys, Sampling & Society
- 36-401 Advanced Data Analysis I

Statistics and Data Analysis Electives: 18 Units

Complete two courses from the following:

- 21-393 Operations Research
- 36-402 Advanced Data Analysis II
- 36-462 Applied Multivariate Methods

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
- 21-127 Concepts of Mathematics
- 76-101 Interpretation and Argument
- 33-111 Physics for Science Students I
- 99-10x Computer Skills Workshop
### Freshman Year: Spring

- 21-122 Integration, Differential Equations, and Approximation
- 36-247 Statistics for Laboratory Sciences
- 79-104 World History
- xx-xxx Science
- xx-xxx Freshman Seminar

### Sophomore Year: Fall

- 21-201 Undergraduate Colloquium
- 21-241 Matrix Algebra
- 36-309 Experimental Design
- xx-xxx Economics, Political and Social Institutions
- xx-xxx Science
- xx-xxx Elective

### Sophomore Year: Spring

- 21-201 Undergraduate Colloquium
- 21-259 Calculus in Three Dimensions
- 21-292 Operations Research I
- xx-xxx Cultural Analysis
- xx-xxx Electives

### Junior Year: Fall

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

### Junior Year: Spring

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

### Senior Year: Fall

- 21-393 Operations Research II
- 36-401 Advanced Data Analysis I
- 36-461 Undergraduate Seminar
- xx-xxx Electives

### Senior Year: Spring

- 21-xxx Mathematical Science Elective
- 36-402 Advanced Data Analysis II
- 36-xxx Senior Research Elective
- xx-xxx Electives

### Unified Double Major in Psychology & Biological Sciences

This unified major is intended to reflect the interdisciplinary nature of 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 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 or the SHS programs.

Students entering from the Mellon College of Sciences receive a Bachelor of Science in Biological Sciences and Psychology.

### Mathematical Sciences/Statistics

- 21-120 Differential Calculus and Integral Calculus
- 21-122 Integration & Differential Equations and Calculus of Approximations
- 36-247 Statistics for Laboratory Sciences
- 36-309 Experimental Design for Behavioral and Social Sciences

* 36-201 can be used as an alternative, but 36-247 is strongly encouraged.

### Natural Sciences

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

### Computational Reasoning

- 99-101/102/103 CSW
- 15-100 Introductory/Intermediate Programming

### Discipline Core Requirements

**Biological Sciences**

- 03-121 Modern Biology
- 03-231 Biochemistry
- 03-240 Cell Biology
- 03-330 Genetics

**Psychology**

- 85-102 Introduction to Psychology

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

- 85-211 Cognitive Psychology or
- 85-213 Human Information Processing and Artificial Intelligence
- 85-219 Biological Foundations of Behavior
- 85-221 Principles of Child Development
- 85-241 Social Psychology
- 85-251 Personality

**Laboratory/Research Methods Requirements**

- 09-221 Chemistry Laboratory I
- 09-222 Chemistry Laboratory II
- 03-343 Experimental Genetics and Molecular Biology

**Research Methods in Psychology**

Complete one of the following:

- 85-310 Research Methods in Cognitive Psychology
- 85-320 Research Methods in Developmental Psychology

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)

See p. 238 (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 Undergraduate Additional Major
In Human-Computer Interaction
Richard Scheines, Undergraduate Advisor
Office: Baker Hall 135
For up to date information, see: www.hcii.cs.cmu.edu/

Overview
Human-Computer Interaction (HCI) is still 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, 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 Industrial Administration).

Curriculum

Required Courses:
85-211 Cognitive Psychology
or
85-213 Human Information Processing and Artificial Intelligence
15-100 Introductory/Intermediate Programming
05-430 or 431 Interface Programming
51-261 Communication Design Fundamentals
51-421 Visual Interface Design
05-410 Introduction to Human-Computer Interaction Methods
05-571 Project Course

Statistics Requirement:
The Statistics requirement can be satisfied by taking any of the following courses, or by receiving credit for courses taken elsewhere.
36-201 Statistical Reasoning, Statistical Methods
or
36-247 Intro to Biostatistics
or
36-220 Engineering Statistics and Quality Control
or
36-225 & 326 Introduction to Probability and Statistics I and II
or
36-207 Prob. and Statistics for Business Applications

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 Market Research

Electives (18 Units):
From the following list, or by permission from the major advisor:
Design
39-648 Wearable Computer Design
51-223 Computer Basics for CD
51-241 How People Work: Human Factors
51-247 Color and Communication
51-251 Digital Prototyping
51-348 Building Virtual Worlds
51-442 Integrated Product Development
51-4xx Interaction Design Seminar
60-414/422 Computer Animation - Robotic Art, etc.
76-273 Writing for Multimedia
76-479 Computers and Writing
76-487 On-line Information Design
76-491 Planning and Testing Documents
80-291 Issues in Multimedia Authoring

Computer Science
15-211 Fundamental Data Structures and Algorithms
15-212 Principles of Programming
15-462 Computer Graphics
15-499 Media Technology
15-880 Speech Recognition
70-459 Distributed Virtual Business

Human Behavior
45-392 Human Behavior in Organizations
45-453 Organizational uses of information systems
85-393 Human Factors
85-370 Perception
85-408 Visual Cognition
85-411 Cognitive Processes & Problem Solving
85-412 Production System Models of Thought
85-417 Intelligent Computer-Assisted Instruction
05-410 Computer Supported Cooperative Work
05-411 Cognitive Modeling
88-367 Computers and Organizations
70-311 Organization Behavior
70-451 Management Information Systems

Multimedia
80-291 Issues in Multimedia Authoring
76-482 Multimedia Authoring I
76-483 Multimedia Authoring II
76-273 Writing for Multimedia

Double Counting
Neglecting the three courses at the prerequisite level (51-261, Stats, & 15-100), at most three courses can be double-counted toward your 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.hcii.cs.cmu.edu/Academics/Undergrad/undergrad.html

The Minor in Arts in Society (AIS)
Sponsored by:
The Center for the Arts in Society (CAS)
College of Humanities and Social Sciences
College of Fine Arts

Faculty Advisor: Judith Schachter
Director, Center for the Arts in Society

The arts communicate a society's vision, voice its ethos, and simultaneously reflect and alter the political, social, and economic realities of the times. The Center for the Arts in Society's "Arts in Society" minor (AIS) provides students with the opportunity to examine the role that creativity plays in the continuity and coherence of cultures.

By definition, the Arts in Society program is multidisciplinary and draws upon the resources of the College of Fine Arts as well as the College of Humanities and Social Sciences. Under the guidance of the program advisor, students can investigate the history, context, and production of an aesthetic or social issue.

Curriculum (minimum) 48 units

The AIS Minor requires five courses from the general themes outlined below, as well as regular meetings.

I. Perspectives 18 units
These courses offer students two different approaches to understanding the role of the arts in society. The first perspective is historical; these courses offer a survey of an art or arts over time in diverse social contexts. The second approach is contextual or theoretical; these courses offer students an approach to the functions the arts may play in varying social contexts.

Distribution Requirement
One course must be historical in nature; one course must offer a contextual or theoretical perspective.

II. Project Courses 18 units
These courses offer students an opportunity to put what they have learned into practice in two ways. Studio/Research courses provide the students with research experience that will culminate either in a substantial written work or an artistic product. Practice courses allow students to apply knowledge to a project that gives them experience with the arts in a public realm. Choice of particular courses should be made in consultation with the AIS advisor.

Distribution Requirement
At least one course must be a studio/research course; one course must fulfill the practice requirement.

III. Independent Study/Capstone 12 units
This is where a student brings it all together. The student will develop an independent project and produce an installation, paper, composition, or other major work that demonstrates his or her understanding of the role of the arts in society. The topic for an independent study should be done in consultation with the AIS advisor.

AIS Monthly Seminar
Facilitated by the Center to insure cohesion and continuity in the minor, the non-credit meetings are to be attended while students are concurrently enrolled in AIS courses.

Courses that fulfill the AIS minor can come from either college, and are available to all undergraduate students. Courses may be from the catalog or be offered by visiting fellows and scholars. Interested students should consult with the advisor to develop an individual course sequence that fulfills their needs and the requirements of the AIS minor.

In a given semester, for example, courses might include the following:

Historical
48-240/79-104 Survey of World Architecture & Urbanism
48-340 Modern Architecture and Theory 1900-1945
48-348 Architecture of Central & South America
48-446 Renaissance & Baroque Architecture
51-271 Design History I
54-239 History of Architecture & Décor
54-245 History of Clothing
54-381 History of Drama
57-173 Survey of Western Music History
57-204 18th and 19th Century Music History
57-283 Music History I
57-306 World Music
57-404 String Quartet: A Social History
57-457 Jazz History I
60-377/79-321 Picasso and 20th Century Art
62-371/79-372 Photography, The First 100 Years
64-100 Critical Histories of the Arts
76-239 Introduction to Film Studies
76-432 Modernism and the Harlem Renaissance
79-237 City Histories: Delhi and London
79-355 American Skyscraper: Its History and Development
79-359 History of African-American Families
82-323 Germany, Austria and Switzerland in the 20th Century
The Minor in Health Care Policy and Management

Sponsored by:
H. John Heinz III School of Public Policy and Management
College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors: Caroline Acker, Naum Kats, and Stephanie Wallach, College of Humanities and Social Sciences
Brenda Peyser, H. John Heinz III School of Public Policy and Management, Amy Burkert, 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 (minimum) 60 units

Six courses (a minimum of 60 units) are required to complete this minor. Entry into the minor requires completion of 73-250, Intermediate Microeconomics or 88-220, Policy Analysis I or the equivalent by approval.

Required Courses 33 units

Students are required to take the following courses.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-384</td>
<td>Medicine and Society</td>
</tr>
<tr>
<td>90-761</td>
<td>Introduction to Health Care Policy and Management</td>
</tr>
<tr>
<td>90-735</td>
<td>Health Economics</td>
</tr>
</tbody>
</table>

Elective Courses 27 units

Complete three courses totaling a minimum of 27 units.

Heinz School Courses (12 units each)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-721</td>
<td>Non-Profit and Health Marketing</td>
</tr>
<tr>
<td>91-830</td>
<td>Financial Management of Health Systems</td>
</tr>
<tr>
<td>91-836</td>
<td>Legal Issues in Health Systems Management</td>
</tr>
<tr>
<td>91-844</td>
<td>Managing Quality Improvement</td>
</tr>
<tr>
<td>91-853</td>
<td>Health Care Information Systems</td>
</tr>
<tr>
<td>91-861</td>
<td>Health Policy</td>
</tr>
<tr>
<td>91-862</td>
<td>Managed Care</td>
</tr>
</tbody>
</table>

Humanities and Social Sciences Courses (9 units each)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-494</td>
<td>Medical Communications</td>
</tr>
<tr>
<td>79-335</td>
<td>Drug Use and Drug Policy</td>
</tr>
<tr>
<td>79-336</td>
<td>Epidemic Disease and Public Health</td>
</tr>
<tr>
<td>80-245</td>
<td>Medical Ethics</td>
</tr>
<tr>
<td>85-241</td>
<td>Social Psychology</td>
</tr>
<tr>
<td>85-442</td>
<td>The Social Psychology of Health</td>
</tr>
<tr>
<td>85-446</td>
<td>The Psychology of Gender</td>
</tr>
<tr>
<td>85-451</td>
<td>The Psychology of Purpose</td>
</tr>
<tr>
<td>88-373</td>
<td>Mental Health Ideologies</td>
</tr>
</tbody>
</table>

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.
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. Amy Burkert at ak11@andrew.cmu.edu in Doherty Hall 1320 or Dr. Mark Stehlik at mjs@cs.cmu.edu in Wean Hall 5103 no later than the end of October.

Degree Requirements

Math/Stats Core

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Diff Equations, and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>21-127 Concepts of Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-XXX Math Elective (21-241, 21-260, 21-341)</td>
<td>9</td>
</tr>
<tr>
<td>36-XXX Statistics Elective (36-217, 36-225, 36-247, 36-625)</td>
<td>9</td>
</tr>
</tbody>
</table>

Total Units 47

General Science Core

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105 Intro to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-106 Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-217 Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>23-111 Physics for Science Students I</td>
<td>12</td>
</tr>
</tbody>
</table>

Total Units 41

Biological Sciences Core

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-231/232 Biochemistry</td>
<td>9</td>
</tr>
<tr>
<td>03-240 Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-330 Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-124 Modern Biology Laboratory or Lab 1: Chemical Analysis</td>
<td>9-12</td>
</tr>
<tr>
<td>03-201 Colloquium</td>
<td>1</td>
</tr>
<tr>
<td>15-128 Immigration</td>
<td>1</td>
</tr>
<tr>
<td>03-411 Topics in Research</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Units 47-50

Computer Science Core

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-111 Intermediate/Advanced Programming</td>
<td>10</td>
</tr>
<tr>
<td>15-123 Effective Programming in C and UNIX</td>
<td>9</td>
</tr>
<tr>
<td>15-211 Fundamental Data Structures and Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>15-251 Great Theoretical Ideas in Computer Science I</td>
<td>12</td>
</tr>
<tr>
<td>15-451 Algorithm Design and Analysis</td>
<td>9</td>
</tr>
</tbody>
</table>

Total Units 52

Major Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-510 Computational Biology or Computational Molecular Biology and Genomics</td>
<td>9-12</td>
</tr>
<tr>
<td>03-511 Computational Molecular Biology and Genomics</td>
<td>9-12</td>
</tr>
<tr>
<td>03-xxx/15-xxx 2 Computational Biology Electives</td>
<td>18-24</td>
</tr>
<tr>
<td>03-3XX Advanced Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td>15-3XX Advanced Computer Science Elective</td>
<td>9</td>
</tr>
<tr>
<td>15-ALG Fundamentals of Algorithms Course</td>
<td>9</td>
</tr>
</tbody>
</table>

Choose one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-354 Computational Discrete Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>15-355 Modern Computer Algebra</td>
<td>9</td>
</tr>
<tr>
<td>15-411 Bug Catching: Automated Program Verification and Testing</td>
<td>9</td>
</tr>
<tr>
<td>21-301 Combinatorics</td>
<td>9</td>
</tr>
<tr>
<td>21-373 Algebraic Structures</td>
<td>9</td>
</tr>
<tr>
<td>21-494 Graph Theory</td>
<td>9</td>
</tr>
</tbody>
</table>

Total Units 54-63

General Education

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>99-101, 102, 103 Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td>76-101 Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td>Elective Cognition, Choice and Behavior</td>
<td>9</td>
</tr>
<tr>
<td>Elective Economics, Political and Social Institutions</td>
<td>9</td>
</tr>
<tr>
<td>Elective Cultural Analysis</td>
<td>9</td>
</tr>
<tr>
<td>Elective Non-technical Elective</td>
<td>9</td>
</tr>
<tr>
<td>Elective Non-technical Elective</td>
<td>9</td>
</tr>
<tr>
<td>Elective Non-technical Elective</td>
<td>9</td>
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<tr>
<td>Elective Non-technical Elective</td>
<td>9</td>
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</tbody>
</table>

Total Units 75

Free Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective Free Elective</td>
<td>32-44</td>
</tr>
</tbody>
</table>

Total Units 32-44

Minimum number of units required for degree: 360
The curriculum encourages students to confront professional problems, accomplished through team and problem-oriented courses, as well as courses which emphasize design or individual projects. These classes stress creativity and independent thought and require the student to define the problem, propose a solution or a design in the presence of technical and socioeconomic constraints, to make judgments among alternative solutions, and to explore innovative alternatives to more conventional solutions.

**First Year for Engineering Students**

The Carnegie Mellon engineering education is based on engineering and science fundamentals that give students the skills to face new and challenging situations. The first year in engineering provides a broad foundation upon which students build a curriculum in their eventual major. Since students in CIT do not select a major until the end of the first year, all first year students share a common experience consisting of introductory courses in the engineering majors (one each semester), calculus, physics, other science courses which complement specific introductory engineering courses, and courses in the College of Humanities and Social Sciences (General Education). This curriculum helps make an informed decision about a final major. Below is an example of a standard schedule for a first-year engineering student.

<table>
<thead>
<tr>
<th>Fall Semester</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductory Engineering Elective</td>
<td>12</td>
</tr>
<tr>
<td>Restricted Technical Elective</td>
<td>9-12</td>
</tr>
<tr>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>A Writing/Expression Course</td>
<td></td>
</tr>
<tr>
<td>Computer Skills Workshop</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring Semester</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductory Engineering Elective</td>
<td>12</td>
</tr>
<tr>
<td>Restricted Technical Elective</td>
<td>10</td>
</tr>
<tr>
<td>Integration, Differential Equations, Approximation</td>
<td></td>
</tr>
<tr>
<td>General Education Course</td>
<td>9</td>
</tr>
</tbody>
</table>

**Notes:**

1. Each semester every CIT department offers its Introductory Engineering Elective*. Every first year CIT student must select one such course each semester.

2. Each Introductory Engineering Elective requires a specific Restricted Technical Elective (to be taken prior to or contemporarily with the Introductory Engineering Elective) chosen from the above set as follows.

**Introductory Engineering Course**

<table>
<thead>
<tr>
<th>Restricted Technical Elective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomedical Engineering</td>
</tr>
<tr>
<td>Chemical Engineering</td>
</tr>
<tr>
<td>Civil &amp; Environmental Engineering</td>
</tr>
<tr>
<td>Electrical &amp; Computer Engineering</td>
</tr>
<tr>
<td>Engineering &amp; Public Policy</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
</tr>
<tr>
<td>Materials Science and Engineering</td>
</tr>
</tbody>
</table>

3. 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 15-100 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 this 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.

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1. Each semester every CIT department offers its Introductory Engineering Elective. Every first year CIT student must select one such course each semester.

2. Each Introductory Engineering Elective requires a specific Restricted Technical Elective (to be taken prior to or contemporarily with the Introductory Engineering Elective) chosen from the above set as follows.

**Introductory Engineering Course**

<table>
<thead>
<tr>
<th>Restricted Technical Elective</th>
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<tbody>
<tr>
<td>Biomedical Engineering</td>
</tr>
<tr>
<td>Chemical Engineering</td>
</tr>
<tr>
<td>Civil &amp; Environmental Engineering</td>
</tr>
<tr>
<td>Electrical &amp; Computer Engineering</td>
</tr>
<tr>
<td>Engineering &amp; Public Policy</td>
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<tr>
<td>Mechanical Engineering</td>
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<tr>
<td>Materials Science and Engineering</td>
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</tbody>
</table>

3. 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 15-100 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 this 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.
**Program In General Education for CIT Students**

**Breadth Requirement** 27 Units

**Humanistic Studies (Cultural Analysis)** 9 units
79-104 Introduction to World History

**Cognitions and Institutions** 9 units
73-100 Principles of Economics
or
85-100 Introduction to Intelligence

**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 School, 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 School 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).

**Double Majors and Double Degrees in CIT**
A major is defined as a program that must be completed for the granting of a degree. Double majors comprise a single degree with majors in two separate areas; for example, the degree of Bachelor of Science in Chemical Engineering and a double major in English. Although the double 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 double 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 double major through the second department and coordinate requirements with both departments. The double 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 CIT students wishing to complete Double Majors**
The student must satisfactorily pass 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 double 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. At the CIT advisor’s discretion, equivalent technical electives may be substituted from either MCS or SCS departments.

Non-technical courses in the curricula can be altered 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 may 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:

* Automation and Control
* Biomedical Engineering
* Colloids, Polymers and Surfaces
* Data Storage Systems Technology
* Electronic Materials
* Engineering Design
* Environmental Engineering
* International Engineering
* Manufacturing Engineering
* Material Science and Engineering
* Mechanical Behavior of Materials
* Robotics (described on the following page)*
* Also available for non-CIT students

Complete descriptions of the designated minors can be found on p. 89-92. To add a CIT Designated Minor, please go to the CIT Dean’s Office (Scaife Hall 110). Contact the director listed under each minor.
Biomedical Engineering Minor  
(for non-engineering students)
Tod Przybycien, Director Office: Doherty Hall A-220

General Requirements (five courses, 51-57 units, plus pre- and co-requisite courses including 03-121, Modern Biology). Students 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.

- Introduction to BME (42-101) 12 units
- A secondary Introductory Engineering Course 12 units
- BME Elective or Domain* 9-12 units
- BME Elective or Domain** 9-12 units
- BME Elective or Domain** 9-12 units

*Cannot be a course required by your home department.

** Courses marked with an (*) must be offered by any of the CIT Departments
(06-xxx, 12-xxx, 18-xxx, 24-xxx, 27-xxx or 42-xxx)

BME Domain Courses
03-121 Modern Biology
03-240 Cell Biology
03-310 Introduction to Computational Biology
03-311 Computational Molecular Biology
03-330 Genetics
03-343 Experimental Genetics and Molecular Biology
03-344 Experimental Biochemistry
03-345 Experimental Cell and Developmental Biology
03-350 Developmental Biology
03-438 Physical Biochemistry
03-439 Introduction to Biophysics
03-441 Molecular Biology of Prokaryotes
03-442 Molecular Biology of Eukaryotes
03-510 Computational Biology
03-533 NMR in Biomedical Sciences
03-534 Bio Imaging Fluorescence Spectroscopy
09-245 Physical Chemistry II
15-211 Fundamental Structures of Computer Science I
42-301 Physiolgy
42-377 Rehabilitation Engineering
42-501 Special Topics: Biomaterials I & II
42-560 Research Project (at CMU or UPMC)
42-604 Biological Transport
42-621/626-621 Biotechnology & Environmental Processes
42-622/626-622 Bio Process Design
42-644 Medical Devices
42-651/652/651 Air Quality Engineering
42-652 Introduction to Biomechanics
42-723/723/723 Biological Processes in Environmental Systems

BME Electives
06-607 Phys Chem of Colloids and Surfaces
06-609/609-609 Physical Chemistry of Macromole
06-613/613-613 Exp Colloid Science
06-314 Exp Polymer Science
08-426 Experimental Colloid Surface Science
08-466 Experimental Polymer Science
19-300* Special Topics in Biotechnology
19-467 General Robotics
24-779 Human Systems and Control

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.

1. Two of the following:
   06-101 Introduction to Chemical Engineering
   12-100 Introduction to Civil and Environmental Engineering
   18-100 Introduction to Electrical & Computer Engineering
   19-101 Introduction to Engineering & Public Policy
   24-101 Introduction to Mechanical Engineering
   27-100 Engineering the Materials of the Future
   42-101 Introduction to Biomedical Engineering

2. Three courses of at least 9 units each from one of more CIT departments

   NOTE: The following courses may NOT be included as part of the Minor in Engineering Studies
   12-090 Technology and the Environment
   18-200/18-202 Math Foundations of Electrical Engineering
   19-319 Law and the Engineer
   19-321 Law and Technology
   24-160 Engineering Graphics
   42-500 Physiology
   42-501 Physiology

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)
Mark Kieler, 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 (Fall) 3 units
   19-451 or 452 EPP Project (Fall or Spring) 12 units
   73-100 Principles of Economics (Fall or Spring) 9 units
   88-223 Decision, Analysis & Decision Support Systems (Spring) 88-302 Behavioral Decision Making (Fall) 19-426 Environmental Decision Making (Fall)

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

Decision Science Course* 9 units

*Choose one of the following:
   88-223 Decision, Analysis & Decision Support Systems (Spring)
   88-302 Behavioral Decision Making (Fall)
   19-426 Environmental Decision Making (Fall)
Robotics Minor

The following courses are required for the Minor in Robotics:

Prerequisites:
- 15-111 Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
- 15-123 Effective Programming in C and UNIX

Minor requirements:
- 16-311 Introduction to Robotics
- One of the following courses:
  - 15-384 Robotic Manipulation
  - 24-355 Kinematics and Dynamics of Mechanisms
- One of the following courses:
  - 16-299 Introduction to Feedback Control Systems
  - 18-370 Fundamentals of Control
  - 24-451 Feedback Control Systems
- Two of the following electives:
  - 15-381 Artificial Intelligence: Representation & Problem Solving
  - 15-385 Computer Vision
  - 15-463 Computational Photography
  - 15-681 Artificial Intelligence: Machine Learning
  - 16-284 Humanoids
  - 16-362 Mobile Robot Programming Laboratory
  - 16-721 Advanced Perception
  - 16-735 Motion Planning
  - 16-778 Mechatronics Design
  - 60-422 Advanced ETB: Robotic Art Studio
  - 85-213 Information Processing and Artificial Intelligence
  - 85-370 Perception

More information on the minor can be found at http://www.r.cmu.edu/education/ugrad_minor.html.

Double-Counting Restriction

Courses in the Robotics Minor may not also be counted towards another SCS minor.

Academic Standards Grading Practices

Undergraduate grading regulations are detailed starting on pages 54.

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. No first-year student will be considered for transfer until 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 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 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.

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 Students
Status Schedule Changes
(See page 29 for add/drop procedure information and page 55 for grading procedures for dropped courses)

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:

* 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 (previously described)

An engineering student may elect to complete a CIT designated minor. Generally, the student takes all the required courses in an engineering major but uses electives to take courses needed to fulfill the requirements of the designated minor. Upon completion of the requirements of a CIT designated minor and the engineering degree, the minor is 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.

### 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

Electrical & Computer Engineering - Pradeep K. Khosla
Civil & Environmental Engineering - James Garrett
Mechanical Engineering - William Messner
Chemical Engineering - Erik Ydstie

#### Course Requirements for Automation and Control Engineering Minor

The minor requires a minimum of six courses as described below:

Note: The course lists below are not necessarily current or complete. Appropriate courses not listed below may be counted toward the requirements for the minor upon approval by one of the departmental faculty advisors. Students interested in the Automation and Control Engineering Designated Minor are encouraged to look for applicable courses each semester in CIT, CS, and Robotics.

**One basic control course:**

- 06-362 Chemical Engineering Process Control
- 18-470 Fundamentals of Control
- 24-451 Feedback Control Systems

**One course on control system analysis and design:**

- 06-708 Advanced Process Dynamics and Control
- 18-771 Linear Systems

**One course on computing and software:**

- 15-200 Advanced Programming/Practicum
- 15-211 Fundamental Structures of Computer Science I
- 15-212 Fundamental Structures of Computer Science II
- 12-741 Advanced Programming Concepts in CAE
- 18-549 Distributed Embedded Systems

**One course on hardware implementation:**

- 06-311 Unit Operations Laboratory
- 18-474 Embedded Control Systems
- 18-578 Mechatronic Design

**One course on applications:**

- 06-606 Computational Methods for Large Scale Process Design and Analysis
- 12-615 Traffic Flow Theory and Operations
- 24-354 General Robotics
- 16-743 Robot Control
- 16-761 Introduction to Mobile Robots
- 24-356 Engineering Vibrations
- 24-351 Engineering Dynamics
- xx-xxx 12 independent project units

**One elective course:**

- xx-xxx Any course in the list above excluding the basic control course category
- 12-748 Design of CAE Systems
- 15-381 Artificial Intelligence: Representation and Problem Solving
- 15-385 Computer Vision
- 15-413 Software Engineering
- 15-498 Introduction to Real-Time Software
- 18-349 Embedded Realtime Systems
- 18-491 Digital Signal Processing I
- 18-771 Linear Systems
- 18-777 Complex Large-Scale Dynamic Systems
- 24-341 Manufacturing Sciences
- 24-772 Multivariable Process and Nonlinear Control
Biomedical Engineering Designated Minor

Todd Przybycien, Director Office: Doherty Hall A-220

Biomedical Engineering (BME) at Carnegie Mellon is designed to train engineering students to apply the techniques of mathematics and science to the solution of 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. Students graduate with an accredited engineering degree in a traditional engineering major with a minor in biomedical engineering.

What Can a Student Do After Completing the Bachelor’s Degree?

Upon completing the Biomedical Engineering Minor, the student may elect to continue graduate studies in Bioengineering at either the Masters or Ph.D. levels, or continue in medical school for the M.D. degree. Many of the courses in the BME minor will assist in preparing you for medical school. Students who remain in the field of biomedical engineering are involved with developing and improving medical instruments and devices, automating medical procedures using computers, characterizing the operation of physiological systems, designing artificial organs and altering microbes and mammalian cells so that useful drugs and chemicals can be produced. The graduate may secure employment in areas of bioinstrumentation, biocompatibility, optics, pharmacology, or the environment.

Faculty Advisors

The Biomedical Engineering Program provides a focus for faculty from diverse engineering backgrounds. There is also extensive collaboration with investigators in the local health care community. Clinical collaborations are seen as vehicles to keep research responsive to clinical needs, enhance the exposure of our students to a variety of clinical environments, and assist the clinical community in solving engineering problems.

One faculty member will be assigned the advisor to each engineering department. Hilda Diamond in Doherty Hall 2100 will also help with the bookkeeping aspects of advising and attention to details (student course requirements, scheduling of BME courses, working with departments to avoid conflict). Coordination with advising in the other major of the student is essential. Students will need to have traditional engineering advisor to approve final schedules. Following are advisors in departments:

Chemical Engineering: Dr. Todd Przybycien, Dr. Michael Domach, Dr. Lynn Walker Civil & Environmental Engineering: Dr. Jean VanBriesen Electrical & Computer Engineering: Dr. Richard Stern, Dr. Chuck Neuman Materials Science & Engineering: Dr. Lisa Porter; Dr. Henry Piehler Mechanical Engineering: Dr. Cristina Amon, Dr. Jon Cagan

A summer opportunities program is available to students pursuing the minor at the completion of their sophomore year.

Course Requirements for Biomedical Engineering Designated Minor

General Requirements (five courses, 48-51 units)

- Introduction to BME (42-101) 12 units
- Modern Biology (03-211) or Biochemistry (03-231 or 232) 9 units
- BME Elective or Domain 9-12 units
- BME Elective or Domain 9-12 units
- BME Elective or Domain 9-12 units

BME Domain Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
</tr>
<tr>
<td>03-240</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>03-310</td>
<td>Introduction to Computational Biology</td>
</tr>
<tr>
<td>03-311</td>
<td>Computational Molecular Biology</td>
</tr>
<tr>
<td>03-330</td>
<td>Genetics</td>
</tr>
<tr>
<td>03-343</td>
<td>Experimental Genetics and Molecular Biology</td>
</tr>
<tr>
<td>03-344</td>
<td>Experimental Biochemistry</td>
</tr>
<tr>
<td>03-345</td>
<td>Experimental Cell and Developmental Biology</td>
</tr>
<tr>
<td>03-350</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>03-438</td>
<td>Physical Biochemistry</td>
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<tr>
<td>03-439</td>
<td>Introduction to Biophysics</td>
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<td>03-441</td>
<td>Molecular Biology of Prokaryotes</td>
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<td>03-442</td>
<td>Molecular Biology of Eukaryotes</td>
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<td>03-510</td>
<td>Computational Biology</td>
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<td>NMR in Biomedical Sciences</td>
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<td>03-534</td>
<td>Bio Imaging Fluorescence Spectroscopy</td>
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<td>09-245</td>
<td>Physical Chemistry II</td>
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<tr>
<td>15-211</td>
<td>Fundamental Structures of Computer Science I</td>
</tr>
<tr>
<td>42-301</td>
<td>Physiology</td>
</tr>
<tr>
<td>42-377</td>
<td>Rehabilitation Engineering</td>
</tr>
<tr>
<td>42-501</td>
<td>Special Topics: Biomaterials I &amp; II</td>
</tr>
<tr>
<td>42-560</td>
<td>Research Project (at CMU or UPMC)</td>
</tr>
<tr>
<td>42-604</td>
<td>Biomedical Transport</td>
</tr>
<tr>
<td>42-621/06-621</td>
<td>Biotechnology &amp; Environmental Processes</td>
</tr>
<tr>
<td>42-622/06-622</td>
<td>Bioproduct Design</td>
</tr>
<tr>
<td>42-644</td>
<td>Medical Devices</td>
</tr>
<tr>
<td>42-651/12-651</td>
<td>Air Quality Engineering</td>
</tr>
<tr>
<td>42-652</td>
<td>Introduction to Biomechanics</td>
</tr>
<tr>
<td>42-723/12-723</td>
<td>Biologically Processes in Environmental Systems</td>
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</tbody>
</table>

BME Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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</thead>
<tbody>
<tr>
<td>06-067</td>
<td>Phys Chem of Colloids and Surfaces</td>
</tr>
<tr>
<td>06-069/09-509</td>
<td>Physical Chemistry of Macromole 06-313</td>
</tr>
<tr>
<td>06-313</td>
<td>Exp Colloid Science</td>
</tr>
<tr>
<td>06-314</td>
<td>Exp Polymer Science</td>
</tr>
<tr>
<td>06-426</td>
<td>Experimental Colloid Surface Science</td>
</tr>
<tr>
<td>06-466</td>
<td>Experimental Polymer Science</td>
</tr>
<tr>
<td>18-3XX*</td>
<td>Special Topics in Biotechnology</td>
</tr>
<tr>
<td>24-354</td>
<td>General Robotics</td>
</tr>
<tr>
<td>24-779</td>
<td>Human Systems and Control</td>
</tr>
<tr>
<td>27-432</td>
<td>Electrical, Magnetic, and Optical Properties of Materials</td>
</tr>
<tr>
<td>27-441</td>
<td>Deformation and Fracture of Materials</td>
</tr>
<tr>
<td>36-247</td>
<td>Statistics for Lab Sciences</td>
</tr>
<tr>
<td>39-319</td>
<td>Law and the Engineer</td>
</tr>
<tr>
<td>88-270</td>
<td>Networking: Organizations, Knowledge, and Technology</td>
</tr>
<tr>
<td>88-302</td>
<td>Behavioral Decision Making</td>
</tr>
<tr>
<td>88-340</td>
<td>Economics of Entrepreneurship in High Technology Industries</td>
</tr>
<tr>
<td>90-830</td>
<td>Financial Management of Health System</td>
</tr>
<tr>
<td>90-831</td>
<td>Health Management Systems</td>
</tr>
<tr>
<td>90-836</td>
<td>Legal Issues in Health Systems Management</td>
</tr>
<tr>
<td>90-837</td>
<td>Health Project Planning &amp; Management</td>
</tr>
<tr>
<td>90-650</td>
<td>Introduction to Health Care Management</td>
</tr>
<tr>
<td>90-853</td>
<td>Health Care Information Systems</td>
</tr>
<tr>
<td>90-861</td>
<td>Health Policy</td>
</tr>
</tbody>
</table>

*Since most Electrical and Computer Engineering courses are electives and circuits and signals integral to many medical technologies, a student could use just about any 18-XYZ course where X is greater than 1 and a student can satisfy prerequisites or obtain permission from the instructor.

Students are encouraged to select an interdisciplinary capstone course or independent research project for one of the BME electives. Like the requirements for the BME double major, the requirements for the BME minor satisfy various categories of electives in the curriculum and should increase the total number of units/courses required for the primary CIT degree.

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 for Colloids, Polymers and Surfaces Designated Minor

One course from the following list:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-221</td>
<td>Thermodynamics</td>
</tr>
<tr>
<td>24-221</td>
<td>Thermodynamics I</td>
</tr>
<tr>
<td>27-215</td>
<td>Thermodynamics of Materials</td>
</tr>
<tr>
<td>33-341</td>
<td>Thermal Physics I</td>
</tr>
<tr>
<td>09-345</td>
<td>Physical Chemistry II (Thermo)</td>
</tr>
</tbody>
</table>

The following four courses are required:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-069/09-509</td>
<td>Physical Chemistry of Macromolecules</td>
</tr>
<tr>
<td>06-607</td>
<td>Physical Chemistry of Colloids and Surfaces</td>
</tr>
<tr>
<td>06-426</td>
<td>Experimental Colloid and Surface Science</td>
</tr>
<tr>
<td>06-466</td>
<td>Experimental Polymer Science</td>
</tr>
</tbody>
</table>
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. Introduction to Data Storage Systems (18-416), Data Storage Systems Design Projects (18-517), 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 for Data Storage Systems Technology Minor

Required Courses (Two Undergraduate Courses):
18-416 Data Storage Systems
18-517 Data Storage Systems Design Project
33-448 Introduction to Solid State Physics

Elective Courses

Materials and Chemistry Concentration
06-607 Physical Chemistry of Colloids and Surfaces
06-609 Physical Chemistry of Macromolecules
06-619 Semiconductor Processing
06-709 Polymeric Materials
06-714 Surfaces and Adsorption
09-248 Inorganic Chemistry
09-511 Solid State Materials Chemistry
27-432 Electrical, Magnetic, and Optical Properties of Materials
27-542 Structure and Properties of Thin Films

Physics of Data Storage Concentration
33-225 Quantum Physics and the Structure of Matter
33-448 Introduction to Solid State Physics
33-453 Intermediate Optics

A graduate course in quantum physics, magnetism, or optics

Dynamics, Control and Signal Processing Concentration
24-451 Feedback Control Systems
24-356 Engineering Vibrations
18-396 Signals and Systems
18-474 Embedded Control Systems

A graduate course in controls, dynamics, or signal processing

Computer Systems Concentration
15-412 Operating Systems
18-348 Embedded Systems Engineering
18-349 Embedded Control Systems
18-549 Distributed Embedded Control Systems

A graduate course in computer systems

Circuit Design Concentration
18-525 Integrated Circuit Design Project
18-527 Digital Systems on a Chip Design
18-545 Advanced Digital Design Project

A graduate course in circuit design

Other Non-Concentration Courses

An independent study project 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.

Faculty Advisors

The designated minor will be administered by the co-directors listed above. Current faculty advisors are:

Chemical Engineering - Paul Sides Civil and Environmental Engineering - Jacobo Bielak Michael Reed and T. E. Schlesinger Engineering and Public Policy - M. Granger Morgan Materials Science Engineering - Marek Skowronski

Course Requirements for Electronic Materials Minor

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 & Computer Engineering (MSE students)
27-201 Perfect Crystals including lab (ECE students)

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)
06-619 Semiconductor Processing Technology
27-542 Thin Films
27-217 Phase Relations (ECE students only)
27-533 Principles of Growth and Processing of Semiconductors
27-432 Electronic, Magnetic, and Optical Properties (only if not required in your curriculum)
27-551 Properties of Ceramics and Glasses
27-216 Transport in Materials (ECE students only)
33-225 Quantum Physics and Structure of Matter (ECE students only)
### Engineering Design Designated Minor

**Gary Fedder, Director Office:** Hamburg Hall 1201

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, teamwork, and real-world problem solving, and three elective courses, at least one of which involves 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 - Robert A. Rutenbar and Daniel P. Siewiorek
- Mechanical Engineering - Jonathan Cagan and Kenji Shimada
- Materials Science and Engineering - David A. Dzombak
- Chemical Engineering - Neil M. Donahue
- Civil and Environmental Engineering - David A. Dzombak
- Electrical and Computer Engineering - Sarosh Talukdar
- Mechanical Engineering - Allen L. Robinson
- Materials Science and Engineering - Henry Pielch

### Course Requirements for Engineering Design Minor

#### Required Courses:
- 39-425 Rapid Prototype Design
- 39-405 Engineering Design: Creation of Products and Processes
- 39-605/606 Engineering Design Projects Courses
- 39-648 Rapid Prototyping of Computer Systems

#### 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, or by permission of the Minor Advisors.

### Undergraduate Elective Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-421</td>
<td>Chemical Process Systems Design</td>
</tr>
<tr>
<td>06-426</td>
<td>Design Project</td>
</tr>
<tr>
<td>12-401</td>
<td>Engineering Synthesis and Design</td>
</tr>
<tr>
<td>12-605</td>
<td>Design and Construction</td>
</tr>
<tr>
<td>12-631</td>
<td>Structural Design</td>
</tr>
<tr>
<td>18-474</td>
<td>Computer Control Systems Design Laboratory</td>
</tr>
<tr>
<td>18-517</td>
<td>Data Storage Design Project</td>
</tr>
<tr>
<td>18-523</td>
<td>Analog Integrated Circuit Design</td>
</tr>
<tr>
<td>18-525</td>
<td>Integrated Circuit Design Project</td>
</tr>
<tr>
<td>18-545</td>
<td>Advanced Digital Design Project</td>
</tr>
<tr>
<td>18-551</td>
<td>Digital Communications and Signal Processing</td>
</tr>
<tr>
<td>18-575</td>
<td>Control System Design</td>
</tr>
<tr>
<td>24-441</td>
<td>Engineering Design</td>
</tr>
<tr>
<td>24-442</td>
<td>Engineering Design - EPP</td>
</tr>
<tr>
<td>24-443</td>
<td>Design for Manufacture</td>
</tr>
<tr>
<td>27-357</td>
<td>Introduction to Materials Selection</td>
</tr>
<tr>
<td>27-421</td>
<td>Processing Design</td>
</tr>
<tr>
<td>39-647</td>
<td>Independent Study in Engineering Design</td>
</tr>
<tr>
<td>39-350/750</td>
<td>Computational Modeling and Analysis of Societies, Organizations and Technologies</td>
</tr>
<tr>
<td>42-580</td>
<td>Medical Instrumental Design</td>
</tr>
</tbody>
</table>

### Graduate Elective Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-606</td>
<td>Computational Methods for Large Scale Design &amp; Analysis</td>
</tr>
<tr>
<td>06-715</td>
<td>Advanced Process Synthesis</td>
</tr>
<tr>
<td>12-747</td>
<td>CAE Software Project</td>
</tr>
<tr>
<td>12-740</td>
<td>CAE Tools</td>
</tr>
<tr>
<td>18-723</td>
<td>Advanced Analog Integrated Circuit Design</td>
</tr>
<tr>
<td>18-725</td>
<td>Digital Integrated Circuit Design</td>
</tr>
<tr>
<td>18-728</td>
<td>Applications of Analog Integrated Circuits</td>
</tr>
<tr>
<td>18-745</td>
<td>Rapid Prototyping Computer Systems (cross-listed with 39-648)</td>
</tr>
<tr>
<td>18-747</td>
<td>Superscalar Processor Design</td>
</tr>
<tr>
<td>18-778</td>
<td>Mechatronic Design (cross-listed with 16-778 and 24-778)</td>
</tr>
<tr>
<td>24-778</td>
<td>Mechatronic Design (cross-listed with 16-778 and 24-778)</td>
</tr>
<tr>
<td>24-781</td>
<td>Design Procedures</td>
</tr>
<tr>
<td>24-784</td>
<td>Computational Design Tools</td>
</tr>
</tbody>
</table>

### Environmental Engineering Designated Minor

**David Dzombak, 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. Effective preparation in Environ-mental Engineering requires broad knowledge and skills in the areas of environmental science, environmental engineering and environ-mental policy.

Course requirements from each of these areas are thus included as part of the program for the Environmental Engineer-ing minor.

**Faculty Advisors**
The Environmental Engineering program is a focus for faculty from diverse engineering backgrounds. The faculty are actively engaged in teaching and conducting research in this field. Current faculty advisors are:

- Chemical Engineering – Neil M. Donahue
- Civil and Environmental Engineering - David A. Dzombak
- Electrical and Computer Engineering - Sarosh Talukdar
- Mechanical Engineering - Allen L. Robinson
- Materials Science and Engineering - Henry R. Pielch

### Course Requirements for Environmental Engineering Minor

The requirements include two science-oriented courses, three engineering courses, and two policy courses. Three of the five science and engineering courses must be from outside the student’s major department to ensure a diversity of exposure. The two policy courses are counted as part of the courses in the areas of humanities, social sciences, or fine arts required of all CIT students. The Environmental Engineering Minor consists of seven courses, chosen from the lists below. Course descriptions are available online from Enrollment Services.

**A. Environmental Science Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
</tr>
<tr>
<td>03-122</td>
<td>Organismic Botany</td>
</tr>
<tr>
<td>03-130</td>
<td>Biology of Organisms</td>
</tr>
<tr>
<td>03-231</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>03-310</td>
<td>Introduction to Computational Biology; or</td>
</tr>
<tr>
<td>03-510</td>
<td>Computational Biology</td>
</tr>
<tr>
<td>06-221</td>
<td>Thermodynamics; or</td>
</tr>
<tr>
<td>24-221</td>
<td>Thermodynamics I; or</td>
</tr>
<tr>
<td>27-215</td>
<td>Thermodynamics of Materials</td>
</tr>
<tr>
<td>06-426</td>
<td>Experimental Colloid and Surface Science</td>
</tr>
<tr>
<td>06-607</td>
<td>Physical Chemistry of Colloids and Surfaces</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II; or</td>
</tr>
<tr>
<td>09-206</td>
<td>Physical Principles of Analytical Chemistry</td>
</tr>
<tr>
<td>09-214</td>
<td>Physical Chemistry</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
</tr>
</tbody>
</table>
B. Environmental Engineering Courses

Three from the following list of engineering-oriented courses:

- 06-620 Global Atmospheric Chemistry
- 06-622 Bioprocess Design (also 42-622)
- 12-251 Introduction to Environmental Engineering (for non-CEE students only)
- 12-651 Air Quality Engineering
- 12-657 Water Resources Engineering
- 12-658 Hydraulic Structures Design
- 19-422 Radiation, Health and Public Policy
- 19-446 Quantitative Risk Analysis
- 19-447 Combustion and Air Pollution Control (also 24-382)
- 19-614 Life Cycle Assessment [6 units; must be combined with additional 3 units]
- 19-616 Case Studies in sustainability [6 units; must be combined with additional 3 units]

- 19-650 Climate and Energy: Science, Economics, and Public Policy
- 24-424 Energy and the Environment (also 19-424)
- 27-322 Processing of Metals
- 27-557 Selection and Performance of Materials
- 42-604 Biological Transport
- 42-621 Biotechnology and Environmental Processes (also 06-621)
- 42-622 Bioprocess Design (also 06-622)
- 48-315 Environment I: Climate and Energy
- 48-415 Advanced Building
- 48-569 GIS/CAFM
- 48-596 LEED Building and Green Design Concepts

(Note 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.)

(Note 2: Course 12-251, Introduction to Environmental Engineering, can be counted toward completion of the environmental engineering course requirements for non-CEE students only.)

(Note 3: At least three of the five Type A + Type B courses counted toward the Environmental Engineering Minor must be from outside the student's major department.)

C. Environmental Policy Courses

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

- 19-291 From Local Pollution to Planetary Management: Environmental Problems and Prospects
- 19-319 Law and the Engineer
- 19-426 Environmental Decision Making
- 19-448 Science, Technology, and Ethics
- 19-623 Environmental Management
- 19-626 Climate Science and Policy
- 48-453 Urban Design
- 48-567 Sustainable Design and Development
- 66-210 Science, Technology, and the Environment
- 70-332 Business, Society and Ethics
- 70-361 Foundations of Law
- 70-436 Corporate Social Responsibility and Global Business
- 70-363 Law in Modern American Society
- 73-248 Environmental Economics
- 73-357 Regulation: Theory and Policy
- 73-358 Economics of the Environment and Natural Resources
- 73-359 Benefit-Cost Analysis
- 76-319 Environmental Rhetoric
- 76-344 Utopias
- 79-111 Cultural Perspectives on the Environment
- 79-244 Pittsburgh and the Transformation of Modern Urban America
- 79-343 Environmental Policy and Development in the Tropical World
- 79-345 American Environmental History
- 79-346 International Environmental Law and Policy (also 88-352)
- 79-365 Climate Change, Energy Policy, and Environmental Protection
- 79-398 Environmental History and Politics Since Silent Spring (also 88-346)
- 79-471 American Built Environment since 1860
- 79-475 Perspectives on the City and the Environment (also 90-762)
- 80-241 Ethical Judgments in Professional Life
- 80-242 Conflict and Dispute Resolution

- 80-243 Business Ethics
- 80-244 Environmental Management and Ethics
- 80-306 Social Choice Theory
- 80-340 Environmental Ethics and Decision Processes
- 85-241 Social Psychology
- 85-442 Health Psychology
- 88-220 Policy Analysis I
- 88-221 Policy Analysis II
- 88-223 Decision Analysis and Decision Support Systems
- 88-322 Behavioral Decision Making
- 88-323 Legislative Processes
- 88-352 International Environmental Law and Policy (also 79-346)
- 88-425 Politics of Economic Deregulation
- 90-765 Cities, Technology and the Environment
- 90-779 Transportation Planning and Financing: Land Use Impacts
- 90-784 Geographic Information Systems
- 90-789 Sustainable Community Development
- 90-851 Environmental Policy

(Note 4: Other humanities and social science courses with similar or related content may be substituted for these environmental policy courses with permission of the student’s departmental advisor for the Environmental Engineering Minor and the Director. A group of three of these environmental policy courses may be counted as fulfilling the H&SS depth requirement requirements of all CIT students. A list of relevant courses offered in particular semesters is provided at the Environmental Engineering Minor web site: http://www.ce.cmu.edu/~dzombak/envminor.html)

International Engineering Studies

Designated Minor

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. Requirements for the minor include:

International Management (1 course)

Complete one course in international management or business such as:

- 70-342 Managing Across Cultures
- 70-365 International Trade and International Law
- 70-381 Marketing
- 70-430 International Management

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. (See page 222 in the undergraduate catalog for a list of courses suggested for Africa, Asia, Europe, Latin America/Caribbean, Middle East and Russia).

Ethics (1 course)

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

- 70-332 Business, Society and Ethics
- 80-243 Business Ethics
- 80-244 Environment Management and Ethics

Or approved equivalent

Modern Languages

Demonstration of basic competency in a foreign language via one of the three options listed below:

1. Complete one (1) Modern Languages course at the 200 level, with a minimum grade of C, or
2. Achieve a score of 4 or higher in one foreign language Advanced Placement examination, or
3. 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. Study abroad shall include an engineering course. The region visited should be consistent with the language and regional culture/history studied.
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:

Course Requirements for Manufacturing Engineering Minor

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 specified 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
27-357 Introduction to Materials Selection (non MSE Majors)

OR
27-401 & 402 MSE Capstone Course, I & II (MSE Majors)

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 Advanced Robot Perception
16-741 Mechanics of Manipulation
16-743 Robot Control
18-474 Real-time Computer Control System Design
18-549 Distributed Embedded Systems
18-778 Mechatronic Design

Design, Materials and Processes

06-362 Chemical Engineering Process Control
24-443 Design for Manufacture 24-789 Advanced Topics in Manufacturing
27-322 Processing of Metals
27-323 Processing of Ceramic Materials
27-421 Design in Process Metallurgy
27-422 Deformation Processing
27-592 Solidification Processing
27-322 Processing Methods
27-421 Processing Design
27-442 Deformation Processing
27-533 Principles of Growth and Processing of Semiconductors
36-600 Design, Manufacturing and Marketing of New Products
39-245 Special Topics: Rapid Prototype Design
39-405 Engineering and Design: the Creation of Products and Processes

Production Management and Control

12-411 Engineering Economics
12-611 Project Management for Construction
36-220 Engineering Statistics and Quality Control
70-430 International Management
70-371 Production and Operations Management
70-471 Production II

Language:

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

82-221/222 Intermediate German: Culture and Society
82-271/272 Intermediate Japanese

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)

Course One (consisting of two half semester minis): Perfect Crystals, 27-201 (6 units), 27-202 Defects in Materials (6 units). The laboratories with these courses are not required as core but will be counted as elective units if desired.

Course Two: 27-217, Phase Relations and Phase Diagrams (9 units), again the laboratory with this course will not be required as core but will be counted as elective units if desired.

Elective Courses (24 units minimum)

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

27-100 Introduction to Materials Science
27-201(a) The Structure of Materials (3 units)
27-202(a) Defects in Materials Laboratory (3 units)
27-217(a) Phase Relations and Phase Diagrams Laboratory (3 units)
27-301 Microstructure and Properties
27-302 Microstructure and Properties II
27-322 Processing of Metals
27-323 Processing of Ceramic Materials
27-357 Introduction to Materials Selection
27-510 Bio-Materials I
27-511 Bio-Materials II
27-582 Phase Transformations in Solids
27-421 Processing Design
27-432 Electrical, Magnetic and Optical Properties of Materials
27-591 Mechanical Behavior of Materials
27-560 Physical Chemistry of Metallurgical Reactions
27-454 Supervised Reading
27-530 Physical Metallurgy with Applications
27-533 Principles of Growth and Processing of Semiconductors
27-542 Processing and Properties of Thin Films
27-551 Properties of Ceramics and Glasses
27-566 Special Topics
27-592 Solidification Processing
42-644 Medical Devices

Mechanical Behavior of Materials Designated Minor

Paul Steif, Director Office: Scaife Hall 304

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
Biomedical engineers apply engineering principles to advance our understanding of living systems and to improve human health. Biomedical engineers are employed in the pharmaceutical, biopharmaceutical, biotechnical and medical device industrial sectors as well as in clinical healthcare settings. A significant number of graduates also choose to pursue graduate studies or medical school. Our approach to biomedical engineering education reflects our belief that successful biomedical engineers in these sectors and settings will be deeply trained in both engineering and the life sciences. To underscore this, we use a additional major B.S. degree format for our undergraduate education program. Carnegie Institute of Technology (CIT) undergraduates will elect any one of these following majors jointly with Biomedical Engineering: Chemical Engineering, Civil & Environmental Engineering, Electrical & Computer Engineering, Materials Science & Engineering, or Mechanical Engineering. Each of the additional major degree programs is designed to be completed in four, very full and rich, years.

The department has undertaken a significant undergraduate curriculum revision to better prepare our graduates to practice their chosen profession. These changes will apply to the entering Class of 2009 and beyond. The new curriculum is structured to provide both breadth and depth within biomedical engineering. Our graduates will have: a firm understanding of biology and physiology; the ability to apply advanced mathematics, science and engineering to solve problems at the interface of medicine and engineering; and the ability to make measurements on and interpret data from living systems addressing the problems associated with the interaction between living and non-living materials and systems.

Our new curriculum comprises three parts: the BME core, the BME track elective system and the BME capstone design course. All biomedical engineering additional majors will share a common exposure to the many facets of biomedical engineering in the BME Intro, Professional courses and Laboratory courses and will build a common life sciences background in the Modern Biology and Physiology courses that comprise the new BME core requirement.

Following the core is our track system. Each student will select a track to build depth within biomedical engineering in the bioimaging, biomaterials and tissue engineering, biomechanics, or cellular and molecular biotechnology areas. Bioimaging is the study of bio/medical phenomena based on the information provided in digital images. It draws upon advances in signal processing, optics, probe chemistry, molecular biology, and machine learning to provide answers to biological and medical questions from the growing numbers of biological and medical images acquired in digital form. This track aligns most naturally with BME/EEC additional majors. A bioimaging specialist will have a broad background and can expect to find work in biomedical industrial labs, pursue further education by going to either graduate or medical school, or be employed by one of the numerous biomedical tech companies developing new instrumentation and/or algorithms for digital imaging.

The Biomaterials and Tissue Engineering track addresses fundamental issues at the interface of materials science, biology and engineering. The course work includes the design and development of materials for biological applications. Students will understand how materials, cells, tissues and organ systems interact and direct rational, practical therapeutic solutions for clinical issues. Characterization techniques for measuring the outcome of biomaterials and biological interactions will be included in the track. BME/CE and BME/ME are the most seamless additional major matches. Job opportunities for the students trained in materials and tissue engineering include work in biotechnology industries or further studies in graduate or medical school. Significant opportunities are expected for engineers trained in the development and production of biological materials, medical devices, and combination drug-cell-material devices.

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, continuum mechanics, experimentation, imaging, applied mathematics, 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. BME/CEE and BME/ME additional majors are strong matches with this track. A biomechanicist’s broad background enables him or her to work in the medical device industry or as a rehabilitation engineer, or to conduct fundamental biomechanics modeling and experimental research, or to pursue medical or graduate school.

The Cellular and Molecular Biotechnology track emphasizes fundamentals and applications of biochemistry, biophysics, and cell biology. It is ideally suited to the BME/CHE additional major, which provides a strong core of chemistry and molecular processing principles, and is also appropriate for BME/CE and BME/ME additional majors who have interests in molecular and cellular level detail. This track can also suit molecularly-oriented projects typically result in the production of a prototype and have resulted in patent applications and the pursuit of licensing opportunities. Several questions naturally arise. Why the additional major? Why not a stand-alone BME degree? Where’s the medical school? Again, we aim to graduate students who are educated deeply in the use of traditional, fundamental engineering tools and analytical techniques as well as in the life sciences and clinical applications of technology. Due to its polydisciplinary nature, the field of biomechanical engineering requires broad exposure to a wide variety of engineering principles. We feel this breadth of exposure should be complemented by the in-depth training in engineering fundamentals that the additional major format affords. While Carnegie Mellon does not have a medical school, the western
Pennsylvania area is rich in medical research activity. We leverage our efforts with extensive collaboration with researchers and instructors from the University of Pittsburgh Medical Center, the Western Pennsylvania/Allegheny Hospital System and the Children’s Hospital system. These collaborations reinforce the clinical relevance of our education and research activities. Our approach to education is very different from that of the biomedical engineering community at large. And as the number of biomedical engineering degree programs continues to grow, we expect that this difference, in particular the additional major degree training of our graduates, will confer a distinct and marketable advantage. Our graduates will shape the future of industrial, clinical and academic biomedical engineering and healthcare.

The Department of Biomedical Engineering also offers a minor program for those students who desire coordinated training in biomedical engineering but who may not have the time available in their schedules to permit pursuit of the additional major. The minor aims to provide undergraduates from within CIT and outside CIT with significant and meaningful exposure to specific biomedical engineering applications. Participants in the minor program can choose from course offerings within the elective track system to build marketable skills in a particular area of biomedical engineering.

The dynamism of the biomedical engineering field has created an incredibly exciting environment for students, faculty and staff alike at Carnegie Mellon. We invite you to share your educational experience in biomedical engineering.

Course Requirements for the Additional Major Degree

The requirements include five BME core courses, participation in a BME elective track consisting of a coherent program of four courses, and the BME Design Course. Core courses will be taken by all students to insure that a basic foundation is acquired in the life sciences and its vocabulary. The BME Intro and Laboratory courses are designed to provide broad exposure to the elective track areas and to help students choose an elective track in which to participate. The elective track sequence will allow students to explore in more depth an area of biomedical engineering that complements their second major; these courses are explicitly focused on technical aspects of biomedical engineering or the underpinning life sciences. The design course is a project course where students with some background, yet different expertise, work on a substantial problem in biomedical engineering. Courses that can fulfill these requirements are listed below; sample curricula for several of the most common additional majors are also provided.

Core Courses (all required)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Prerequisites</th>
<th>Term(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-101</td>
<td>Introduction to Biomedical Engineering</td>
<td>Fall and Spring</td>
<td></td>
</tr>
<tr>
<td>42-201</td>
<td>Professional Issues in Biomedical Engineering</td>
<td>Fall and Spring</td>
<td></td>
</tr>
<tr>
<td>42-202</td>
<td>Physiology</td>
<td>Fall and Spring</td>
<td></td>
</tr>
<tr>
<td>42-203</td>
<td>Biomedical Engineering Laboratory</td>
<td>Fall and Spring</td>
<td></td>
</tr>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>Fall and Spring</td>
<td></td>
</tr>
</tbody>
</table>

Elective Tracks (participation in one track required)

The tracks are: Bioimaging (BIMG), Biomaterials and Tissue Engineering (BMTE), Biomechanics (BMEC), and General Biomedical Engineering (GBME). Tracks courses include a “gateway” required track course taken typically during the junior year, in addition to three electives at the junior or senior level chosen from a set of track electives. A student may replace one track elective with a research project, either 42-200 Sophomore BME Research Project, 42-300 Junior BME Research Project, 42-400 Senior BME Research Project or 39-500 CIT Honors Thesis, as long as the research project is supervised by a regular or courtesy BME faculty member and the project is conducted for 9 or more units of credit.

BIMG Track

**BIMG Gateway Course (required)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Term(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-334</td>
<td>Introduction to Computational Biology</td>
<td>Spring</td>
</tr>
<tr>
<td>42-434</td>
<td>Computational Biology</td>
<td>Spring</td>
</tr>
<tr>
<td>42-431/18-496</td>
<td>Biomaging- Spring</td>
<td>Spring</td>
</tr>
<tr>
<td>42-731/18-799</td>
<td>Advanced Biomaging- Fall</td>
<td>Fall</td>
</tr>
<tr>
<td>18-791</td>
<td>Digital Signal Processing</td>
<td>Fall</td>
</tr>
<tr>
<td>18-798</td>
<td>Image and Video Processing</td>
<td>Spring</td>
</tr>
<tr>
<td>42-735/16-725</td>
<td>Medical Image Analysis- Spring</td>
<td>Spring</td>
</tr>
</tbody>
</table>

BMTE Track

**BMTE Gateway Course (required)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Term(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-232</td>
<td>Biochemistry</td>
<td>Spring</td>
</tr>
<tr>
<td>03-240</td>
<td>Cell Biology</td>
<td>Spring</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry</td>
<td>Fall</td>
</tr>
<tr>
<td>09-218</td>
<td>Organic Chemistry II</td>
<td>Spring</td>
</tr>
<tr>
<td>42-311/27-510</td>
<td>Polymeric Biomaterials</td>
<td>Spring</td>
</tr>
<tr>
<td>42-312/27-511</td>
<td>Metallic and Ceramic Biomaterials</td>
<td>Fall</td>
</tr>
<tr>
<td>42-413</td>
<td>Biomaterial Interfaces</td>
<td>Spring</td>
</tr>
<tr>
<td>42-424</td>
<td>Biological Transport</td>
<td>Spring</td>
</tr>
<tr>
<td>42-419</td>
<td>Biomaterial/Host Interactions</td>
<td>Fall</td>
</tr>
</tbody>
</table>

BMEC Track

**BMEC Gateway Course (required)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Term(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-341</td>
<td>Introduction to Biomechanics</td>
<td>Spring</td>
</tr>
<tr>
<td>42-321</td>
<td>Cellular and Molecular Biotechnology</td>
<td>Spring</td>
</tr>
<tr>
<td>42-347</td>
<td>Rehabilitation Engineering</td>
<td>Fall</td>
</tr>
<tr>
<td>42-502</td>
<td>Cellular Biomechanics</td>
<td>Spring</td>
</tr>
<tr>
<td>42-424</td>
<td>Bioprocess Design</td>
<td>Spring</td>
</tr>
<tr>
<td>42-441</td>
<td>Cardiovascular Biomechanics</td>
<td>Fall</td>
</tr>
<tr>
<td>42-444</td>
<td>Medical Devices</td>
<td>Spring</td>
</tr>
<tr>
<td>42-502</td>
<td>Mechanical Biomechanics</td>
<td>Spring</td>
</tr>
<tr>
<td>42-1720</td>
<td>Biomechanics II: Biodynamics of Movement</td>
<td>Spring</td>
</tr>
<tr>
<td>42-1064</td>
<td>Biomechanics III: Tissues and Organs</td>
<td>Spring</td>
</tr>
</tbody>
</table>

CMBT Track

**CMBT Gateway Course (required)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Term(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>42-321</td>
<td>Cellular and Molecular Biotechnology</td>
<td>Spring</td>
</tr>
<tr>
<td>42-422</td>
<td>Bioprocess Design</td>
<td>Spring</td>
</tr>
<tr>
<td>42-424</td>
<td>Biological Transport</td>
<td>Spring</td>
</tr>
<tr>
<td>42-426</td>
<td>Biosensors and BioMEMS</td>
<td>Spring</td>
</tr>
<tr>
<td>42-502</td>
<td>Cellular Biomechanics</td>
<td>Spring</td>
</tr>
<tr>
<td>42-723/12-723</td>
<td>Biological Processes in Environmental Systems</td>
<td>Spring</td>
</tr>
</tbody>
</table>

GBME Track

Four courses selected from any of those listed with the BIMG, BMTE, BMEC or CMBT tracks above. At least one of the selected courses must be a track gateway course.
Undergraduate Course Requirements for the Minor

For CIT students
General Requirements: (five courses, minimum of 48 units)

42-101 Introduction to Biomedical Engineering  
42-202 Physical Biology  
03-121 Modern Biology  
BME track course

For non-CIT students
General Requirements: (six courses, minimum of 60 units)

42-101 Introduction to Biomedical Engineering  
42-202 Physical Biology  
03-121 Modern Biology  
*BME track course  
**BME track course

* This course cannot be a required course in your home department.  
** This course must be offered by one of the CIT Departments (06-xxx, 12-xxx, 18-xxx, 19-xxx, 24-xxx, 27-xxx or 42-xxx)

Both CIT and non-CIT students may replace one BME track course in the minor program with a research project, either 42-200 Sophomore BME Research Project, 42-300 Junior BME Research Project, 42-400 Senior BME Research Project or 39-500 CIT Honors Thesis, as long as the research project is supervised by a regular or courtesy BME faculty member and the project is conducted for 9 or more units of credit.

Advising

Each student who declares a BME additional major or minor will be assigned a BME faculty member as an academic advisor; for additional majors, this may be in addition to an advisor assigned in the second CIT department. Faculty members associated with other departments may also serve as information resources for those students contemplating participation in the additional major or minor program. By department, these faculty members include:

Biological Sciences: Profs. Amy Burkert; Robert Murphy  
Chemical Engineering: Profs. Michael Domach, Steinar Hauan, Todd Przybycien, James Schneider, and Robert Tilton  
Chemistry: Prof. Newell Washburn  
Civil & Environmental Engineering: Prof. Jeanne VanBriesen  
Electrical & Computer Engineering: Profs. Jelena Kovacevic, José Moura and Richard Stern  
Mechanical Engineering: Profs. Cristina Amon, Jim Antaki, Jonathan Cagan and Phil LeDuc

Mrs. Hilda Diamond, located in Doherty Hall 2100, will also help with aspects of advising and attention to details, including student course requirements, scheduling of BME courses and working with departments to avoid conflicts. Coordination of advising with a second engineering department is essential. Note that for additional majors, the second engineering department advisor must approve final schedules. Prof. Przybycien and Mrs. Diamond will serve as advisors to BME minor program students from the SCS and H&SS colleges.

If you are a additional major in Biomedical Engineering:

1. Always select your Engineering Core Courses First!  
Many times it becomes very difficult to make up these courses, as they will inevitably conflict with required courses expected to be taken in subsequent years. In a few majors, BME substitutions occur for a few core courses. If you are ahead of schedule, consult with your advisor about possible options.

2. Make sure you take the BME required (core) courses as soon as possible.  
Again, the likelihood of a major conflict increases if you wait, as these courses are scheduled so as to minimize conflicts in the year and semester they are most likely to be taken.

3. 42-101 Introduction to Biomedical Engineering should be taken, ideally, in the freshman year. If this is not possible, the fall of the sophomore year is the next best choice.

4. Minimum units to graduate.  
Additional majors must satisfy the minimum course requirements established by the second major department to graduate.

5. QPA requirements:

   The QPA for BME core, track and design courses must be 2.00 or better to graduate with the BME additional major. In addition, CIT has the following requirement for graduation: “A student must also achieve a cumulative quality point average of 2.00 in a series of core courses, up to a maximum of 184 units, specified by the department. When more than one possibility exists for meeting a specific requirement (e.g., Breadth), the courses will be chosen 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.”
Sample Schedule for BME-ECE Additional majors in the BIMG Track

<table>
<thead>
<tr>
<th>First Year</th>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-100</td>
<td>Intro to ECE</td>
<td>12</td>
</tr>
<tr>
<td>15-100</td>
<td>Introductory/Intermediate Programming</td>
<td>10</td>
</tr>
<tr>
<td>21-115</td>
<td>Differential Calculus</td>
<td>5</td>
</tr>
<tr>
<td>21-116</td>
<td>Integral Calculus</td>
<td>5</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
<td>9</td>
</tr>
<tr>
<td>99-101</td>
<td>Computing Skills Workshop</td>
<td>3</td>
</tr>
</tbody>
</table>

| Spring | xx-xxx | Intro. to Engineering Course | 12 |
|        | xx-xxx | Intro. to Engineering Course | 12 |
|        | 21-117  | Integration & Differential Equations | 5  |
|        | 21-118  | Calculus of Approximation | 5   |
|        | 76-xxx  | Designated Writing Course | 9   |

<table>
<thead>
<tr>
<th>Second Year</th>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-220</td>
<td>Fundamentals of Electrical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-202</td>
<td>Mathematical Foundations of EE</td>
<td>12</td>
</tr>
<tr>
<td>33-107</td>
<td>Physics II for Engineers</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
<td>9</td>
</tr>
</tbody>
</table>

| Spring | 18-240 | Fundamentals of Computer Engineering | 12 |
|        | 21-127 | Concepts of Mathematics | 9   |
|        | xx-xxx | ECE Breadth Course I | 12  |
|        | xx-xxx | General Education Course | 9   |

<table>
<thead>
<tr>
<th>Third Year</th>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>xx-xxx</td>
<td>ECE Breadth Course 2</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>ECE Breadth Course 3</td>
<td>12</td>
</tr>
<tr>
<td>36-xxx</td>
<td>Probability and Statistics</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Math/Science Elective 1</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
<td>9</td>
</tr>
</tbody>
</table>

| Spring | 18-380 | Junior Seminar | 0   |
|        | xx-xxx | ECE Depth Course | 12  |
|        | xx-xxx | ECE Coverage Course 1 | 12  |
|        | xx-xxx | Engineering Elective | 12 |
|        | xx-xxx | General Education Course | 9   |

<table>
<thead>
<tr>
<th>Fourth Year</th>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>xx-xxx</td>
<td>Capstone Design</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Math/Science Elective 2</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Free Elective</td>
<td>6</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Free Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
<td>9</td>
</tr>
</tbody>
</table>

| Spring | xx-xxx | Free Elective | 12 |
|        | xx-xxx | Free Elective | 12 |
|        | xx-xxx | Free Elective | 12 |

- The bolded courses are BME courses for the additional track.
- The track requirement course is 18-396 and must be taken for the Bioimaging track.
- You must take 3 courses designated as Bioimaging Electives to satisfy track requirements. Four are noted in the schedule to give you flexibility, you have to take three. These courses must be taken from the following list:
  1. 42-334 Introduction to Computational Biology (S,9) OR 42-434 Computational Biology (S,9)
  2. 42-431 Bioimaging (S,9)
  3. 42-731 Advanced Bioimaging (F,12)
  4. 42-735 Medical Image Analysis (S,12) (16-725)
  5. 18-791 DSP 1 (F,12)
  6. 18-798 Image and Video Processing (S,12)

Minimum number of units for degree: 367
### Sample Schedule for BME-MSE Additional majors in the BMTE Track

#### Materials Science & Engineering First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential &amp; Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>33-106 Physics I for Engineers</td>
<td>12</td>
</tr>
<tr>
<td>27-100 Materials in Engineering</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx General Education Elective</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43</strong></td>
</tr>
</tbody>
</table>

**Spring**

| 21-122 Integration, Differential Equations, and Approximations 10 |       |
| 15-100 Intro/Intermediate Programming                              | 10    |
| 99-101 Computer Skills Workshop                                   | 3     |
| xx-xxx Introductory Engineering Elective                          | 12    |
| xx-xxx General Education Elective                                 | 9     |
|                                           |       |
| **Total**                                 | **55**|

#### Second Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>27-201 Structure of Materials</td>
<td>9</td>
</tr>
<tr>
<td>27-202 Defects in Materials</td>
<td>9</td>
</tr>
<tr>
<td>27-215 Thermodynamics of Materials</td>
<td>12</td>
</tr>
<tr>
<td>27-299 Professional Development I</td>
<td>1</td>
</tr>
<tr>
<td>33-107 Physics II for Engineers</td>
<td>12</td>
</tr>
<tr>
<td>21-126 Intro to Mathematical Software</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>55</strong></td>
</tr>
</tbody>
</table>

**Spring**

| 09-101 Introduction to Experimental Chemistry | 3     |
| 09-105 Modern Chemistry I                   | 10    |
| 21-260 Differential Equations               | 9     |
| 27-205 Materials Characterization Lab       | 3     |
| 27-216 Transport in Materials               | 9     |
| 27-217 Phase Relations and Diagrams         | 12    |
| xx-xxx General Education Course             | 9     |
|                                           |       |
| **Total**                                 | **52**|

#### Third Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-399 Professional Development II</td>
<td>1</td>
</tr>
<tr>
<td>27-301 Microstructure and Properties I</td>
<td>9</td>
</tr>
<tr>
<td>27-367 Selection and Performance</td>
<td>6</td>
</tr>
<tr>
<td>33-225 Quantum Physics &amp; Structure of Matter</td>
<td>9</td>
</tr>
<tr>
<td><strong>or</strong></td>
<td></td>
</tr>
<tr>
<td>09-217 Organic Chemistry</td>
<td>9</td>
</tr>
<tr>
<td><strong>or</strong></td>
<td></td>
</tr>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
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**Spring**

| 36-220 Engineering Statistics & Quality Control | 9     |
| xx-xxx General Education Elective             | 9     |
| xx-xxx Free Elective                          | 9     |
| xx-xxx Free Elective                          | 9     |
| 27-xxx MSE Restricted Elective                | 6     |
| 27-xxx MSE Restricted Elective                | 6     |
|                                           |       |
| **Total**                                 | **54**|

#### Fourth Year

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**Spring**

| xx-xxx Free Elective                      | 9     |
| 27-xxx MSE Restricted Elective            | 6     |
| 27-xxx MSE Restricted Elective            | 6     |
| xx-xxx General Education Elective         | 9     |
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### Materials Science & Engineering and BME

#### First Year

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**Spring**

| 21-122 Integration, Differential Equations and Approximations |       |
| 15-100 Intro/Intermediate Programming                     |       |
| 99-101 Computer Skills Workshop                           |       |
| 42-101 Intro to Biomedical Engineering                    |       |
| 33-107 Physics II for Engineers                           |       |
|                                           |       |
| **Total**                                 | **49**|

#### Second Year

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<tr>
<td>21-259 Calculus in Three Dimensions</td>
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<tr>
<td>27-201 Microstructure and Properties I</td>
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<td>27-202 Defects in Materials</td>
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<td>27-215 Thermodynamics of Materials</td>
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<td>21-126 Intro to Mathematical Software</td>
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**Spring**

| 09-101 Introduction to Experimental Chemistry | 3     |
| 09-105 Modern Chemistry I                   | 10    |
| 21-260 Differential Equations               | 9     |
| 27-205 Materials Characterization Lab       | 3     |
| 27-216 Transport in Materials               | 9     |
| 27-217 Phase Relations and Diagrams         | 12    |
| xx-xxx General Education Course             | 9     |
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#### Third Year

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**Spring**

| 36-220 Engineering Statistics & Quality Control | 9     |
| xx-xxx General Education Elective             | 9     |
| xx-xxx Free Elective                          | 9     |
| xx-xxx Free Elective                          | 9     |
| 27-xxx MSE Restricted Elective                | 6     |
| 27-xxx MSE Restricted Elective                | 6     |
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| **Total**                                 | **49**|

#### Fourth Year

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**Spring**

| xx-xxx Free Elective                      | 9     |
| 27-xxx MSE Restricted Elective            | 6     |
| 27-xxx MSE Restricted Elective            | 6     |
| xx-xxx General Education Elective         | 9     |
|                                           |       |
| **Total**                                 | **48**|

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This Biomaterials and Tissue Engineering track requires Biochemistry (03-232) and two track electives chosen from: Polymeric Biomaterials (42-311); Metallic and Ceramic Biomaterials (42-312); Biomaterial Interfaces (42-413); Biological Transport (42-424); Cell Biology (03-240); Organic Chemistry II (09-218). Also, Organic Chemistry (09-217) should be chosen from the three science course options in the Fall of the Junior Year.

Minimum number of units for degree: **403**
# Sample Schedule for BME-CEE Additional majors in the BMEC Track

## Civil & Environmental Engineering

### First Year

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<td>12-271 Intro. to Computer Apps in Civil &amp; Environmental Engineering</td>
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### Third Year

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<td>12-331 Solid Mechanics</td>
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### Fourth Year

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<tr>
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<td>12-411 Engineering Economics</td>
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## Civil & Environmental Engineering and BME

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### Third Year

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<td>Fall</td>
<td>12-301 Civil &amp; Environmental Engineering Projects</td>
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### Fourth Year

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<tr>
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<td>12-401 Civil &amp; Environmental Engineering Design</td>
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Three Biomechanics electives must be chosen from: 42-312 Metallic and Ceramic Biomaterials; 42-424 Biological Transport; 42-444 Medical Devices; 42-453 Rehabilitation Engineering; 42-502 Cellular Biomechanics; BIOE 1720 Biomechanics II: Biodynamics of Movement (Univ of Pittsburgh Dept of Bioengineering); and BIOE 1064 Biomechanics III: Tissues and Organs (University of Pittsburgh Dept of Bioengineering).

Minimum number of units required for degree: 388.
Sample Schedule for BME-ME Additional majors in the BMEC Track

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<th>Mechanical Engineering and BME</th>
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<td><strong>Spring</strong></td>
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<td>24-371 Electromechanical Systems</td>
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<td>24-303 Mechanical Engineering Seminar II</td>
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<td>42-341 Introduction to Biomechanics</td>
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* As a additional major, you should take 24-441 ME Design in Fall and 42-401 BME Design in Spring (sr.)

42-401 BME Design replaces 24-401 Engineering Analysis for the MechE-BME Additional majors. Three Biomechanics electives must be chosen from: 42-312 Metallic and Ceramic Biomaterials; 42-424 Biological Transport; 42-441 Cardiovascular Biomechanics; 42-444 Medical Devices; 42-453 Rehabilitation Engineering; 42-502 Cellular Biomechanics; BIOE 1720 Biomechanics II: Biodynamics of Movement (Univ of Pittsburgh Dept of Bioengineering); and BIOE 1064 Biomechanics III: Tissues and Organs (Univ of Pittsburgh Dept of Bioengineering). At least one CMBT elective chosen should also satisfy the second 24-xxxx ME Technical Elective.

Minimum number of units for degree: 393
## Sample Schedule for BME-ChE Additional majors in the CMBT Track

<table>
<thead>
<tr>
<th>Chemical Engineering and BME</th>
<th>First Year</th>
<th>Units</th>
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<tbody>
<tr>
<td>Fall</td>
<td>21-120</td>
<td>Differential &amp; Integral Calculus 9</td>
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<td>Designated Writing Course 9</td>
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<td>99-101</td>
<td>Computing Skills Workshop 3</td>
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<td>06-100</td>
<td>Intro. to Chemical Engineering 10</td>
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<tr>
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<td>09-105</td>
<td>Modern Chemistry 9</td>
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<td>21-122</td>
<td>Integration, Differential Equations &amp; Approximations 10</td>
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<td>33-108</td>
<td>Physics I for Engineers 12</td>
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<td>Thermodynamics 9</td>
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<td>Fluid Mechanics I 9</td>
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<td>Math: Methods of Chem. Engineering 12</td>
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<td>Lab I: Introduction to Chemical Analysis 12</td>
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<td>Physics II for Engineers 12</td>
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<td>06-321</td>
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<td>Chemical Engineering Process Control 9</td>
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<td>Process Laboratory 6</td>
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<td>02-232</td>
<td>Biochemistry 9</td>
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<th>Units</th>
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<td>xx-xxx</td>
<td>General Education Course 9</td>
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</table>

Minimum number of units for degree: 408
## Sample Schedule for BME-CEE Additional majors in the

### CMBCMBCMBCMBCMBCMBT TT TT TT TT Trrrrrack

#### Civil & Environmental Engineering and MBE

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<thead>
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<th>First Year</th>
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<td>12-271</td>
<td>Intro. to Computer Apps in Civil &amp; Environmental Engineering</td>
<td>9</td>
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<tr>
<td>09-101</td>
<td>Intro. to Experimental Chemistry</td>
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<td>Modern Chemistry I</td>
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<tr>
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#### Spring

| xx-xxx    | Introduction to Engineering | 12   |
| 21-212    | Integration, Differential Equations & Approximations | 10   |
| 33-207    | Physics I for Engineers | 9    |
| xx-xxx    | General Education Course | 9    |
|            | **Total** | **43** |

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<td>Fluid Mechanics Lab</td>
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<td>21-259</td>
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#### Spring

| xx-xxx    | General Education Course | 9    |
| xx-xxx    | Elective | 9    |
| xx-xxx    | Elective | 9    |

|            | **Total** | **48** |

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<tbody>
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<td>12-301</td>
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<td>Solids Mechanics</td>
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<td>21-259</td>
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#### Spring

| xx-xxx    | General Education Course | 9    |
| xx-xxx    | Elective | 9    |
| xx-xxx    | Elective | 9    |

|            | **Total** | **48** |

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<tr>
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<td>Engineering Statistics &amp; Quality Control</td>
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<td>General Education Course</td>
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#### Spring

| xx-xxx    | General Education Course | 9    |
| xx-xxx    | Elective | 9    |
| xx-xxx    | Elective | 9    |

|            | **Total** | **45** |

* Cellular and Molecular Biotechnology Electives: Choose from 42-422 Bioprocess Design, 42-424 Biological Transport, 42-426 Biosensors and BioMEMS, 42-502 Cellular Biomechanics, 42-723/12-723 Biological Processes in Environmental Systems and 03-240 Cell Biology. (03-232 Biochemistry counts as both a required course for CEE and a CMBCMTrack elective.)

Minimum number of units for degree: 388.
Sample Schedule for BME-ME Additional majors in the CMBT Track

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<thead>
<tr>
<th>Mechanical Engineering and BME First Year</th>
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<tr>
<td>24-101 Fundamentals of Mechanical Eng.</td>
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<tr>
<td>33-106 Physics for Engineering Students</td>
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<tr>
<td>99-101 Computing Skills Workshop</td>
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<td>xx-xxx Writing/Expression Course</td>
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**Spring**

- 21-122 Integration, Differential Equations & Approximations 10
- xx-xxx Restricted Technical Elective 10-13
- xx-xxx General Education Course 9

Total: 46

<table>
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<tbody>
<tr>
<td>Fall 21-259 Calculus in Three Dimensions</td>
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<tr>
<td>24-221 Thermodynamics I</td>
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<td>24-261 Statics</td>
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Total: 41-44

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<td>24-311 Numerical Methods</td>
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<td>24-322 Heat Transfer</td>
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<td>24-351 Dynamics</td>
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Total: 48-51

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Total: 48-51

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<tr>
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Total: 48


Minimum number of units for degree: 396.
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, ink, and integrated circuits). Opportunities exist in biotechnology, the computer industry, environmental firms, and consulting companies. Other examples include the processing of advanced polymer 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.

The objectives for the department are that graduates of the department will obtain employment or attend graduate school, will advance in their careers, and will be productive and fulfilled professionals throughout their careers. The curriculum and programs are developed to prepare students to attain these 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:

- mathematics, science, and engineering skills, and the ability to apply them to solve engineering problems,
- the ability to design and conduct experiments and interpret data,
- the ability to design a component or system, within realistic constraints,
- the ability to identify, formulate and solve engineering problems,
- the ability to use modern engineering tools,
- the ability to function on teams,
- an understanding of personal and professional ethics,
- an ability to communicate effectively,
- an ability to understand impact of engineering in a global/societal context,
- an appreciation and capability for life-long learning,
- a knowledge of contemporary issues facing engineers.

The department offers a number of special programs for students majoring in Chemical Engineering. In addition to the double majors or minors offered by the College of Engineering such as Biomedical Engineering and Manufacturing Management & Consulting, students may choose a minor in Colloids, Polymers, and Surfaces. Undergraduate research projects are also available in the areas of bioengineering, complex fluids engineering, environmental engineering, process systems engineering, and solid state materials. Students may participate in study abroad programs during their junior year. In addition to the University program with EPFL in Switzerland and ITESM Monterrey in Mexico, the department provides its own exchange programs with the University of Aachen in Germany and Imperial College in London, Great Britain. The latter two programs are jointly organized with industrial partners, i.e., Bayer Corporation, Air Products & Chemicals, and Procter & Gamble respectively. Students may also participate in Practical Internships for Senior Chemical Engineering Students, a one-year industrial internship program offered between the junior and senior years. Finally, qualified students may enroll in our Master of Chemical Engineering program. This degree is typically completed in the fifth year. However, depending on the number of advanced placement courses and course load at Carnegie Mellon, this degree could be awarded during the B.S. graduation, or after one additional semester.

Curriculum

First Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
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<tr>
<td>Fall</td>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
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<tr>
<td>Fall</td>
<td>76-xxx</td>
<td>Designated Writing/Expression Course</td>
<td>9</td>
</tr>
<tr>
<td>Fall</td>
<td>99-101</td>
<td>Computing Skills Workshop</td>
<td>3</td>
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<tr>
<td>Fall</td>
<td>06-100</td>
<td>Intro to Chemical Engineering</td>
<td>12</td>
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<tr>
<td>Fall</td>
<td>09-105</td>
<td>Intro to Modern Chemistry</td>
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<td>Fall</td>
<td>39-101</td>
<td>CIT First-Year Seminar</td>
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<tr>
<td>Spring</td>
<td>21-122</td>
<td>Integration, Differential Equation &amp; Approximation</td>
<td>10</td>
</tr>
<tr>
<td>Spring</td>
<td>xx/100/101</td>
<td>Introductory Engineering Elective other than ChE</td>
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<tr>
<td>Spring</td>
<td>33-106</td>
<td>Physics for Engineering Students I</td>
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<td>General Education Course</td>
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<th>Second Year</th>
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<td>21-259</td>
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<td>06-221</td>
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<td>xx-xxx</td>
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<td>xx-xxx</td>
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<td><strong>Spring</strong></td>
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<td>06-462</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Units</strong></td>
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</table>

**Notes:**

1. In addition to the graduation requirement of an overall QPA of 2.0 (not counting the First Year), the Department of Chemical Engineering requires a cumulative QPA of 2.0 in all chemical engineering courses (all those numbered 06-xxx).

2. Minimum number of units required for graduation: 386.

3. Overloads are permitted only for students maintaining a QPA of 3.0 or better during the preceding semester.

4. Electives: To obtain a Bachelor of Science degree in Chemical Engineering, students must complete 06-100 and one other Introductory Engineering Elective. There are also five Unrestricted Electives. At most, 9 units of ROTC or Physical Education can be counted toward these electives. Students must decide among electives with their faculty advisors.

5. Undergraduate Research: Independent research projects are available by arrangement with a faculty advisor. Many students conduct these research projects for elective credit by enrolling in 06-200, 300, or 400 (Sophomore, Junior, or Senior Research Projects) or 39-500 (CIT Honors Research) for eligible Seniors.

The following two tracks have been designed as thematic guidelines. Students are not required to follow either of these tracks. They may take courses from both tracks and they may take courses that are not listed in either track. The Process Systems Track is designed for students interested in focusing on the design and optimization of chemical processes. The Chemical Engineering Sciences Track is designed for students interested in the scientific principles underlying the fabrication and processing of synthetic and/or biological materials.

Some electives contain elements of both tracks and are therefore listed under each. Undergraduate research projects that fit either track are available by arrangement with a faculty advisor. Advanced undergraduates may also take Chemical Engineering graduate courses (600+ level).

### Process Systems Track

<table>
<thead>
<tr>
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<tr>
<td>06-200, 300, or 400 Sophomore, Junior, or Senior Research Projects (or 39-500 CIT Honors Research)</td>
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<td>06-606, 06-608, 06-619, 06-630, 06-708, 06-713, 06-720, 06-722, 12-271, 12-411, 12-651, 15-111, 15-200, 15-211, 18-470, 19-424, 21-127, 21-292, 24-451, 27-322, 36-220, 70-371, 70-391, 03-240, 03-231, 03-330, 03-380, 03-438, 03-441, 03-442, 06-200, 300, or 400 Sophomore, Junior, or Senior Research Projects (or 39-500 CIT Honors Research)</td>
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### Chemical Engineering Sciences Track

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<td>03-240, 03-231, 03-330, 03-380, 03-438, 03-441, 03-442, 06-200, 300, or 400 Sophomore, Junior, or Senior Research Projects (or 39-500 CIT Honors Research)</td>
</tr>
<tr>
<td>06-426 Experimental Colloid Surface Science</td>
</tr>
</tbody>
</table>
**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 or an EPP faculty representative.

**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 or a BME faculty representative.

**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, Engineering Design, Environmental Engineering, Data Storage Systems Technology, and Automation and Control Engineering. The minor requirements may be fulfilled with electives. Other minors, such as the Manufacturing Management and Consulting 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, microstructured fluids, and interfacially engineered materials. Completion of the following five courses constitutes the CPS minor:

- 06-221 Thermodynamics
- 06-607 Physical Chemistry of Polymers
- 06-426 Experimental Colloid and Surface Science
- 06-466 Experimental Polymer Science
- 06-609 Physical Chemistry of Macromolecules

(cross-listed as 09-509)

Typically 06-607 is taken in the spring of the junior year, while 06-609/09-509, 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. Students should register for 06-051 - Study Abroad, Fall and/or 06-051 - Study Abroad, Spring. 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 provide skillful 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 GPA of 3.0. Junior and Senior undergraduates from the department may apply to the MChE program if they have an overall GPA 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—.
- LORENZ T. BIEGGLER, Bayer Professor of Chemical Engineering — Ph.D., University of Wisconsin; Carnegie Mellon, 1981—.
- KRIS 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, Assistant 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—.
- STEINAR HAUAN, Associate Professor of Chemical Engineering — Ph.D., Norwegian Institute of Science and Technology; Carnegie Mellon, 1999—.
- MOHAMMAD F. ISLAM, Assistant Professor of Chemical Engineering — Ph.D., Lehigh University; Carnegie Mellon, 2005—.
ANNETTE M. JACOBSON, Principal Lecturer in 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—.

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—.


JAMES B. MILLER, Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2006—.

SPYROS N. PANDIS, Elia Professor of Chemical Engineering and Engineering and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon, 1993—.

GARY J. POWERS, Professor of Chemical Engineering — Ph.D., University of Wisconsin; Carnegie Mellon, 1974—.

DENNIS C. PRIEVE, Gulf Professor of Chemical Engineering — Ph.D., University of Delaware; Carnegie Mellon, 1974—.

TODD M. PRZYBYCIEN, Professor of Chemical Engineering and Head of Biomedical Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1998—.

JAMES W. SCHNEIDER, Associate Professor of Chemical Engineering — Ph.D., University of Minnesota; Carnegie Mellon, 1999—.

DAVID SHOLL, Professor of Chemical Engineering — Ph.D., University of Colorado; Carnegie Mellon, 1998—.

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 Swearingen Professor of Chemical Engineering — Ph.D., DIC, Imperial College, University of London; Carnegie Mellon, 1976—.

LEE R. WHITE, Professor of Chemical Engineering — Ph.D., Australian National University; Carnegie Mellon, 1998—.

B. ERIK YDSTIE, Professor of Chemical Engineering — Ph.D., Imperial College, University of London; Carnegie Mellon, 1992—.
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 the 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 specific 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 who can work independently or as a productive member of a team
- Graduates who can communicate with other professionals and with society at large both in writing and in speech
- Graduates who aspire to leadership and who are prepared for a breadth of career challenges and for 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.

By the end of the B.S. program, students should have a variety of abilities and skills:

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. An understanding of the impact of engineering solutions in a global and social 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 understanding of professional practice issues, such as: how design and construction professionals interact on a project
M. Proficiency in a minimum of four recognized major civil engineering areas: structural engineering, environmental engineering, construction and management and computer-aided engineering

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.

### Curriculum

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 Modern Chemistry I 10
09-101 Intro to Experimental Chemistry 3
15-100 Introductory/Intermediate Programming 10
21-120 Differential and Integral Calculus 10
21-122 Integration, Differential Equations & Approximations 10
33-xxx Physics I for Engineering Students 12
33-xxx 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**

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<tr>
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<td>12-100</td>
<td>Introduction to Civil and Environmental Engineering</td>
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<tr>
<td>12-210</td>
<td>Differential and Integral Calculus</td>
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<tr>
<td>33-106</td>
<td>Physics for Engineering Students I</td>
<td>12</td>
</tr>
<tr>
<td>99-103</td>
<td>Computer: Skill Workshop</td>
<td>3</td>
</tr>
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<td>xx-xxx</td>
<td>H&amp;SS Elective</td>
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<td>39-101</td>
<td>CIT First-Year Seminar</td>
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**Spring**

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<td>Introduction to Engineering (other than CEE)</td>
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<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
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<td>33-xxx</td>
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**Sophomore Year Fall**

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<td>Introduction to Environmental Engineering</td>
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<td>12-252</td>
<td>Environmental Engineering Lab</td>
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<tr>
<td>12-271</td>
<td>Intro Computer Apps in Civil &amp; Environmental Engineering</td>
<td>9</td>
</tr>
<tr>
<td>09-101</td>
<td>Intro to Experimental Chemistry</td>
<td>3</td>
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<td>09-105</td>
<td>Modern Chemistry I</td>
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**Spring**

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<td>21-260</td>
<td>Differential Equations</td>
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</tr>
<tr>
<td>15-100</td>
<td>Introductory/Intermediate Programming</td>
<td>10</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>H&amp;SS or CFA Elective</td>
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<td>Elective 1</td>
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<td>12-301</td>
<td>Civil and Environmental Engineering Projects</td>
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<td>12-331</td>
<td>Solid Mechanics</td>
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<td>12-332</td>
<td>Solid Mechanics Lab</td>
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<td>27-357</td>
<td>Materials Selection</td>
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<td>21-259</td>
<td>Calculus in Three Dimensions</td>
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**Spring**

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-355</td>
<td>Fluid Mechanics</td>
<td>9</td>
</tr>
<tr>
<td>12-356</td>
<td>Fluid Mechanics Lab</td>
<td>3</td>
</tr>
<tr>
<td>12-333</td>
<td>Soil Mechanics</td>
<td>9</td>
</tr>
<tr>
<td>12-336</td>
<td>Soil Mechanics Lab</td>
<td>3</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>H&amp;SS or CFA Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective 2</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective 3</td>
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**Senior Year**

**Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>12-401</td>
<td>Civil and Environmental Engineering Design</td>
<td>15</td>
</tr>
<tr>
<td>12-411</td>
<td>Engineering Economics</td>
<td>6</td>
</tr>
<tr>
<td>36-220</td>
<td>Prob &amp; Stat or Engr Stat and Qual Control</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>H&amp;SS or CFA Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective 4</td>
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</tr>
</tbody>
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**Spring**

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<th>Course Title</th>
<th>Units</th>
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<tr>
<td>xx-xxx</td>
<td>H&amp;SS or CFA Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective 5</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective 6</td>
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<td>Elective 7</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective 8</td>
<td>9</td>
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</table>

**Minimum number of units required for degree: 373**

**Notes on Electives**

1. One elective must be in the basic sciences, either:
   03-121 Modern Biology
   09-106 Modern Chemistry II or
   33-104 Experimental Physics

Substitutions may be made only with the approval of the Department Head.

2. One elective course is restricted to any Civil Engineering course
numbered 300 or above. The Civil Engineering elective is a co-
requisite for 12-401.

**Specialty Areas in Civil Engineering**

Students are encouraged to select a set of civil engineering and
technical electives in the junior and senior years that enable them to
concentrate in a specialty area if they so desire. Some available
options for grouping electives into specialty areas, together with
representative course selections, are indicated below.

**Infrastructure Systems**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-600</td>
<td>AutoCAD</td>
<td></td>
</tr>
<tr>
<td>12-605</td>
<td>Design and Construction</td>
<td></td>
</tr>
<tr>
<td>12-611</td>
<td>Project Management for Construction</td>
<td></td>
</tr>
<tr>
<td>12-631</td>
<td>Structural Design</td>
<td></td>
</tr>
<tr>
<td>12-636</td>
<td>Geotechnical Engineering</td>
<td></td>
</tr>
<tr>
<td>12-657</td>
<td>Water Resources Engineering</td>
<td></td>
</tr>
<tr>
<td>15-211</td>
<td>Fundamental Data Structures and Algorithms I</td>
<td></td>
</tr>
<tr>
<td>18-100</td>
<td>Introduction to Electrical and Computer Engineering</td>
<td></td>
</tr>
<tr>
<td>21-228</td>
<td>Discrete Mathematics</td>
<td></td>
</tr>
<tr>
<td>21-241</td>
<td>Matrix Algebra</td>
<td></td>
</tr>
</tbody>
</table>

**Environmental Engineering**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-611</td>
<td>Project Management for Construction</td>
<td></td>
</tr>
<tr>
<td>12-657</td>
<td>Water Resources Engineering</td>
<td></td>
</tr>
<tr>
<td>12-636</td>
<td>Geotechnical Engineering</td>
<td></td>
</tr>
<tr>
<td>06-221</td>
<td>Thermodynamics</td>
<td></td>
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<tr>
<td>06-620</td>
<td>Global Atmospheric Chemistry</td>
<td></td>
</tr>
<tr>
<td>09-510</td>
<td>Introduction to Green Chemistry</td>
<td></td>
</tr>
<tr>
<td>24-424</td>
<td>Energy and the Environment</td>
<td></td>
</tr>
<tr>
<td>48-596</td>
<td>LEED Buildings and Green Design</td>
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</tbody>
</table>

**Structures, Mechanics and Geotechnical Engineering**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-600</td>
<td>Auto CAD</td>
<td></td>
</tr>
<tr>
<td>12-605</td>
<td>Design and Construction</td>
<td></td>
</tr>
<tr>
<td>12-611</td>
<td>Project Management for Construction</td>
<td></td>
</tr>
<tr>
<td>12-635</td>
<td>Structural Analysis</td>
<td></td>
</tr>
<tr>
<td>12-631</td>
<td>Structural Design</td>
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<tr>
<td>12-636</td>
<td>Geotechnical Engineering</td>
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<tr>
<td>21-228</td>
<td>Discrete Mathematics</td>
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</tr>
<tr>
<td>21-241</td>
<td>Matrix Algebra</td>
<td></td>
</tr>
<tr>
<td>24-262</td>
<td>Stress Analysis</td>
<td></td>
</tr>
<tr>
<td>24-356</td>
<td>Engineering Vibrations</td>
<td></td>
</tr>
<tr>
<td>24-401</td>
<td>Engineering Analysis</td>
<td></td>
</tr>
</tbody>
</table>
Double Majors and Minors

Civil engineering students may pursue double majors and minors in a variety of subjects, taking advantage of the free elective courses for other requirements. The college of engineering has added designated minors to promote flexibility and diversity among engineering students. Many CEE undergraduates pursue designated minors in such areas as Engineering Design or Environmental Engineering.

Co-Operative Education Program

Students in civil engineering are encouraged to undertake professional internships during summer breaks. In addition, a formal co-operative 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 373 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, Associate 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 – PhD., 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—.

CLIFF I. DAVIDSON, Professor of Civil and Environmental Engineering and Director, Environmental Institute — Ph.D., California Institute of Technology; Carnegie Mellon, 1977—.

DAVID A. DZOMBAK, Professor of Civil and Environmental Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989—.

SUSAN FINGER, Associate 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—.

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—.

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—.

HOON SOHN, Assistant Professor of Civil and Environmental Engineering – Ph.D., Stanford University; Carnegie Mellon, 2004—.

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

JEANNE VANBRIESEN, Associate Professor of Civil and Environmental Engineering — Ph.D., Northwestern University; Carnegie Mellon, 1999—.
Department of Electrical and Computer Engineering

T.E. (Ed) Schlesinger, Head
Bruce H. Krogh, 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

(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 multi-disciplinary teams
(e) An ability to identify, formulate, and solve engineering problems
(f) An understanding of professional and ethical responsibility
(g) An ability to communicate effectively

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) A recognition of the need for, and an ability to engage in lifelong learning
(j) A knowledge of contemporary issues
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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: 360 (An average of 45 units per semester)

In addition to the Carnegie Institute of Technology general education and freshman year requirements (131 units), the B.S. in Electrical and Computer Engineering requires Physics II (12 units), two math or science electives (18 units), a Probability and Statistics course (9 units), an Engineering Elective (12 units), 109 units of Electrical and Computer Engineering coursework, and 2 math co-requisites (21 units). The remaining units needed to reach the 360 required to graduate are Free Electives.

The Electrical and Computer Engineering coursework is divided into the categories of Core, Breadth, Depth, Coverage, and Capstone Design. The Core consists of 3 Electrical and Computer Engineering courses (18-100 Introduction to Electrical and Computer Engineering, 18-220 Fundamentals of Electrical Engineering, and 18-240 Fundamentals of Computer Engineering), 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 during the sophomore year. The two Fundamentals courses are split between the fall and the spring semesters (the department strongly recommends that students not take the two Fundamentals courses in the same semester). Although the Fundamentals courses (and their co-requisites) may be taken in either 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 ECE, introduces students to the many areas within ECE and helps them decide which areas are of primary interest to them.

The courses in the ECE curriculum are grouped into five principal subject areas. To satisfy the ECE Breadth Requirement, at least one Breadth course must be completed from three of the five principle areas (36 units). The areas and their Breadth courses are as follows:

**Applied Physics**
In this area students study Solid State Physics, Magnetics, Fields, Optics etc. The following courses are the current Breadth courses in this area:
- 18-300 Fundamentals of Electromagnetics
- 18-310 Fundamentals of Semiconductors

**Signals and Systems**
In this area students study Signals, Linear Systems, Controls, DSP etc. The following course is the current Breadth course in this area:
- 18-396 Signals and Systems

**Circuits**
In this area students study Analog and Digital Circuits, IC Design, etc. The following courses are the current Breadth courses in this area:
- 18-321 Analysis and Design of Analog Circuits
- 18-322 Analysis and Design of Digital Circuits

**Computer Hardware**
In this area students study Logic Design, Computer Architecture, Networks, etc. The following courses are the current Breadth courses in this area:
- 15-213 Introduction to Computer Systems
- 18-340 Digital Computation
- 18-341 Logic Design Using Simulation, Synthesis, and Verification Techniques
- 18-345 Introduction to Telecommunication Networks

**Computer Software**
In this area students study Programming, Data Structures, Compilers, Operating Systems, etc. The following course is the current Breadth course in this area:
- 15-211 Fundamental Data Structures and Algorithms

**B.S. Curriculum**
Minimum number of units required for degree: 360 (An average of 45 units per semester)

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/](http://www.ece.cmu.edu/)

**University Requirement**

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

- CIT General Education 72 units
- 2 semesters of calculus 20 units
- 33-106 Physics for Engineering Students I* 12 units
- 1 other introductory engineering course, generally taken during the freshman year 12 units
- 39-101 CIT First Year Seminar 0 Units

**Specific ECE requirements:**

1. **Introduction to Electrical and Computer Engineering course,** to be taken during the freshman year 12 units
   - 18-100 Introduction to Electrical and Computer Engineering

2. **ECE Seminar,** taken during fall of the sophomore year 1 unit
   - 18-200 Emerging Trends in ECE

2. **ECE core courses,** each with their own math co-requisites 45 units
   - 18-220 Fundamentals of Electrical Engineering 12 units
   - 18-202 Mathematical Foundations of Electrical Engineering 12 units (co-requisite to 18-220)
   - 18-240 Fundamentals of Computer Engineering 12 units
   - 21-127 Introduction to Modern Math (co-requisite to 18-240)

3. **Breadth Courses** 36 units (introductory-level courses, must be taken from 3 of the 5 different areas within ECE)
   - 1 Depth Course 12 units (must have one of the Breadth courses as a prerequisite)
   - 2 Coverage Courses 24 units (may be from any of the five areas or additional courses as indicated on the ECE Website)
   - 1 Capstone Design Course Any 18-5xx course (may be double-counted with either Depth, Coverage or Engineering Elective)
   - 1 Engineering Elective 12 units (any technical course from anywhere within CIT, or a 200-level or higher CS or Robotics course except for 15-251 and 15-351)

**Other ECE Requirements:**

15-100/111, Introductory/Intermediate Programming, to be taken during the Freshman year 10 units

33-107, Physics for Engineering students II 12 units

*33-106/107 is the recommended sequence for engineering students, although 33-111/112 or 33-131/132 would also meet the CIT Physics requirement.

2 Math/Science electives minimum of 18 units

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
- 21-259 Calculus in Three Dimensions
- 21-260 Differential Equations

1. **Probability and Statistics course** (either 36-217, Probability Theory and Random Processes or 36-220, Engineering Statistics and Quality Control or 36-225, Introduction to Probability and Statistics) 1) 9 units

36-217 (a prerequisite for 18-345, Introduction to Telecommunications Networks and 18-450, Digital Wireless Communications) is recommended for students interested in communications, control, networks, and signal processing. 36-220 is appropriate for students interested in quality control, manufacturing, and statistical methods. The two-course sequence 36-217 and 36-220 (or 36-225 and 36-226) will be of interest for Business Administration double majors.

**Free Electives**

Additional courses to be used toward the required 360 units can be any graded course (i.e., not taken as Pass/Fail) taken from one of the academic units on campus (no Physical Education courses, StuCo or ROTC courses may be used toward Free Electives or any graduation requirements).

**Total:** 360 units.
The following table shows a possible roadmap through our broad and flexible curriculum:

<table>
<thead>
<tr>
<th>Freshman Year</th>
<th>Sophomore Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>Introduction to Electrical &amp; Computer Engineering (12)</td>
<td>Introductory Engineering Elective (12)</td>
</tr>
<tr>
<td>CIT First-Year Seminar (0)</td>
<td>Writing/Expression Course (9)</td>
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<tr>
<td>Computer Skills Workshop (3)</td>
<td>General Education Course (9)</td>
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<tr>
<td>Total Units: 44</td>
<td>43</td>
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<table>
<thead>
<tr>
<th>Junior Year</th>
<th>Senior Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>ECE Breadth Course 1 (12)</td>
<td>ECE Breadth Course 3 (12)</td>
</tr>
<tr>
<td>ECE Breadth Course 2 (12)</td>
<td>ECE Depth Course (12)</td>
</tr>
<tr>
<td>Math/Science Elective 1 (9)</td>
<td>Math/Science Elective 2 (9)</td>
</tr>
<tr>
<td>General Education Course (9)</td>
<td>General Education Course (9)</td>
</tr>
<tr>
<td>Free Elective (3, 6, 9)</td>
<td>Free Elective (3, 6, 9)</td>
</tr>
<tr>
<td>45/48/51</td>
<td>45/48/51</td>
</tr>
</tbody>
</table>

### 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, or if his or her overall QPA is at least 3.5.

### Pass/Fail policy

No course taken as Pass/Fail may be used in any way toward graduation (including Free Elective credit).

### 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. 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, 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 apply to the ECE Undergraduate Office for the program at the close of their sophomore year. 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 depart-ment, the Career Center in the University Center, or online at http://www.ece.cmu.edu/undergrad/.

#### Integrated M.S./B.S. Degrees Program

Qualifying undergraduates also have the opportunity to receive an M.S. Degree in ECE by taking an additional 96 units (nominally eight 12 unit courses) of coursework at Carnegie Mellon. The degrees may be awarded simultaneously or sequentially depending on the progress and preference of the student. The primary purpose of the Integrated Masters/Bachelors (IMB) Degree Program is to provide students with superior breadth and depth of technical material, which will better prepare them for careers in industry. The Integrated Masters/Bachelors Degree Program normally requires an additional year of course work beyond the B.S. Degree Requirements. 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. In the face of the ever increasing technological complexity of the workplace, the additional year of advanced undergraduate and graduate classes required for the Integrated M.S./B.S. Degrees substantially enhances a student’s readiness to contribute in an industrial position.
M.S. Degree Requirements

Total units required for M.S.: 96

The Integrated Masters/Bachelors Degrees Program is available to all undergraduates who maintain a cumulative GPA of at least 3.0, including the Freshman Year. Students must also maintain a GPA of 3.0 in courses used to satisfy the requirements of the M.S. degree.

The following are the requirements for the M.S. Degree. These are in addition to 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 the M.S. requirements listed below.

1. A minimum of 96 units must be completed for the M.S., in addition to the 360 units required for the B.S.

2. Of the 96 units, the College of Engineering requires that a minimum of 60 units must be at the ECE graduate level (600-level and above), including both course and project units.*

3. At least 48 units of the 60 required ECE units must be ECE graduate-level courses (600-level and above). The remaining 12 units may either be an additional ECE graduate course, or may be 12 units of project units.

4. 36 units additional units (may be from any academic unit of the University).
   - A minimum of 24 of the 36 units must be at the 500-level and above
   - No more than 12 units of undergraduate (400 level and below) coursework may count toward the 96-unit requirement

* No more than 15 units of project/research (18-980) may be counted toward the 96-unit requirement. Of this 15 units, no more than 12 of them may be used towards the 60 units of 600-level and above requirement.

Notes

- No course with a grade lower than C will be counted toward the Masters Degree requirements for the Integrated M.S./B.S. Degree (those over and above the requirements for the B.S. Degree). Students become eligible to declare their intention to participate during the spring semester of the junior year, or the semester in which they accumulate 270 or more units, whichever is earlier.

- Up to 15 units of 39-500, CIT Honors Project, can be used towards item 4; however, no additional research units can then be used to count towards the 96-unit requirement. The student must have graduate standing in order to conduct graduate research. The graduate project must contain substantial design and/or research experience. Graduate projects must be proposed (one-page abstract describing the project), supported by an ECE Faculty advisor, and submitted for approval to the ECE Undergraduate Office.

- Any student going beyond 8 semesters to complete both the B.S. and M.S. degree requirements may maintain undergraduate standing. However, they will be required to take graduate standing for at least the last semester in which they are enrolled. This means that all B.S. degree requirements and any requirements for second majors or minors must be met prior to this last semester.
Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983—.

MARIOS SAVVIDES, Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005—.

TUVIAH E. SCHLESINGER, Professor of Electrical and Computer Engineering; Head, Department of Electrical and Computer Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1985—.

SRINI SESHAH, Associate Professor of Computer Science and Electrical and Computer Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon 2000—.

TUVIAH E. SCHLESINGER, Professor of Electrical and Computer Engineering; Head, Department of Electrical and Computer Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1985—.

SRINI SESHAH, Associate Professor of Computer Science and Electrical and Computer Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon 2000—.

DANIEL P. SIEWIOREK, Buhl University Professor of Electrical and Computer Engineering and Computer Science; Director, Human Computer Interaction Institute — Ph.D., Stanford University; Carnegie Mellon, 1972—.

MARVIN A. SIRBU, Professor of Engineering and Public Policy, Tepper School of Business and Electrical and Computer Engineering — Sc.D., Massachusetts Institute of Technology; Carnegie Mellon, 1985—.

METIN SITTI, Assistant Professor of Mechanical Engineering and Electrical, Computer Engineering and Robotics Institute — Ph.D., Univeristy of Toledo; Carnegie Mellon, 2002—.

ASIM SMAILAGIC, Research Professor of ICES and Electrical and Computer Engineering; Director, LINCS — Ph.D., University of Sarajevo and University of Edinburgh; Carnegie Mellon, 1992—.

DAWN SONG, Assistant Professor of Electrical and Computer Engineering and Computer Science — Ph.D. University of California, Berkeley; Carnegie Mellon, 2002—.

DANIEL D. STANCIL, Professor of Electrical and Computer Engineering; Director, Center for Wireless and Broadband Networking — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1986—.

PETER STEENKISTE, Professor of Electrical and Computer Engineering and Computer Science — Ph.D., Stanford University; Carnegie Mellon, 1987—.

RICHARD M. STERN, JR., Professor of Electrical and Computer Engineering, Computer Science, and Biomedical Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1977—.

ANDRZEJ J. STROJWAS, Keithley Professor of Electrical and Computer Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983—.

THOMAS SULLIVAN, Associate Teaching Professor, Electrical and Computer Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1996—.

SAROSH N. TALUKDAR, Professor of Electrical and Computer Engineering — Ph.D., Purdue University; Carnegie Mellon, 1974—.

ALFRED A. THIELE, Distinguished Scholar — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1981—.

DONALD E. THOMAS, JR., Professor of Electrical and Computer Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977—.

OZAN TONGUZ, Professor of Electrical and Computer Engineering — Ph.D., Rutgers University; Carnegie Mellon, 2000—.

ELIAS TOWE, Professor of Electrical and Computer Engineering, Groebstein Memorial Professor of Materials Science and Engineering; Director, CNXT — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2001—.

CHENXI WANG, Research Scientist — Ph.D. University of Virginia; Carnegie Mellon, 2001—.

ROBERT WHITE, Emeritus, University Professor Emeritus of Electrical and Computer Engineering and Engineering and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1993—.

JEANNETTE WING, Department Head, Computer Science; President’s Professor of Computer Science; Professor of Electrical and Computer Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1985—.

TINA WONG, Systems Scientist; CyLab, INI and ECE — Ph.D., University of California, Berkeley; Carnegie Mellon, 2005—.

PATRICK YUE, Adjunct Professor of Electrical and Computer Engineering — Ph.D., Stanford University; Carnegie Mellon, 2003—.
Department of Engineering and Public Policy

M. Granger Morgan, Head
Mark Kieler, Assistant Department Head
Office: Baker Hall 129

Mission Statement
The Department of Engineering and Public Policy (EPP) is a unique engineering department, whose overall objective is to enhance undergraduate engineering education with the perspectives and skills that enable the engineer to understand and work at the interface between technology and society. Society is largely responsible for setting the goals and framing the problems that engineers work on. However, technologies designed by engineers profoundly change the societies in which they operate. Technology has enabled a healthier, richer and more productive society. At the same time, technology has contributed to the creation of many of the more serious problems our society faces.

Technology can help us build a happier, freer, and more fulfilling life, while maintaining risks and undesirable impacts at acceptable levels. But that does not happen automatically. It takes careful hard work by people who understand both technology and the society in which they live. In order to do their jobs responsibly and well in today’s world, engineers must develop an understanding of the interface between technology and society and a command of the skills necessary to work at that interface. The undergraduate degree programs of the Department of Engineering and Public Policy (EPP) have been designed to allow engineering students at Carnegie Mellon University to add this important dimension to their traditional engineering education. EPP double major graduates, for the most part, will enter traditional engineering careers ...and in doing so 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 though 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 including:

- Display 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.
- Recognize situations and know 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.
- Display 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.
- Use, or seek 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.
- Consider career paths more diverse than those traditionally associated with engineering or other technical careers.
- Demonstrate 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.

Overview
The department offers double-major B.S. degree programs with each of the five traditional engineering departments in the engineering college (e.g., B.S. in chemical engineering, engineering and public policy), as well as with the School of Computer Science. These joint degree programs, which have been offered since 1971, are now chosen by about 10 percent of all undergraduate engineering students at Carnegie Mellon. Typically, they only require the unit equivalent of less than one added 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 include subject matter which is not part of traditional engineering or social science curricula, but which contains elements of each. This is accomplished by Engineering and Public Policy technical elective courses, social analysis courses, and through participation by each student in at least two interdisciplinary problem-solving projects. Problem areas for these projects are chosen from local, state, and national situations and include such topics as industrial automation and robotics, environmental control, telecommunciation 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, and the social science, humanities, and industrial administration courses offered in the College of Humanities and Social Sciences and GSIA's under-graduate business program. There is also significant interaction between EPP students and the Environmental...
All undergraduates interested in the programs of the department 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 in 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 under-graduate advisors early.

The majority of the double-major graduates in Engineering and Public Policy pursue conventional engineering careers, using 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.

Current faculty advisors of the program are the following:

For Chemical Engineering/Engineering and Public Policy majors: Mark Kieler
For Civil Engineering/EPP majors: Cliff I. Davidson, Mitchell J. Small, Scott Matthews, Peter Adams
For Computer Science/EPP majors: Mark Kieler
For Electrical and Computer Engineering/EPP majors: Jon Peha, Marvin A. Sirbu, Mark Kieler, Marija Ilic, Adrian Perrig
For Mechanical Engineering/EPP majors: Edward S. Rubin, Allen Robinson
For Materials Science and Engineering/EPP majors: Mark Kieler
For EPP-Heinz School Accelerated Masters program students: Mark Kieler

Designated Minors are possible with an EPP double major. Students should see their advisor early to plan for these. Students can also obtain general academic advice and guidance from Mark Kieler, the undergraduate assistant department head of EPP.

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 on the next page.

### Double-Major Curricula

#### Bachelor of Science in an Engineering Specialty and Engineering and Public Policy, or Computer Science and Engineering and Public Policy

The EPP double-major curricula allow the student the option of a number of non-traditional career paths, and at the same time preserve the option of a traditional technical career. Following the sample curricula below, the student simultaneously satisfies all requirements for the undergraduate degree in a traditional engineer-ing 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.

This degree program has the attractive feature of allowing technical students to keep a number of options open after they graduate. Students graduating with a double-major degree have found a range of job possibilities, from traditional engineering jobs in industrial organizations to assignments in consulting firms and positions in local and national government. Students have also entered graduate schools of engineering, business, urban management, and law.

### Note on EPP double major requirements

This note is intended to clarify the major substitutions that occur in the single major curriculum when it is fashioned into an EPP double major curriculum.

Freshman Electives: An EPP major is not required to take the Introduction to EPP course although taking it may be a way to find out the kind of questions and issues studied in EPP. All EPP students are required to take 19-102 EPP Sophomore Seminar in the fall of their sophomore year. 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, as explained below, 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 described later. 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.

Under the IIO option the student enhances classroom learning by alternating one-semester work periods in industry with on-campus semesters, beginning in the summer following the sophomore year. Interested students should read the relevant parts of the MSE section carefully.

The student graduates with a bachelor's degree in MSE and EPP in four-and- one-third years. The internship option curriculum differs from the standard curriculum in the last three academic semesters, as indicated in the MSE section.
**EPP Core courses**

The EPP double major curriculum consists of two sets of core courses: one set for the disciplinary major (ChE, CEE, 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 EPP core consists of the following courses:

- 19-102 EPP Sophomore Seminar
- 19-451 EPP Project I
- 19-452 EPP Project II
- 73-100* Principles of Economics
- 88-xxx/19-xxx Decision Analysis (see below)
- 36-xxx Probability and Statistics (2 courses, see below)
- xx-xxx 4 EPP Technical Electives
- xx-xxx 4 EPP Social Analysis Electives

* Students who expect to take advanced economics courses should take 73-150 instead of 73-100.

These requirements are described in more detail below.

The above EPP Core Courses in general replace technical and general education requirements, seminars, and free electives of the single major. The one exception is the first EPP Project that replaces 24-401: Engineering Analysis in the MEG/EPP curriculum. In all other cases, the two EPP Projects substitute for technical or free electives.

**Technical Course Requirements**

**Probability and Statistics Sequence**

In today's world, knowledge of probability and statistics are critical in understanding how technological systems operate. The EPP double major requires that students take a 2 course sequence in probability and statistics. If the student's primary major has a statistics requirement as well, that course may count towards meeting one of the two course requirement. The courses should be selected from the following list:

- 36-217 Probability Theory and Random Processes
- 36-220 Engineering Statistics and Quality Control
- 36-310 Fundamentals of Statistical Modeling

All students generally take 36-220 and then one other statistics course.

- ChE/EPP majors take 36-220 in place of a technical elective and the second course in place of a free elective.
- CE/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 36-220 or 36-217 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 are generally a subset of the courses taught in the engineering school (CIT), college of science (MCS), or the School of Computer Science (SCS). These electives are either disciplinary courses that provide background knowledge or skills necessary for problem solving in the technology/policy area; or, courses that have a multidisciplinary approach to problems with substantial technological and societal components. A more detailed listing of EPP technical electives is given later in this section. Note that the catalog listing is not exhaustive, and that the offering of courses changes all the time. Prior to the beginning of the registration process each semester, a list of EPP Technical Electives is distributed by the department. Classes can then be selected from this list.

All double majors must complete four EPP technical electives with the following special cases:

- ChE/EPP students count 27-401 and 402 in place of one EPP technical elective.
- CE/EPP students count two CEE core mini courses, 12-411 Engineering Economics, and 27-357, Introduction to Materials Selection, as one EPP Technical Elective. CE/EPP students take only three more EPP Technical Electives.
- ME/EPP students count 24-441 Engineering Design, as an EPP technical elective. ME/EPP students take only three more EPP technical electives.
- MSE/EPP students count 27-401 and 402 in place of one EPP technical elective. So MSE/EPP students 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, and which are also EPP technical electives to prevent unnecessary overloading.

**Social Analysis 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

Students should complete 73-100 as early as possible, preferably during their freshman year. Students who intend to take advanced courses in economics should take 73-150 in place of 73-100, as that course is required for all subsequent economics courses.

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

- 88-223 Decision Analysis and Decision Support Systems
- 88-302 Behavioral Decision Making
- 19-426 Environmental Decision Making

88-223 and 88-302 have a statistics course prerequisite.

**Social Analysis Electives**

Social Analysis electives are a subset of courses taught in the College of Humanities and Social Sciences (H&SS), the H. John Heinz III School of Public Policy and Management and GSIA's undergraduate business department. Some examples of these courses are provided later in this section. Students selecting Social Analysis electives should always refer to the department's current list, which is revised prior to registration for each semester. 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.
Special Feature: Interdisciplinary Problem-Solving Projects

One of the most interesting and unique features of the Department of Engineering and Public Policy is the problem-solving project courses which are designed to provide a student with real-world experiences. Each student participates in two technology/policy projects (generally, one each in the junior and senior years) 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, the Heinz School, and H&SS, 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.

Although a different topic is chosen for each project, every project has the same basic characteristics:

1. The problem selected for study is associated with a public policy problem and is constrained by technology, politics, and economics.

2. A client is defined to focus the framework within which the project is worked. Often, the client agency or institution interacts closely with the students in the project.

3. A set of external experts acts as an advisor for the project and composes a review panel which critiques class efforts during the semester.

4. Class organization is aimed at putting together a workable set of alternatives to the problem. Typically, groups of four to eight students investigate specified aspects of the problem; group efforts are coordinated by student managers and faculty advisors; and objectives and personnel are reassigned during the semester. Three formal oral reports are given before the review panel during the semester; a written report is also submitted at the end of the semester.

5. Problem areas for the projects are abstracted from local, state, and national situations. Examples of topics and clients of projects undertaken by EPP students are listed below.

- “Effects of Windshear in Aviation” (1989)—Public
- “Household Batteries: Is There a Need for Change in Regulation and Disposal?” (1989)—Public;
- “Magnetic Levitation Transportation: The Pittsburgh Frontier” (1990) — public;
- “Safety with Fuel Efficiency: Alternatives to CAFE” (1991)—public;
- “Design Issues in Waste Avoidance” (1991) - Pennsylvania Department of Environmental Resources;
- “Aral Sea Regional Ecological Crisis” (1992) - Senator Albert Gore of Tennessee;
- “Airbags: Help or Harm?” (1997) — public;
- “Food Irradiation” (1998) — public;
- “Hybrids and Diesels: Forecasting Future Impacts” (2005) — public;

Each academic year at graduation, the best undergraduate project from the previous year is awarded the Stephen O. Lee Undergraduate Policy Project Award. All student participants are recognized.

Fifth Year M.S. program in Engineering and Public Policy

Juniors 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. Interested students must have a minimum 3.0 QPA and should contact their advisor for details on the application process.

Following are the additional requirements for the MS degree. Note that no course taken may count for both a BS in CIT and the MS degree (students minoring in Technology and Policy from a non-CIT department should consult with their home college about double counting issues). Note that successful completion of the MS degree requires 96 units of coursework and research.

Requirements for Fifth year M.S. in Engineering and Public Policy

Public Policy

I. Type A [Technical] Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-704 Estimation Methods</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx Technical Elective 1</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Technical Elective 2</td>
<td>9</td>
</tr>
</tbody>
</table>

II. Type B [Social Analysis] Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-908 Microeconomics</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx Social Analysis (Graduate Level)</td>
<td>12</td>
</tr>
</tbody>
</table>

III. Type C [EPP Core] Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-701 Theory and Practice of Policy Analysis</td>
<td>12</td>
</tr>
<tr>
<td>19-702 Quantitative Methods for Policy Analysis</td>
<td>12</td>
</tr>
</tbody>
</table>

Total units required for degree 96 units

* 12 units of these courses will be taken (and counted) as an under-graduate Technical Elective, and will not count toward the 96 unit MS degree.

** The primary concern for scheduling and completing this integrated program is completing the 2-year sequence of core EPP graduate courses (19-701 in addition to 19-702, or 2 courses from 19-703, 19-704, or 19-705). These courses are individually taught every other academic year. The student should ensure that they schedule the courses offered in their senior year, followed by the remainder in their fifth year.

Students may elect to begin the Project Research component after their fourth year.

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.
Bachelor of Science in Engineering and Public Policy and Master of Science in Public Management and Policy

Highly motivated and talented students can earn the EPP double major bachelor’s degree, and a master’s degree in the H. John Heinz School of Public Policy and Management in a five-year course of study. Students interested in the combined degree program should enroll in a standard double-major program in an engineering specialty and EPP. During the third year of study, the student applies to the Heinz School 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 School programs: (1) some social analysis requirements in EPP, usually four semester courses, can be satisfied with Heinz School common core courses in economics and social science; (2) at least one project course is common and applicable to both curriculums; (3) at least one additional EPP technical elective, engineering option or project course will be accepted for Heinz School credit following the usual request to the master’s committee.

[Comment on (2): A second physical/technical systems course would count automatically for all program cores except financial analysis.]

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 Mark Kieler (Assistant Head, EPP) for more information. For general information on Heinz 3-1-1 programs please contact the Heinz school or refer to their website.
### Chemical Engineering

#### Single Major

<table>
<thead>
<tr>
<th>Sophomore Year</th>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-259</td>
<td>Calculus in Three-Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>06-221</td>
<td>Thermodynamics</td>
<td>9</td>
</tr>
<tr>
<td>06-222</td>
<td>Sophomore Chemical Engineering Seminar</td>
<td>1</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>15-100/</td>
<td>Introductory Intermediate Programming /</td>
<td>10-12</td>
</tr>
<tr>
<td>33-107/</td>
<td>Physics for Engineering Students II /</td>
<td></td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
<td>9</td>
</tr>
</tbody>
</table>

**Spring**

| 06-261         | Fluid Mechanics                       | 9     |
| 06-262         | Mathematical Methods of Chemical Engineering | 12 |
| 09-221         | Lab 1: Introduction to Chemical Analysis | 12   |
| 33-107/        | Physics for Engineering Students II / |      |
| 15-100         | Introductory Intermediate Programming | 12-10 |
| xx-xxx         | General Education Course              | 9     |

**Junior Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-321</td>
<td>Chemical Engineering Thermodynamics</td>
</tr>
<tr>
<td>06-323</td>
<td>Heat and Mass Transfer</td>
</tr>
<tr>
<td>06-322</td>
<td>Junior Chemical Engineering Seminar</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td>09-347</td>
<td>Advanced Physical Chemistry</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
</tr>
</tbody>
</table>

**Spring**

| 06-361       | Unit Operations of Chemical Engineering | 9     |
| 06-362       | Chemical Engineering Process Control   | 9     |
| 06-233       | Biochemistry                            | 9     |
| xx-xxx       | Elective                                | 9     |
| xx-xxx       | General Education Course                | 9     |

**Senior Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-421</td>
<td>Chemical Process Systems Design</td>
</tr>
<tr>
<td>06-422</td>
<td>Chemical Reaction Engineering</td>
</tr>
<tr>
<td>06-423</td>
<td>Unit Operations Laboratory</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>General Education Course</td>
</tr>
</tbody>
</table>

**Spring**

| 06-461       | Process Design Project                  | 6     |
| 06-462       | Economics & Optimization                 | 9     |
| xx-xxx       | Elective                                | 9     |
| xx-xxx       | Elective                                | 9     |
| xx-xxx       | General Education Course                | 9     |

**Minimum number of units required for degree:** 386

### Chemical Engineering with an Additional Major in Engineering and Public Policy

<table>
<thead>
<tr>
<th>Sophomore Year</th>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
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**Spring**

| 06-261         | Same   | 9     |
| 06-262         | Same   | 9     |
| 09-221         | Same   | 12    |
| 33-107/        | Same   | 12-10 |
| xx-xxx         | EPP Social Analysis Elective*             | 9     |

**Junior Year**

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**Spring**

| 06-361       | Same  | 9     |
| 06-362       | Same  | 9     |
| 09-363       | Same  | 6     |
| 36-220       | Engineering Stats and Quality Control   | 9     |
| 19-451       | EPP Project                              | 12    |
| xx-xxx       | EPP Social Analysis Elective*            | 9     |

**Senior Year**

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**Spring**

| 06-461       | Same  | 6     |
| 06-462       | Same  | 6     |
| xx-xxx       | EPP Technical Elective                   | 9     |
| xx-xxx       | EPP Technical Elective                   | 9     |
| 36-310       | Fundamentals of Statistical Modeling      | 9     |
| xx-xxx       | EPP Social Analysis Elective*            | 9     |

**Minimum number of units required for degree:** 392

* One of these must be taken from the following list:
- 88-302 Behavioral Decision Making
- 88-223 Decision Analysis and Decision Support Systems
- 19-426 Environmental Decision Making
# Civil Engineering
## Single Major

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<td>Differential Equations</td>
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<td>12-331</td>
<td>Solid Mechanics</td>
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<tr>
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<td>Engineering Statistics and Quality Control</td>
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Minimum number of units required for degree: 373

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# Civil Engineering with an Additional Major in Engineering and Public Policy

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<tr>
<td>73-100</td>
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Minimum number of units required for degree: 382

* One of these must be taken from the following list:
  88-302 Behavioral Decision Making
  88-223 Decision Analysis and Decision Support Systems
  19-426 Environmental Decision Making
## Computer Science
### Single Major

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<th>Units</th>
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| Minimum number of units required for degree: 360 |

## Computer Science with an Additional Major in Engineering and Public Policy

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| Minimum number of units required for degree: 369 |

* One Social Analysis Elective must be a Decision Analysis course from the following list:
  88-223 Decision Analysis and Decision Support Systems
  88-302 Behavioral Decision Making
  19-426 Environmental Decision Making

+ 73-100, Principles of Economics, satisfies the BSCS category 2 breadth requirement and is also required for the CS/EPP double major.
## Electrical and Computer Engineering
### Single Major

#### Sophomore Year

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<td>18-202 Mathematical Foundations of Electrical Engineering</td>
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<td>21-127 Introduction to Modern Mathematics (18-240 co req)</td>
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<td>33-107 Physics for Engineering Students II</td>
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#### Spring

| 18-2x0 ECE Core Course      | 12    |
| 18-202 Mathematical Foundations of Electrical Engineering | 12 |
| 21-127 Introduction to Modern Mathematics (18-240 co req) | 9    |
| 36-217 Probability and Statistics | 9    |
| xx-xxx General Education Course | 9     |
| xx-xxx Free Elective        | 9     |
|                            |   46 / 49 |

#### Junior Year

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#### Spring

| xx-xxx ECE Depth Course     | 12    |
| xx-xxx ECE Breadth Course 3 | 12    |
| xx-xxx Math / Science Elective 2 | 9     |
| xx-xxx General Education Course | 9     |
| xx-xxx Free Elective        | 9     |
|                            |   45 / 48 / 51 |

#### Senior Year

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#### Spring

| xx-xxx Capstone Design (e.g., ECE Coverage Course 2) | 12    |
| xx-xxx General Education Course                     | 9     |
| xx-xxx Free Elective                                | 9     |
| xx-xxx Free Elective                                | 9     |
|                            |   48 / 51 |

#### Minimum number of units required for degree: 360

## Electrical and Computer Engineering with an Additional Major in Engineering and Public Policy

#### Sophomore Year

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<tr>
<td>18-202 Same or</td>
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<td>33-107 Same</td>
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#### Spring

| 18-2x0 Same                 | 12    |
| 18-202 Same or              | 12    |
| 21-127 Same                 | 9     |
| 36-217 Same                 | 9     |
| xx-xxx EPP Social Analysis Elective | 9 |
| xx-xxx EPP Social Analysis Elective | 9 |
|                            |   48 / 51 |

#### Junior Year

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#### Spring

| xx-xxx Same                 | 12    |
| xx-xxx Same                 | 12    |
| 19-451 EPP Project          | 12    |
| xx-xxx EPP Social Analysis Elective* | 9 |
|                            |   45 |

#### Senior Year

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#### Spring

| xx-xxx Same                 | 12    |
| xx-xxx EPP Technical Elective | 9     |
| 36-217/220 Second Statistics Course | 9 |
| xx-xxx EPP Social Analysis Elective | 9 |
| xx-xxx EPP Technical Elective | 9     |
|                            |   45 / 48 |

#### Minimum number of units required for degree: 361

* One of these must be taken from the following list:
88-302 Behavioral Decision Making
88-223 Decision Analysis and Decision Support Systems
19-426 Environmental Decision Making

---

**Notes:**
- Courses marked with an asterisk (*) are part of the EPP major requirements.
- The department recommends that students who are planning to enter the ECE major as sophomores consult with their academic advisor to ensure proper course selection and sequencing.
- The above curriculum is subject to change. Students should consult the Engineering and Public Policy Department for the most current information.
### Materials Science and Engineering

#### Single Major

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<td>Thermodynamics of Materials</td>
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<tr>
<td>27-201</td>
<td>The Structure of Materials</td>
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| Minimum number of units required for degree: 379 |

* MSE single major restricted electives must total 45 units in any combination of appropriate courses. 9 unit examples are shown.

---

### Materials Science and Engineering with an Additional Major in Engineering and Public Policy

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<td>6+3</td>
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| Minimum number of units required for degree: 385 |

* One of these must be taken from the following list:
  88-302 Behavioral Decision Making
  88-223 Decision Analysis and Decision Support Systems
  19-426 Environmental Decision Making
### Mechanical Engineering

#### Single Major

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Minimum number of units required for degree: 380

### Mechanical Engineering with an Additional Major in Engineering and Public Policy

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<td>EPP Project (replaces single major 24-401 requirement)</td>
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<td>xx-xxx</td>
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<tr>
<td>xx-xxx</td>
<td>EPP Social Analysis Elective*</td>
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<th>Spring</th>
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<tr>
<td>36-310</td>
<td>Fundamentals of Statistical Modeling</td>
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<td>Same</td>
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<tr>
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<td>EPP Social Analysis Elective*</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>EPP Social Analysis Elective</td>
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Minimum number of units required for degree: 384

* One of these must be taken from the following list:
88-302 Behavioral Decision Making
88-223 Decision Analysis and Decision Support Systems
19-426 Environmental Decision Making
Engineering and Public Policy
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 / 19-712 Telecommunications Technology, Policy and 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 19-650 Climate and Energy: Science and Public Policy. 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.

Engineering and Public Policy Electives

Engineering and Public Policy technical elective courses are taught in CIT, MCS, or SCS. EPP technical electives generally belong to two categories: courses which synthesize engineering analysis and social analysis perspectives and apply them to problems with substantial societal and technological components; or, courses that teach methods or background vital to classes of important problems at the technology-society interface.

Specific areas of interest in which courses are taught are energy, resources, and the environment; risk assessment; forensic engineering; urban engineering; telecommunications, advanced information systems, and robotics. Courses may be elected in any of these areas or concentrated in one area. Each student elects four of these courses.

A categorical listing of representative EPP technical electives is provided below. There are more than 130 EPP Technical Electives available in various semesters. Also, course offerings are subject to change, and may have prerequisites. Students should always consult the EPP advising packet for the specific courses for which they are enrolling. The course listing in the current semester advising packet always has precedent over the following list.

### Energy, Resources and the Environment

- 19-424/24-424 Energy and the Environment
- 12-651 Air Quality Engineering
- 12-655 Water Quality Engineering
- 19-707 The Business of Brownfields

### Information and Telecommunication Technologies

- 19-402/18-482 Telecommunications Policy Analysis
- 15-381 Artificial Intelligence: Representation and Problem Solving
- 15-385 Artificial Intelligence: Computer Vision
- 15-827 Security and Cryptography
- 19-601 Information Warfare

### Other

- 03-121 Modern Biology
- 03-360 The Biology of the Brain
- 15-540 Rapid Design and Prototyping of Computer Systems
- 19-448 Science, Technology and Ethics
- 18-443 Civilian and Military Applications of Space
- 19-605 Science Technology and Innovation Policy
- 15-391 Technology Consulting and the Community
- 21-292 Operations Research
- 39-600 Integrated Product Development

### Social Analysis Electives

In addition to traditional engineering skills, double majors in the Engineering and Public Policy Department are expected to acquire social science skills that complement their engineering skills and prepare them to address the complicated problems which confront engineers in both the public and private sector. Listed below are areas of social analysis deemed relevant to double majors’ career objectives and some of the courses currently available in each area.

Courses may be elected in any of these areas, or concentrated in one or two specific areas. Faculty advisors can help students in choosing areas best suited to individual needs. Each student elects four courses in addition to 73-100 and the decision science course (88-223, 88-302, or 19-426). The Social Analysis Electives replace the CIT depth sequence requirement. Students may also count one foreign language course (82-XXX) as a Social Analysis Elective.

The following is a representative sample: Over 300 Social Analysis Electives are offered in various semesters. Also, course offerings are subject to change. Students should always consult the EPP advising packet for the semester for which they are enrolling. The current semester advising packet list always has precedent over the course listing below.

### Economics

Economics skills are aimed at the understanding of the free economy, and the development and use of analytical tools for handling complex economic variables. All economics courses qualify as social analysis electives. Examples are:

- 73-100 Principles of Economics (required but 73-150 may be preferable)
- 73-150 Principles of Economics with Calculus (required for advanced economics classes)
- 73-248 Environmental Economics
- 73-340 Labor Economics
- 73-469 Economics of E-Commerce

### Interpersonal Processes and Organizations

Skills in interpersonal processes involve an awareness of the development of relationships, the obligations of relationships, processes of bargaining, coalition formation, and power and dependence. Examples are:

- 85-221 Principles of Child Development
- 85-241 Social Psychology
- 70-311 Organizational Behavior
- 88-260 Organizations
- 88-302 Behavioral Decision Making

### Ethics

As technology and society become more closely intertwined, it becomes imperative that engineers whose products serve society, be aware of ethical problems that may arise in their work. Courses in ethics taught by the Department of Philosophy address issues of ethics in different spheres.

- 80-230 Ethical Theory
- 80-241 Ethical Judgments in Professional Life
- 80-244 Management, Environment, and Ethics
- 80-130 Introduction to Ethics
- 80-341 Computers Society and Ethics
Political Analysis
Political analysis includes knowledge of the structure of American government, especially legislative, executive, budgetary, regulatory and electoral processes.
70-364 Business Law
88-104 Decision Processes in American Political Institutions
88-324 Electoral Processes
88-358 Policy Making Institutions
88-332 Foreign Aid: The US, EU, and the Developing World

Urban Analysis
Urban analysis provides a better understanding of phenomena such as urbanism and urbanization, urban economic base and growth, metropolitanization and suburbanization, urban ecology and social differentiation, location behavior and the distribution of activities, and transportation development in the evolution of land use.
79-237 Cities in History: London and Delhi
79-319 The City and Country in Modern Europe
79-243 A History of Urban American Life
79-244 Pittsburgh and the Transformation of Modern Urban America
79-380 Making the American Landscape
90-743 Urban and Regional Economic development

Technology and Society
This area deals with the interaction of technology and society from a historical and humanistic perspective. Among the questions considered are the role of technology in the industrial revolution, the impact of technology on the city and the relationship of government policy to technological development.
79-212 Disastrous Encounters: Technology and the Environment in Global Historical Context
79-230 Technology in American Society
79-384 Medicine and Society
88-343 Economics of Technological Change
88-345 The Rise of Industrial Research and Development

International Peace and Security
National and international problems dealing with security and strategy and their political and historical perspectives are examined in these courses.
79-231 American Foreign Policy 1945-Present
79-232 Vietnam: America’s Lost War
79-350 Theories in International Relations
79-351 The Cold War in Documents and Film
79-352 Arab-Israeli Condition: War and Peace

Policy Analysis
This area deals with the analyses and assessments which form the basis of policies and decisions as well as the methodologies of policy making which are used to transform a model into a workable policy.
80-321 Causation and Social Policy
80-346 Value Fact and Policy
88-220 Policy Analysis I
88-222 Decision Analysis and Decision Support Systems
88-352 International Environmental Law and Policy

Role of Computers in Institutions
This area deals with the institutional, interpersonal, and policy aspects of the increasing role of computers in our society.
95-757 Information Security: Risk Policy and Management
90-802 Information Security: Comparison of U.S. and European Policies
95-758 Cyber Security Policy and Implementation
95-810 Managing in a Virtual Environment
95-730 Electronic Commerce

Students are urged to elect as a social analysis elective one technical writing course, such as 76-270 Writing for the Professions or 76-379 Technical Communications for Engineers.

Faculty
PETER ADAMS, Associate Professor of Civil and Environmental Engineering/Engineering and Public Policy — Ph.D., Caltech; Carnegie Mellon 2001—.

JAY APT, Associate Research Professor of The Tepper School of Business; Distinguished Service Professor of Engineering and Public Policy; Executive Director, Carnegie Mellon Electricity Industry Center — Ph.D., MIT; Carnegie Mellon 2000—.

V.S. ARUNACHALAM, Distinguished Service Professor of Engineering and Public Policy/Materials Science and Engineering/Robotics Institute — Ph.D., Wales; D.Eng. (h.c.), Roorkee; Carnegie Mellon 1992—.

ALFRED BLUMSTEIN, J. Erik Jonsson University Professor of Urban Systems and Operations Research; Professor of The H. John Heinz III School of Public Policy and Management/Engineering and Public Policy — Ph.D., Cornell University; Carnegie Mellon 1969—.

KATHLEEN M. CARLEY, Professor of the Institute for Software Research International/Social and Decision Sciences/The H. John Heinz III School of Public Policy and Management/Engineering and Public Policy; Director, Center for Computational Analysis of Social and Organizational Systems — Ph.D., Harvard University; Carnegie Mellon 1984—.

ELIZABETH CASMAN, Associate Research Professor of Engineering and Public Policy — Ph.D., The Johns Hopkins University; Carnegie Mellon 1997—.

JARED L. COHON, President of Carnegie Mellon University; Professor of Civil and Environmental Engineering/Engineering and Public Policy — Ph.D., MIT; Carnegie Mellon 1997—.

LORRIE FAITH CRANOR, Associate Research Professor of Computer Science/Engineering and Public Policy — Sc.D., Washington University; Carnegie Mellon 2003—.

CLIFF I. DAVIDSON, Professor of Civil and Environmental Engineering/Engineering and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon 1977—.

MICHAEL L. DEKAY, Associate Research Professor of Engineering and Public Policy — Ph.D., University of Colorado, Boulder; Carnegie Mellon 1996—.

DAVID J. FARBER, Distinguished Career Professor of Computer Science and Public Policy — D.Eng. (honorary), Stevens Institute of Technology; Carnegie Mellon 2002—.

PAUL S. FISCHBECK, Professor of Social and Decision Sciences/Engineering and Public Policy; Director, Center for the Study and Improvement of Regulation — Ph.D. Stanford University; Carnegie Mellon 1990—.

BARUCH FISCHHOFF, Howard Heinz University Professor; Professor of Social and Decision Sciences/Engineering and Public Policy — Ph.D., Hebrew University; Carnegie Mellon 1987—.

EDEN FISHER, Professor of the Practice of Engineering and Public Policy; Executive Director, MS Program in Engineering and Technology Innovation Management — Ph.D., Carnegie Mellon University; Carnegie Mellon 2006—.

H. KEITH FLORIG, Senior Research Engineer of Engineering and Public Policy; Executive Director, Carnegie Mellon Electricity Industry Center — Ph.D., MIT; Carnegie Mellon 1996—.

JIM GOODBY, Distinguished Service Professor Emeritus — A.B., Harvard College; Honorary Doctor of Laws, Stetson University; Carnegie Mellon 1989—.

ALEX HILLS, Distinguished Service Professor of Engineering and Public Policy — Ph.D., Carnegie Mellon University; Carnegie Mellon 1992—.

JAY APT, Associate Research Professor of The Tepper School of Business; Distinguished Service Professor of Engineering and Public Policy; Executive Director, Carnegie Mellon Electricity Industry Center — Ph.D., MIT; Carnegie Mellon 2000—.

V.S. ARUNACHALAM, Distinguished Service Professor of Engineering and Public Policy/Materials Science and Engineering/Robotics Institute — Ph.D., Wales; D.Eng. (h.c.), Roorkee; Carnegie Mellon 1992—.

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EDEN FISHER, Professor of the Practice of Engineering and Public Policy; Executive Director, MS Program in Engineering and Technology Innovation Management — Ph.D., Carnegie Mellon University; Carnegie Mellon 2006—.

H. KEITH FLORIG, Senior Research Engineer of Engineering and Public Policy; Executive Director, Carnegie Mellon Electricity Industry Center — Ph.D., MIT; Carnegie Mellon 1996—.

JIM GOODBY, Distinguished Service Professor Emeritus — A.B., Harvard College; Honorary Doctor of Laws, Stetson University; Carnegie Mellon 1989—.

ALEX HILLS, Distinguished Service Professor of Engineering and Public Policy — Ph.D., Carnegie Mellon University; Carnegie Mellon 1992—.

JAY APT, Associate Research Professor of The Tepper School of Business; Distinguished Service Professor of Engineering and Public Policy; Executive Director, Carnegie Mellon Electricity Industry Center — Ph.D., MIT; Carnegie Mellon 2000—.
MARK KIELER, Lecturer and Assistant Department Head for Undergraduate Affairs of Engineering and Public Policy — M.S., Carnegie Mellon University; Carnegie Mellon 2000—.

LESTER B. LAVE, University Professor; Harry B. and James H. Higgins Professor of Economics; Professor of Engineering and Public Policy; Director, Green Design Institute; Co-Director, Carnegie Mellon Electricity Industry Center — Ph.D., Harvard University; Carnegie Mellon 1963—.

H. SCOTT MATTHERS, Associate Professor of Civil and Environmental Engineering/Engineering and Public Policy; Research Director, Green Design Institute — Ph.D., Carnegie Mellon University; Carnegie Mellon 1999—.

FRANCIS C. McMICHAEL, Walter J. Blenko, Sr. Professor of Environmental Engineering; Professor of Civil and Environmental Engineering/Engineering and Public Policy, Emeritus — Ph.D., California Institute of Technology; Carnegie Mellon 1967—.

BENOÎT MOREL, Associate Teaching Professor of Engineering and Public Policy/Physics — Ph.D., University of Geneva; Carnegie Mellon 1987—.

M. GRANGER MORGAN, University and Lord Chair Professor of Engineering; Head of the Department of Engineering and Public Policy; Professor of Engineering and Public Policy/Electrical and Computer Engineering/The H. John Heinz III School of Public Policy and Management; Co-Director, Carnegie Mellon Electricity Industry Center — Ph.D., University of California, San Diego; Carnegie Mellon 1974—.

INDIRA NAIR, Vice Provost for Education; Professor of Engineering and Public Policy — Ph.D., Northwestern University; Carnegie Mellon 1978—.

HERBERT L. TOOR, University Professor of Chemical Engineering/Engineering and Public Policy, Emeritus — Ph.D., Northwestern University; Carnegie Mellon, 1953—.

FRANCISCO VELOSO, Assistant Professor of Engineering and Public Policy— Ph.D., MIT; Carnegie Mellon 2002—.

ROBERT M. WHITE, University Professor of Electrical and Computer Engineering/Engineering and Public Policy, Emeritus — Ph.D., Stanford University; Carnegie Mellon, 1993—.

MITCHELL J. SMALL, The H. John Heinz III Professor of Environmental Engineering and Science; Professor of Engineering and Public Policy/Mechanical Engineering; Director, Center for Energy and Environmental Studies — Ph.D., Stanford University; Carnegie Mellon 1969—.

SAROSH TALUKDAR, Professor of Electrical and Computer Engineering/Engineering and Public Policy — Ph.D., Purdue University; Carnegie Mellon 1970—.

JOEL A. TARR, Richard S. Caliguiri Professor of Urban and Environmental History and Policy; Professor of History/Engineering and Public Policy/The H. John Heinz III School of Public Policy and Management— Ph.D., Northwestern University; Carnegie Mellon 1967—.

RAHUL TONGIA, Research Engineer of Engineering and Public Policy; Systems Scientist of Computer Science — Ph.D., Carnegie Mellon University; Carnegie Mellon 1998—.
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 lower production cost or respond to mandates of the marketplace. The overarching paradigm of materials science and engineering is to exploit the connection between processing, 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 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/degref/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, therefore, the discipline that provides understanding and tools for working with the (atomic) structure of materials, the defects (dislocations, interfaces etc.) that largely govern their properties, the thermodynamic relationships that govern the structure 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 "Microstructure & 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 student's chosen specialty, whether it is ceramics, semiconductors, metals, composites, magnetic or optical materials, biomaterials 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. (http://neon.mems.cmu.edu/MSE/tracks.html)

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

All ABET accredited academic programs publish long term program objectives, along with statements that describe what students are expected to know or be able to do by the time of graduation from the program. 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) apply science and engineering principles to materials systems, integrate their understanding of the principles of Materials Science and Engineering as they apply to structure, properties, processing, performance, and select materials to meet relevant performance criteria during the design of engineered systems and components;
(2) work in teams, solve open-ended problems, develop skills for critical thinking, and communicate effectively with others orally, in writing, and by listening;
(3) employ the techniques, skills and tools of modern materials engineering practice in a professional and ethical manner;
(4) understand the impact of materials engineering solutions in a global and societal context and continually evolve their knowledge of the field of materials in response to the changing needs of society;
(5) are successful in a top graduate school in Materials Science and Engineering or in a related discipline;
(6) take positions as materials engineers and are successful in our field or in related professional activities.

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 accepted the following definitions for the educational outcomes of the department; 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

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<td>21-120</td>
<td>Differential and Integral Calculus</td>
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<td>Physics for Engineering Students I #</td>
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<td>H&amp;S Elective</td>
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<td>39-101</td>
<td>CIT First-Year Seminar</td>
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Spring

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<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximations</td>
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<tr>
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<td>Introductory/Intermediate Programming</td>
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<tr>
<td>99-101</td>
<td>Computing Skills Workshop</td>
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Sophomore Year

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<td>Calculus in Three Dimensions</td>
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<tr>
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<td>Introduction to Mathematical Software</td>
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<td>33-107</td>
<td>Physics for Engineering Students II**</td>
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<td>27-299</td>
<td>MSE Professional Development I</td>
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<tr>
<td>27-215</td>
<td>Thermodynamics of Materials</td>
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<td>27-201</td>
<td>Structure of Materials</td>
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<td>27-202</td>
<td>Defects in Materials</td>
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Spring

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<tbody>
<tr>
<td>21-260</td>
<td>Differential Equations</td>
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<td>09-105</td>
<td>Intro to Modern Chemistry I**</td>
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<tr>
<td>09-101</td>
<td>Introduction to Experimental Chemistry**</td>
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<td>27-216</td>
<td>Transport in Materials</td>
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<td>27-217</td>
<td>Phase Relations and Diagrams</td>
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<td>27-205</td>
<td>Introduction to Materials Characterization</td>
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Junior Year

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<td>Quantum Physics and Structure of Matter</td>
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<td>Organic Chemistry I</td>
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<tr>
<td>03-121</td>
<td>Modern Biology</td>
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<td>MSE Professional Development II</td>
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<td>Microstructure and Properties I</td>
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Spring

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<td>Engineering Statistics and Quality Control</td>
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<td>Selection and Performance</td>
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Senior Year

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<tr>
<td>27-401</td>
<td>MSE Capstone Course</td>
</tr>
<tr>
<td>49</td>
<td></td>
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</tbody>
</table>

Spring

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>xx-xxx</td>
<td>H&amp;S Elective [8]</td>
</tr>
<tr>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>

Minimum number of units required for degree: 379
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 before 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
27-321 Processing of Metals
27-322 Introduction to Polymer Science and Engineering
27-324 Polymer Physics and Morphology
27-327 MSE Capstone Course II
24-421 Composites and Engineering
27-421 Electronic and Thermal Properties of Metals, Semiconductors and Related Devices
27-433 Dielectric, Magnetic and Superconducting Properties of Materials
27-442 Deformation Processing
27-445 Structure, Properties and Performance Relationships in Magnetic Materials
27-454 Supervised Reading
27-510 Introduction to Biomaterials I
27-511 Introduction to Biomaterials II
27-512 Diffraction Methods in Materials Science
27-530 Advanced Physical Metallurgy
27-533 Principles of Growth and Processing of Semiconductors
27-542 Processing and Properties of Thin Films
27-551 Properties of Ceramics and Glasses
27-555 Materials Project I
27-556 Materials Project II
27-560 Physical Chemistry of Metallurgical Reactions
27-565 Nanostructured Materials
27-571 Mechanical Behavior of Materials
27-591 Solidification Processing
27-594 Electrochemical Processes in Materials
06-466 Experimental Polymer Science
06-609 Physical Chemistry of Macromolecules
06-619 Semiconductor Processing Technology
06-620 Structural Analysis
12-605 Design and Construction
12-611 Engineering Economics
12-612 Project Management Construction
12-631 Structural Design
18-311 Semiconductor Devices I
18-412 Semiconductor Devices II
24-262 Stress Analysis
24-341 Manufacturing Sciences
24-361 Intermediate Stress Analysis
24-401 Engineering Analysis
33-341 Thermal Physics I
33-448 Introduction to Solid State Physics
42-644 Medical Devices
42-600 CIT Honors Project
42-601 Senior BME Research Project
42-612 Supper BME Research Project
42-612 Supper BME Research Project

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
Industry 1

Summer
21-260 Differential Equations 9

Junior Year

Fall
Industry 2

Spring
09-105 Introduction to Modern Chemistry ** 10
09-101 Introduction to Experimental Chemistry ** 3
xx-xxx MSE Restricted Elective [1] 9
27-236 Transport in Materials 9
27-217 Phase Relation and Diagrams 9+3
27-205 Introduction to Materials Characterization 3

Summer
Industry 3

Senior Year

Fall
xx-xxx Free Elective [1] 9
33-225 Quantum Physics and Structure of Matter 9
09-121 Modern Biology 9
27-399 MSE Professional Development II 1
27-301 Microstructure and Properties I 6+3

Spring
36-220 Engineering Statistics & Quality Control 9
xx-xxx H&SS Elective [8] 9
27-367 Selection and Performance 6

Summer
Industry 4
### Fifth Year

<table>
<thead>
<tr>
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<th>Course Title</th>
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<tbody>
<tr>
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<td>Free Elective</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>xx-xxxx</td>
<td>Free Elective</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>27-499</td>
<td>MSE Professional Development III</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>27-xxx</td>
<td>MSE Restricted Elective</td>
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<td>9</td>
</tr>
<tr>
<td>27-xxx</td>
<td>MSE Restricted Elective</td>
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</tr>
<tr>
<td>27-401</td>
<td>MSE Capstone Course</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

### 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 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)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-780</td>
<td>Thermodynamics</td>
<td></td>
</tr>
<tr>
<td>27-788</td>
<td>Defects in Materials</td>
<td></td>
</tr>
<tr>
<td>27-766</td>
<td>Diffusion in Materials</td>
<td></td>
</tr>
<tr>
<td>27-796</td>
<td>Structure of Materials</td>
<td></td>
</tr>
<tr>
<td>27-797</td>
<td>Bonding of Materials</td>
<td></td>
</tr>
</tbody>
</table>

*plus 60 units of 500 or 700 level Materials Science and Engineering courses.*

#### 2. Research Option (30 units, Summer 4-th year)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-780</td>
<td>Thermodynamics</td>
<td></td>
</tr>
<tr>
<td>27-788</td>
<td>Defects in Materials</td>
<td></td>
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<tr>
<td>27-766</td>
<td>Diffusion in Materials</td>
<td></td>
</tr>
<tr>
<td>27-796</td>
<td>Structure of Materials</td>
<td></td>
</tr>
<tr>
<td>27-797</td>
<td>Bonding of Materials</td>
<td></td>
</tr>
</tbody>
</table>

*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).*

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.

As with all M.S. Degrees in the Department of Materials Science and Engineering, students must pass the master’s comprehensive examination which should be taken near the end of the Spring semester of the fourth 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 BARMAK, Professor of Materials Science and Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon 1999—.

MICHAEL BOCKSTALLER, Assistant Professor of Materials Science and Engineering — Ph.D., Max-Planck Institute for Polymer Research; Carnegie Mellon 2005—.

ROBERT F. DAVIS, Bertucci Professor of Materials Science and Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 2004—.

MARCE DE GRAEF, Professor of Materials Science and Engineering — Ph.D., Catholic University Leuven (Belgium); Carnegie Mellon, 1993—.

RICHARD J. FRUEHAN, University Professor and U.S. Steel Professor of Materials Science and Engineering — Ph.D., University of Pennsylvania; Carnegie Mellon, 1981—.

WARREN M. GARRISON, JR., Professor of Materials Science and Engineering — 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 of Materials Science and Engineering and Chemical Engineering - Ph.D., Lehigh University; Carnegie Mellon 2005—.

PRASHANT KUMTA, Professor of Materials Science and Engineering — Ph.D., University of Arizona; Carnegie Mellon; 1990—.

DAMIT E. LAUGHLIN, ALCOA Professor of Materials Science and Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1974—.

MICHAEL E. MCHENRY, Professor of Materials Science and Engineering — Ph.D. Massachusetts Institute of Technology; Carnegie Mellon 1989—.

HENRY R. PIEHLER, Professor of Materials Science and Engineering, and Public Policy — D.Sc., Massachusetts Institute of Technology; Carnegie Mellon, 1967—.

LISA M. PORTER, Professor of Materials Science and Engineering — Ph.D., North Carolina State; Carnegie Mellon, 1997—.

GREGORY S. ROHRER, W.W. Mullins Professor and Head of Materials Science and Engineering Ph.D., University of Pennsylvania; Carnegie Mellon, 1990—.

ANTHONY D. ROLLETT, Professor of Materials Science and Engineering — Ph.D., Drexel University; Carnegie Mellon, 1995—.

PAUL A. SALVADOR, Associate Professor of Materials Science and Engineering — Ph.D., Northwestern University; Carnegie Mellon, 1999—.

SRIDHAR SEETHARAMAN, Associate Professor and POSCO Professor of Materials Science and Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000—.

MAREK SKOWRONSKI, Professor of Materials Science and Engineering — Ph.D., Warsaw University; Carnegie Mellon, 1988—.

ELIAS TOWE, Grobstein Professor of Materials Science and Engineering and Electrical and Computer Engineering – Ph.D.,
Emeritus 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—.

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, 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 —.

DAVID LAMBETH, Professor, Electrical and Computer Engineering and Materials Science and Engineering— Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989—.

KRZYSZTOF MATYJASZEWSKI, J.C. Warner Professor of Natural Sciences, Department of Chemistry and Materials Science and Engineering – Ph.D., Politechnical University of Lodz, Poland; Carnegie Mellon 1985—.

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—.

CHARLES SFEIR, Assistant Professor, University of Pittsburgh, School of Dental Medicine— Ph.D., Northwestern University; Carnegie Mellon, 2003—.

DAVID SHOLL, Associate Professor, Chemical Engineering— Ph.D., University of Colorado; Carnegie Mellon, 1998—.

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—.
The profession of mechanical engineering, second largest among engineering disciplines, involves the design, analysis, and manufacturing of machines. Central to the profession is the importance of innovation and creating new technologies and products. The Department's curriculum is structured to provide students with the analytical tools, technical skills, engineering insights, and practical problem-solving abilities that are necessary to convert a concept into a reliable, cost-effective, and safe device.

Mechanical engineers are employed by small start-ups, multinational corporations, government agencies, national laboratories, consulting firms, and universities. They can work in the areas of research, design, manufacturing, sales, quality assurance, or management. Mechanical engineers work in teams that design jet engines; automobiles; aircraft and spacecraft; microelectromechanical acceleration and pressure sensors; heating, ventilation, and air conditioning systems; power generation systems; biomedical and biotechnological devices such as artificial hip implants; and such integrated mechanical and electronic (mechatronic) systems as robots. The Department of Mechanical Engineering at Carnegie Mellon University is respected for the many significant advances in these technologies and others that have been made by its alumni and faculty.

The Department's curriculum provides students with a solid foundation upon which they can build to meet the challenges associated with their individual career paths, and to adapt to the rapidly changing technologies faced by today's engineers. Early in their education, Carnegie Mellon students develop a strong scientific foundation by taking courses in mathematics, physics, computer programming, and chemistry. In addition, all students are exposed at the Freshman level to two engineering disciplines through introductory courses taught by each department in the engineering college. The Department's Freshman-level course is project-based, and it orients the students to the various disciplines of mechanical engineering through lecture, laboratories, and hands-on learning. In the Sophomore and Junior years, students take core engineering courses in solid and fluid mechanics, thermodynamics, heat transfer, dynamics, systems and controls, and numerical methods.

While the program is demanding, the Department's curriculum is also flexible and enables students to (i) begin taking elective courses during the Junior year, (ii) develop a specialization within mechanical engineering, (iii) develop a technical emphasis within another engineering or science department, or (iv) pursue studies in any other Carnegie Mellon department, such as foreign languages, economics, or design. This liberal approach to engineering education recognizes the broader role that mechanical engineers play in society, as leaders in business, government, and law. During the Senior year, students take electives and capstone courses in engineering analysis and design with projects that often result in prototype hardware for new products. Students work in teams, on projects of their choosing, and are exposed to the design process from conceptualization to production. Recent examples include low-squeal disk brakes, high efficiency engines, neck gear to minimize spinal cord injury in sports, a stabilizer support arm for movie cameras, and equipment to improve the mobility of disabled persons. Effective writing, speaking, and presentation skills, and engineering ethics are also emphasized as important attributes of successful leaders.

Throughout the undergraduate program, beginning in the Freshman year, students use the latest computer-based design and analysis methods in their courses and project work. An undergraduate computing laboratory is available for design work, structural and thermal/thermal/fluid finite element analyses, and dynamic system simulations. Students work with industry-standard computer-aided design tools to develop engineering drawings, and to visualize the performance of those parts through computer simulation before they are fabricated. After the design is optimized, the computer model can be down-loaded to a multi-axis computer-controlled milling machine, from which the part is manufactured. Other resources within the Undergraduate Design and Manufacturing Laboratory include MIG welding, injection molding, and a full student shop equipped with lathes, drill presses, milling machines, band saws, and other hand and power tools. In coursework and projects, students work with state-of-the-art instrumentation and laboratory equipment, including spectrum analyzers, digital oscilloscopes, multi-waveform generators, and sensors which measure acceleration, strain, pressure, temperature, and force. Through such experiences, the Department emphasizes the modern industrial practice of seamlessly integrating computer-based design, analysis, characterization, and manufacturing.

Through electives and special degree programs, mechanical engineering students are able to pursue their personal interests both inside and outside the Department. Advanced courses in mechanical engineering are available in such areas as energy conversion, control, vibration, dynamics, manufacturing, robotics, internal combustion engines, mechatronics, fluid and solid mechanics, aerodynamics, and engineering design. Mechanical engineering students can also take a wide variety of technical and non-technical electives from other departments in order to develop a double major, minor, or concentration through an individualized program of study that is developed in collaboration with a faculty advisor. Exceptional students can participate in a Departmental senior honors program through a design or research project. Students often find that solving unstructured open-ended problems in project-based courses or in their honors thesis provides the ultimate educational experience.

The Department also offers an Accelerated Graduate Program, with access restricted to Carnegie Mellon undergraduates. In this program, students can take graduate courses during the Senior year in order to receive academic credit towards the Master’s degree. After being admitted to the program, students can complete the coursework-based M.S. degree with only an additional summer and one semester of study beyond the traditional B.S. program.

In addition to teaching, the Department's faculty are actively involved in research sponsored by industry, consortia, and government agencies. Results of the research often serve as specific examples, case studies, and projects in undergraduate courses. Frequent seminars are sponsored by the Department, and they keep both students and faculty aware of recent advances in mechanical engineering and its related fields. Speakers of national and international reputation are invited to give these lectures. Seminars are open to all students within the Department, and they can provide students with a broad perspective on the mechanical engineering profession.

Additional information about the program is available through the Department's web page located at www.me.cmu.edu. The Department's Undergraduate Student Handbook includes further description of the Department's resources and policies. The handbook is distributed to sophomores in the Department each Fall, and is also available on-line at the Department's main web site. Additional copies can be requested in SH 426.

**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 multi-disciplinary teams
E. an ability to identify, formulate, and solve engineering problems
F. an understanding of professional and ethical responsibility
G. an ability to communicate effectively
H. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
I. a recognition of the need for, and an ability to engage in life-long learning
J. a knowledge of contemporary issues
K. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

**Overview of the Curriculum**

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 for the four-year B.S. program depicts the standard and recommended course sequences. In order to ensure that prerequisites are satisfied, and to prevent scheduling conflicts, students should discuss any significant deviation from this exemplar with the department academic advisor.

**Freshman Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
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<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>24-101 Fundamentals of Mechanical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>33-106 Physics for Engineering Students I</td>
<td>12</td>
</tr>
<tr>
<td>99-101 Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td>xx-xxx Writing/Expression Course</td>
<td>9</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>21-122 Integration, Differential Equations, and Approximations</td>
<td>10</td>
</tr>
<tr>
<td>xx-xxx Second Introductory Engineering Course</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx Restricted Technical Elective</td>
<td>10-13</td>
</tr>
<tr>
<td>xx-xxx General Education Course</td>
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44

**Sophomore Year**

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<tbody>
<tr>
<td>21-259 Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>24-221 Thermodynamics I</td>
<td>10</td>
</tr>
<tr>
<td>24-261 Statics</td>
<td>10</td>
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<td>10-13</td>
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48-51

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>21-260 Differential Equations</td>
<td>9</td>
</tr>
<tr>
<td>24-231 Fluid Mechanics</td>
<td>10</td>
</tr>
<tr>
<td>24-262 Stress Analysis</td>
<td>12</td>
</tr>
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<td>xx-xxx Restricted Technical Elective</td>
<td>10-13</td>
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50-53

**Junior Year**

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<tr>
<td>24-302 Mechanical Engineering Seminar</td>
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<tr>
<td>24-311 Numerical Methods</td>
<td>9</td>
</tr>
<tr>
<td>24-322 Heat Transfer</td>
<td>10</td>
</tr>
<tr>
<td>24-351 Dynamics</td>
<td>12</td>
</tr>
<tr>
<td>36-220 Engineering Statistics and Quality Control</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx General Education Course</td>
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54

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>24-371 Electromechanical Systems</td>
<td>10</td>
</tr>
<tr>
<td>24-321 Thermal-Fluids Engineering</td>
<td>12</td>
</tr>
<tr>
<td>24-352 Dynamic Systems and Control</td>
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<tr>
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43
### Senior Year

**Fall**

<table>
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<tr>
<td>24-401 Engineering Analysis</td>
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<tr>
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</tr>
<tr>
<td>24-441 Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>xx-xxx Elective</td>
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<tr>
<td>xx-xxx General Education Course</td>
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48

**Spring**

<table>
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<tbody>
<tr>
<td>24-441 Engineering Design</td>
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<tr>
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</tr>
<tr>
<td>24-xxx Mechanical Engineering Technical Elective</td>
<td>3</td>
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<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>xx-xxx Elective</td>
<td>3</td>
</tr>
<tr>
<td>xx-xxx General Education Course</td>
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</tr>
</tbody>
</table>

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### Notes on the Curriculum

1. A minimum of 380 units is required for completion of the B.S. degree.

2. In the Freshman year, 24-101 Fundamentals of Mechanical Engineering can be taken in either the Fall or Spring semesters.

   A second introductory engineering course is taken in the other semester of the Freshman year.

   For those students who did not complete 24-101 Fundamentals of Mechanical Engineering during the Freshman year, this course should be taken during the Fall semester of the Sophomore year in place of the General Education Course. In this event, the replaced General Education Course should be taken during the Junior or Senior years. The additional introductory engineering course can be used to fulfill one of the Elective requirements as described below.

   21-120, 21-122 and 33-106 must be passed before beginning the sophomore core Mechanical Engineering courses.

3. By the end of the Sophomore year, a mechanical engineering student should have completed the following mathematics, computer science, and introductory engineering courses:

   - 21-120 Differential and Integral Calculus (10 units)
   - 21-122 Integration, Differential Equations and Approximation (10 units)
   - 21-259 Calculus in Three Dimensions (12 units)
   - 21-260 Differential Equations (12 units)
   - 33-106* Physics I for Engineering Students (12 units)
   - 33-107* Physics II for Engineering Students (12 units)
   - XX-XXX Science Laboratory Requirement (3-12 units)
   - 09-105 Modern Chemistry I (10 units)
   - 15-100 Introductory/Intermediate Programming (10 units)
   - or
   - 15-111 Intermediate/Advanced Programming (10 units)
   - 24-101 Introduction to Mechanical Engineering (12 units)
   - xx-xxx Second Introductory Engineering Course (12 units)

   * 33-106/107 is the recommended sequence for engineering students, although 33-111/112 or 33-131/132 would also meet the CIT Physics requirement.

   Mechanical engineering undergraduates must satisfy a Science Laboratory requirement to graduate. Normally the Science Laboratory requirement is satisfied by passing 09-101 Introduction Experimental Chemistry (3 units).

   Students can also satisfy the Science Laboratory requirement by passing one of the following courses:

   - a. 03-124 Modern Biology Laboratory (9 units)
   - b. 33-100 Basic Experimental Physics (6 units)
   - c. 33-104 Experimental Physics (9 units)
   - d. 33-353 Intermediate Optics (12 units)
   - e. 42-203 Biomedical Engineering Laboratory (9 units)

   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 for any semester. The sequence of calculus courses (21-120, 21-122, 21-259) and the differential equations course (21-260) should be scheduled as indicated, due to Mechanical Engineering core class prerequisites.

5. In the Junior year, the communications requirement can be satisfied by completing at least one of the following options:

   - 24-302 (fall or spring) ME Seminar (2 units)
   - 70-340 Business Communications (9 units)

6. In the Senior year, students enroll in either 24-401 Engineering Analysis or 24-441 Engineering Design during the Fall semester. The other course is taken during the Spring semester of the Senior year.

### Restricted Technical Electives

By the end of the Sophomore year, students should have completed each of the following courses, which are listed as "Restricted Technical Electives" in the exemplary curriculum. Students have some flexibility in the sequencing of these courses during the Freshman and Sophomore years.

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>33-107 Physics for Engineering Students II</td>
<td>1</td>
</tr>
<tr>
<td>09-101 Introduction to Experimental Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>09-105 Modern Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>15-100 Introductory/Intermediate Programming</td>
<td>1</td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>15-111 Intermediate/Advanced Programming</td>
<td>1</td>
</tr>
</tbody>
</table>

### Mechanical Engineering Technical Electives

Students are required to complete one departmental technical elective. This elective course is listed under the "Mechanical Engineering Technical Electives" in the exemplary curriculum. The courses below are grouped according to their discipline within mechanical engineering. Students must take at least one of the following courses for a minimum of 9 units to fulfill the Mechanical Engineering Technical Elective Requirement.

### Design and Manufacturing

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-201 Engineering Graphics</td>
<td>3</td>
</tr>
<tr>
<td>24-341 Manufacturing Sciences</td>
<td>3</td>
</tr>
<tr>
<td>24-443 Design for Manufacture</td>
<td>3</td>
</tr>
</tbody>
</table>

### Mechanical Systems

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-353 Intermediate Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>24-355 Kinematics and Dynamics of Mechanisms</td>
<td>3</td>
</tr>
<tr>
<td>24-356 Engineering Vibrations</td>
<td>3</td>
</tr>
<tr>
<td>24-361 Intermediate Stress Analysis</td>
<td>3</td>
</tr>
<tr>
<td>24-451 Feedback Control Systems</td>
<td>3</td>
</tr>
</tbody>
</table>

### Thermal-Fluid Systems

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-323 Thermodynamics II</td>
<td>3</td>
</tr>
<tr>
<td>24-331 Viscous Flow</td>
<td>3</td>
</tr>
<tr>
<td>24-332 Potential Flow and Aerodynamics</td>
<td>3</td>
</tr>
<tr>
<td>24-333 Gas Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>24-421 Internal Combustion Engines</td>
<td>3</td>
</tr>
<tr>
<td>24-422 Thermal Systems Analysis</td>
<td>3</td>
</tr>
<tr>
<td>24-423 Direct Energy Conversion</td>
<td>3</td>
</tr>
<tr>
<td>24-424 Energy and the Environment</td>
<td>3</td>
</tr>
<tr>
<td>24-425 Combustion and Air Pollution Control</td>
<td>3</td>
</tr>
</tbody>
</table>

### Special Topics

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-380-386 Special Topics in Mechanical Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>
Electives

Students are required to complete five courses which are listed as "Electives" in the exemplary curriculum. These electives can be technical or non-technical courses. Only one such elective can be taken in the areas of Physical Education (69-xxx) or ROTC (30-xxx, 31-xxx, and 32-xxx).

Elective courses can be taken in the Mechanical Engineering Department, in other departments within the College of Engineering, or in any other department of the University. This feature of the curriculum is intended to provide students with sufficient flexibility to allow specialization in a wide variety of fields, and to facilitate minor and double major curricula.

Constructing a Program of Study

A total of six electives (one Mechanical Engineering Technical Elective and five Electives) are available to students. These courses should be selected through consultation with a faculty advisor, and reflect long-term planning on the part of the student. For instance, the electives can be allocated in order to meet the requirements of minor, double major, or double degree programs. The Department's Undergraduate Student Handbook provides additional information on course and elective selection. Options available to students for structuring their programs of study include the following:

Specialization Within Mechanical Engineering

Students can develop deeper focus within mechanical engineering by using the Elective slots to take additional courses offered by the Department beyond the required Mechanical Engineering Technical Elective. These courses can be chosen from the list of Mechanical Engineering Technical Electives, or from the list of the Department's graduate courses.

Research and Independent Study Projects

Students can pursue independent study within the Department on a design or research project under the supervision and coordination of a faculty advisor. Interested students are encouraged to contact faculty members and identify potential project areas of mutual interest. Mechanical engineering projects generally involve open-ended problem solving with laboratory, analytical, field, design, or computa-tional work.

Students complete projects and research by taking either or both of the following courses within the Elective slots:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-391/392</td>
<td>Mechanical Engineering Project</td>
</tr>
<tr>
<td>24-491/492</td>
<td>Departmental Research Honors</td>
</tr>
</tbody>
</table>

These courses do not qualify as Mechanical Engineering Technical Electives. There is no additional quality point average (QPA) requirement for students who choose to enroll in 24-391/392 Mechanical Engineering Project. Qualified students can pursue 24-491/492 Departmental Research Honors and receive such recognition at commencement. In order to graduate with research honors, a student must have attained a QPA of 3.2 or higher at graduation, have completed 18 units of 24-491/492 Departmental Research Honors in which grades of B or better were attained, and have submitted an approved thesis to the faculty advisor.

A student who completes all requirements for CIT Honors Research will also graduate with Departmental Research Honors upon completion of 18 units of 39-500 CIT Honors Research. Such research projects must be conducted under the supervision of a mechanical engineering faculty member.

Student-Structured Interdisciplinary Studies

Using the Elective slots, students can take courses outside the Mechanical Engineering Department in technical or non-technical areas. For instance, depending on a student's particular career interests, courses can be taken in such departments as Design, Biomedical Engineering, or Materials Science and Engineering, or through the College of Engineering's interdisciplinary 39-xxx series. Often, Elective courses are selected around a common theme that can span several departments, and are chosen so as to form a student-structured area of concentration. Such programs of study can be constructed in an informal manner by the student and a faculty advisor, or they can be part of a minor or double major program.

Minors and Double Majors

The College of Engineering offers a series of designated minors in different areas of engineering specialization. The Electives, and Mechanical Engineering Technical Elective Elective slots can be used to complete the requirements of these minors. Although students can generally complete a designated minor without increasing the number of units required for graduation, early planning is important.

Double major programs within the College of Engineering are also available. Students in the Department can earn double majors in (i) Mechanical Engineering, and Engineering and Public Policy, and (ii) Mechanical Engineering, and Biomedical and Health Engineering.

In addition, many departments in the University offer minor and double major degree programs. The Elective slots available to mechanical engineering students can be used to advantage in completing the requirements for a minor or double major, but early schedule planning is important. Interested students should contact the main office in the department of interest and inquire as to those requirements.

Advising

The department academic advisor is assigned initially to all new students and will continue to assist with any curriculum questions and registration issues for the remainder of their studies.

During the sophomore year, students are encouraged to request a faculty mentor. To assist in this process, students should attend the fall sophomore dinner to meet professors, utilize faculty introductions provided during sophomore core classes and check the website for additional faculty information (Current Students-Advising). 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.

Faculty will:
- Explain technical content of coursework and suggest concentrations appropriate to career objectives
- Discuss research and summer internship opportunities
- Offer graduate school and employment path advice
- Offer general advice and mentoring

The 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

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

An accelerated program is available to Carnegie Mellon undergraduate students who also wish to complete a coursework Master's degree in mechanical engineering. Exceptional students can apply for admission to the program at the end of the first semester of the Senior year and must meet the requirements for admission to the Department's graduate program. Financial aid in the form of Teaching or Research Assistantships is not offered to students in the Accelerated Graduate Program.

In this program, students must complete at least 24 units of graduate coursework by the end of the Senior year. A 3.0 or better must be attained in those courses, and they can not be used to satisfy the requirements of the baccalaureate degree. During the summer immediately after the Senior year, students complete up to 24 units of 24-793 Supervised Reading and 24-794 Master of Science Project. During the following Fall semester, students then complete all remaining coursework. A total of 96 units is required for completion of the coursework Master's degree. Students who wish to pursue the Accelerated Graduate Program should contact the graduate coordinator in the Department's main office for further information.
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.

Faculty

ADNAN AKAY, Lord Professor of Mechanical Engineering — Ph.D., North Carolina State University; Carnegie Mellon, 1992—.

CRISTINA HORTENSIA AMON, Lane Distinguished Professor of Mechanical Engineering — Sc.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.

SHELLEY ANNA, Assistant Professor of Mechanical Engineering — Ph.D., Harvard University; Carnegie Mellon, 2003—.

NADINE N. AUBRY, Professor of Mechanical Engineering; Head, Department of Mechanical Engineering — Ph.D., Cornell University; Carnegie Mellon, 2006.

JACK LEE BEUTH, Professor of Mechanical Engineering — Ph.D., Harvard University; Carnegie Mellon, 1992—.

JONATHAN CAGAN, Professor of Mechanical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1990—.

NORMAN CHIGIER, Professor of Mechanical Engineering — Sc.D., University of Cambridge; Carnegie Mellon, 1981—.

JERRY HOWARD GRIFFIN, William J. Brown Professor of Mechanical Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1980—.

C. FRED HIGGS III, Assistant Professor of Mechanical Engineering — Ph.D., Rensselaer Polytechnic Institute; Carnegie Mellon University, 2003—.

LEVENT BURAK KARA, Assistant Professor of Mechanical Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon University, 2007—.

PHILIP R. LeDUC, Assistant Professor of Mechanical Engineering — Ph.D., The Johns Hopkins University; Carnegie Mellon, 2002—.

ALAN J.H. McGAUGHEY, Assistant Professor of Mechanical Engineering — Ph.D., University of Michigan; Carnegie Mellon, 2005—.

WILLIAM CHARLES MESSNER, Professor of Mechanical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1993—.

JEREMY J. MICHALEK, Assistant Professor of Mechanical Engineering — Ph.D., University of Michigan; Carnegie Mellon, 2005—.

JOHN FLETCHER OSTERLE, Theodore Ahrens Professor of Mechanical Engineering, Emeritus — D.Sc., Carnegie Mellon University; Carnegie Mellon, 1946—.

O. BURAK OZDOGANLAR, Assistant Professor of Mechanical Engineering — Ph.D., University of Michigan; Carnegie Mellon, 2004—.

YOED RABIN, Professor of Mechanical Engineering — D.Sc., Technion–Israel Institute of Technology; Carnegie Mellon University, 2000—.

ALLEN L. ROBINSON, Associate Professor of Mechanical Engineering, and Engineering and Public Policy — Ph.D., University of California, Berkeley; Carnegie Mellon, 1998—.

WILFRED THOMAS ROULEAU, Professor of Mechanical Engineering, Emeritus — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1954—.

EDWARD STEPHEN RUBIN, Professor of Mechanical Engineering and Engineering and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1969—.

KENJI SHIMADA, Professor of Mechanical Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1996—.
The College of Fine Arts

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 101 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 television, stage and film worlds; are collected in numerous international museums; have composed for and are performing in orchestras, choruses and opera companies; have built notable buildings, designed building systems and architectural imaging 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 educational 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) and the Master of Arts Management (MAM, jointly with the Heinz School of Public Policy and Management). These are presented only briefly below, but a complete listing of the graduation requirements 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 careers in architectural practice. Beyond the standard professional preparation in architectural design, history and representation, its curriculum stresses the centrality of scientific knowledge and technical know-how in the preparation of future practicing professionals. A significant body of core university course work in mathematics, physical sciences, social sciences, writing and history is prerequisite to sequences in design, building science/technology, and architectural history. Other degrees offered by the School are a M.S. and a Ph.D. in the areas of Building Performance and Diagnostics and Computer Aided Design. We also offer a joint Masters degree with the Heinz School in Public Policy and Management. Three additional Masters Degrees will begin in Fall 2002: Masters of Urban Design, Masters of Science in Sustainable Design and Masters of Science in Architecture Engineering and Construction Management.

### 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 three areas: 1) Painting, Drawing, and Printmaking; 2) Electronic and Time-Based Work; and 3) Sculpture, Installation, and Site Work. 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); and Master of Design in Communication Planning and Information Design (a joint degree with the Department of English).

### Drama Office: PCA 220

The School of Drama offers a highly focused, world-class theatre education with thorough preparation for today’s entertainment industries. The undergraduate programs lead to BFA degrees in Drama, with focuses in acting, music theatre, directing, design, production technology and management; MFA programs are offered in scene, costume 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 experienced artists in a conservatory environment, 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.

### Bachelor of Humanities and Arts (BHA) Bachelor of Science and Arts (BSA) Intercollege Degree Programs

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.
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.

The Master of Arts Management Program

1104 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 School 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. 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. 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 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.

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.
University Suspension: For exceptionally poor performance, or for personal problems that create an impediment to any academic achievement. The student is required to withdraw from the University for a period to be determined by faculty action. Re-admission is subject to conditions specified in each case by the School faculty concerned. 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 is not eligible for employment by the university during the period of the suspension.

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 with the Associate Dean of the College of Fine Arts to discuss 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 two choices:

- Transfer to another Carnegie Mellon University College. A student must contact that College of choice to discuss possible transfer.
- 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 29 for Add/Drop procedures.)

Withdrawal/Leave of Absence

Please refer to the Student Leave Policy on page 50.

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 with the Associate Dean of the College of Fine Arts 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 Student’s 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.
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
Architectural Technology
Art
Building Science (available only to B. Arch candidates)
Communication Design
Drama
History of the Arts
Industrial Design
Jazz Performance
Music Performance
Music Composition
Music Technology
Music Theory
Photography, Film, and Digital Imaging

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: Mark Cato; Design: Melissa Cicozi; Drama; Music: Lewis Strouse.

**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**

- 64-100 Critical Histories of the Arts 9
- 79-104 Introduction to World History 9

**Required Courses**

- 48-100 Architecture Design Studio: Form 12
- 48-095 Architecture for Non-Majors 9
- 48-240 Historical Survey of World Architecture and Urbanism 9

**Elective Courses**

- 48-130 Architectural Drawing I: A Tactile Foundation 6
- 48-135 Architectural Drawing II: Appearance 9
- 48-230 Architectural Drawing III: Perspective 9
- 48-210 Statics 9
- 48-215 Materials and Assemblies 9
- 48-217 Structures 9
- 48-351 Human Factors in Architecture 9
- 48-452 Real Estate Design and Development 9
- 48-453 Urban Design 9
- 48-551 Ethics and Decision Making in Architecture 9
- 48-xxx Architecture Elective 9

**Minimum Units: 54**

* Where students can demonstrate equivalent experience with design issues within other disciplines, for example in the School of Design, this requirement can be waived. However, this 12 unit requirement must then be replaced with another 12 units of elective coursework with the School.

**Students interested in a minor in Architecture should consult the Architecture advisor regarding elective choice.**

**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**

- 64-100 Critical Histories of the Arts 9
- 79-104 Introduction to World History 9
- 48-240 Historical Survey of World Architecture and Urbanism 9

**Elective Courses**

- 48-340 American Built Environment to 1860 9
- 48-343 American Built Environment Since 1860 9
- 48-344 Henry Hornbostel 9
- 48-348 History of Central American Architecture 9
- 48-440 American Built Environment to 1860 9
- 48-441 Frank Lloyd Wright 9
- 48-445 The City in History 9
- 48-446 Renaissance and Baroque Architecture 9
- 48-447 History and Preservation 9
- 48-448 History of Sustainable Architecture 9

**Minimum Units: 54**

**Minor in Architectural Representation and Visualization**

This sequence is for candidates who intend to develop particular skills in architectural representation.

**Required Courses**

- 48-120 Introduction to Digital Media I 6
- 48-130 Architectural Drawing I: A Tactile Foundation 6
- 48-135 Architectural Drawing II: Appearance 9
- 48-230 Architectural Drawing III: Perspective 9

**Elective Courses**

- 48-125 Introduction to Digital Media II 6
- 48-560 Advanced Computer Modeling 9
- 48-573 Color Theory 9
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 14 - 22 units
21-114 Calculus for Architecture 5
or 21-120 Differential and Integral Calculus 10
48-115 Physics for Architecture 9
or 33-106 Physics for Engineering Students I 12

Elective Courses 32 - 40 units
48-210 Statics 9
48-215 Materials and Assemblies 9
48-217 Structures 9
48-315 Environment I: Climate and Energy 9
48-410 Environment II: Acoustics and Light 9
48-412 Environment III: Mechanical Systems 9
48-415 Advanced Building Systems 6
48-xxx Architecture Elective 9

Minor in Building Science

(Only available to B. Arch Candidates)

This sequence is intended for candidates seeking in depth knowledge in several areas of architectural science and for those interested in gaining advance placement into the Graduate M.S. Program offered by the School of Architecture in Building Performance and Computer Aided Design.

Required Courses 9 units
48-711 Research Models and Methods 9

Elective Courses 45 units
48-596 LEED Building and Green Design 9
48-721 Building Controls and Diagnostics 12
48-722 Building Performance Modelling 12
48-723 Performance of Advanced Building Systems 9
48-729 Productivity, Health, and Quality of Buildings 9-12
48-742 Design Databases 9
48-745 Geometric Modeling: Theory, Programming, Practice 9
48-747 Shape Grammars 9
48-746 Graphic User Interface Design 9
48-725 Building Economics 9
48-728 Special Topics in BPD 9
48-749 Special Topics in CAD 9
48-756 Object Oriented CAD 12

Minimum Units: 54

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 Henry Hornbostel 9
48-348 History of Modern American Architecture 9
48-440 American Built Environment to 1860 9
48-441 Frank Lloyd Wright 9
48-445 The City in History 9
48-446 Renaissance and Baroque Architecture 9
48-447 History & Preservation 9
48-448 History of Sustainable Architecture 9
51-272 Design History II: Spring Only 9
51-378 History of the Book and Printing 9
54-381 History of Drama: Fall - 3 units 9
54-382 History of Drama II: 3 units 9
57-202 Opera History: Spring Only 9
57-205 20th Century Music History 9
60-350-98 Art History/Thsey Special Topics (Instructor Permission Only) 9
62-360 Photographers: Photography since WWII 9
62-371 Photography, The First 100 years 9
79-324 Modernism and Painting, 1880-1945 9
79-325 Art and Religion 9
79-355 The American Skyscraper: It’s History and Development 9
79-364 Art, Anthropology and Empire 9
79-395 The Arts in Pittsburgh 9
79-396 Music and Society in the 19th/20th Century Europe and the US 9

Minimum units required: 54

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 9 units
60-105 Pre-Industrial Visual Cultures 1789 (spring) 9
60-205 Modern Visual Cultures 1789-19145 (fall) 9
60-206 Contemporary Visual Cultures 1945 to the Present 9
60-3xx Art History/Theory Electives 9

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 in the Arts must be taken outside of their major School, with the exception of the School of Architecture. Interested students should contact Jarrin Nevel in the College of Fine Arts, Room 100.

Introductory Level Courses: 27 units
(choose three, CFA students pick 3 outside of major)
48-240 Historical Survey of World Architecture and Urbanism 9
51-271 Design History I: Fall Only 9
54-239 History of Architecture and Decor 6
54-245 History of Clothing: Fall 6
54-246 History of Clothing: Spring 6
54-281 History of Drama: Fall 6
54-282 History of Drama I: Spring 6
57-173 Survey of Western Music History 9
60-105 Pre-Industrial Culture to 1789 9
60-205 Modern Visual Cultures; 1945 to the Present 9
60-206 Contemporary Visual Culture: 1945 to Present 9
62-148 Art & Culture 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 Henry Hornbostel 9
48-348 History of Modern American Architecture 9
48-440 American Built Environment to 1860 9
48-441 Frank Lloyd Wright 9
48-445 The City in History 9
48-446 Renaissance and Baroque Architecture 9
48-447 History & Preservation 9
48-448 History of Sustainable Architecture 9
51-272 Design History II: Spring Only 9
51-378 History of the Book and Printing 9
54-381 History of Drama: Fall - 3 units 9
54-382 History of Drama II: 3 units 9
57-202 Opera History: Spring Only 9
57-205 20th Century Music History 9
60-350-98 Art History/Thsey Special Topics (Instructor Permission Only) 9
62-360 Photographers: Photography since WWII 9
62-371 Photography, The First 100 years 9
79-324 Modernism and Painting, 1880-1945 9
79-325 Art and Religion 9
79-355 The American Skyscraper: It’s History and Development 9
79-364 Art, Anthropology and Empire 9
79-395 The Arts in Pittsburgh 9
79-396 Music and Society in the 19th/20th Century Europe and the US 9

Minimum units required: 54

166 Minors Offered By the College of Fine Arts
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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>51-261</td>
<td>Communication Design Fundamentals (fall)</td>
<td>9</td>
</tr>
<tr>
<td>51-271</td>
<td>Design History I (fall)</td>
<td>9</td>
</tr>
</tbody>
</table>

**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 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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>51-263</td>
<td>Industrial Design Fundamentals (fall)</td>
<td>9</td>
</tr>
<tr>
<td>51-271</td>
<td>Design History I (fall)</td>
<td>9</td>
</tr>
</tbody>
</table>

**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 an opportunity to participate in a preliminary professional exposure to the theatre arts. Courses may involve acting, dance, text analysis, directing, playwriting, design and a series of related history of theatre and drama courses. Students must also become involved with Drama productions by signing up for Production Preparation. Production Preparation III is optional but encouraged. These courses specifically involve evening crew work on various Drama productions, both main stage and studio theatre.

**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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-163/4*</td>
<td>Introduction to Production</td>
<td>12</td>
</tr>
<tr>
<td>54-177/8*</td>
<td>Text to Stage</td>
<td>12</td>
</tr>
<tr>
<td>54-281/2</td>
<td>History of Drama</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-113/4*</td>
<td>Ballet Elective (Beginning &amp; Advanced)</td>
<td>12</td>
</tr>
<tr>
<td>54-134</td>
<td>Directing for Non-Majors</td>
<td>6</td>
</tr>
<tr>
<td>54-187/8</td>
<td>Introduction to Playwriting</td>
<td>6</td>
</tr>
<tr>
<td>54-189/90</td>
<td>Advanced Playwriting</td>
<td>9</td>
</tr>
<tr>
<td>54-191/2</td>
<td>Acting for Non-Majors</td>
<td>9</td>
</tr>
<tr>
<td>54-239/40*</td>
<td>History of Architecture and Décor</td>
<td>6</td>
</tr>
<tr>
<td>54-245/6*</td>
<td>History of Clothing</td>
<td>6</td>
</tr>
<tr>
<td>54-259</td>
<td>or 262 Production II (Crew)</td>
<td>9</td>
</tr>
<tr>
<td>54-251/2*</td>
<td>Introduction to Lighting Design</td>
<td>6</td>
</tr>
<tr>
<td>54-309/10</td>
<td>Theatre Lab</td>
<td>4</td>
</tr>
<tr>
<td>54-381/2</td>
<td>History of Drama (Minis)</td>
<td>3 units each</td>
</tr>
<tr>
<td>54-481/2</td>
<td>History of Drama (Minis)</td>
<td>3 units each</td>
</tr>
<tr>
<td>54-475</td>
<td>Theatre Management</td>
<td>6</td>
</tr>
</tbody>
</table>

The following courses are available by audition and the agreement of the instructor:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-123/4*</td>
<td>Dance I</td>
<td>6</td>
</tr>
<tr>
<td>54-223/4*</td>
<td>Dance II</td>
<td>6</td>
</tr>
</tbody>
</table>

**Minimum units required:** 60

Minor in Jazz Performance

This sequence is for candidates who are majors from any discipline in the university who have substantial potential as demonstrated by an acceptable audition and would like to improve their jazz performance skills.

**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. For the audition, the student should perform two contrasting pieces and demonstrate the potential for the development of improvisatory skills.

**Required Music Courses 12 units**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-150 or 57-152</td>
<td>Basic Harmony I or Harmony I</td>
<td>6</td>
</tr>
<tr>
<td>57-180 or 57-181</td>
<td>Basic Solfege I or Solfege I</td>
<td>3</td>
</tr>
</tbody>
</table>

**Required Jazz Courses 24 units**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-xxx</td>
<td>Jazz Ensemble or Jazz Vocal Ensemble</td>
<td>3</td>
</tr>
<tr>
<td>57-xxx</td>
<td>Jazz Ensemble or Jazz Vocal Ensemble</td>
<td>3</td>
</tr>
<tr>
<td>57-319</td>
<td>Jazz Piano</td>
<td>3</td>
</tr>
<tr>
<td>57-320</td>
<td>Jazz Piano</td>
<td>3</td>
</tr>
<tr>
<td>57-328</td>
<td>Jazz Chamber Music</td>
<td>3</td>
</tr>
<tr>
<td>57-328</td>
<td>Jazz Chamber Music</td>
<td>3</td>
</tr>
<tr>
<td>57-450</td>
<td>Jazz Ear Training</td>
<td>3</td>
</tr>
<tr>
<td>57-453</td>
<td>Jazz Improvisation</td>
<td>3</td>
</tr>
</tbody>
</table>

**Required Studio Courses 24 units**

This requirement must be fulfilled by taking Minor Studio for 4 semesters.

**Elective Courses (choose 1) 6 units**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-451</td>
<td>Jazz Arranging</td>
<td>6</td>
</tr>
<tr>
<td>57-452</td>
<td>Jazz Composition</td>
<td>6</td>
</tr>
<tr>
<td>57-454</td>
<td>Jazz Transcription and Analysis</td>
<td>6</td>
</tr>
<tr>
<td>57-457</td>
<td>Jazz History I</td>
<td>6</td>
</tr>
<tr>
<td>57-458</td>
<td>Jazz History II</td>
<td>6</td>
</tr>
</tbody>
</table>

**Minimum units required:** 54
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 Courses 3 units
Beginning Piano is required of students who do not pass a piano proficiency test.

57-103 Beginning Piano 3

Introductory Courses 22 units
57-161 Eurhythmics I 3
57-180 or 57-181 Basic Solfege I or Solfege I 3
57-150 or 57-152 Basic Harmony I or Harmony I 6
57-173 Survey of Western Music History 9
57-189 Repertoire and Listening for Musicians I 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)
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

Other courses (choose 6 units)
These courses are to 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.) Additional diction, literature and repertoire, and language electives are encouraged for voice minors.

Minimum units required: 70

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 Courses 3-6 units
Beginning Piano is required of students who do not pass a piano proficiency test.

57-103 Beginning Piano 3
99-xxx Computing @ Carnegie Mellon 3

Introductory Music Courses 16 units
57-150 or 57-152 Basic Harmony I or Harmony I 6
57-173 Survey of Western Music History 9
57-189 Repertoire and Listening for Musicians I 1

Required Music Technology Courses 33 units
57-101 Introduction to Music Technology 6
57-337 Sound Recording 6
57-338 Sound Editing and Production 6
57-347 Electronic and Computer Music 6
57-438 MultiTrack Recording 9

Technical Courses (choose 2) 15 units
xx-xxx H&SS multimedia course 9
15-100 Introductory/Intermediate Programming 10
15-229 Multimedia Programming and Computer Science 9
33-114 Physics of Musical Sound 6
54-165 Introduction to Sound Design for Theater I 6
57-610 Internship 9

Minimum units required: 64

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 Director of Student Services (CFA 108).

Prerequisite Course 3 units
Beginning Piano is required of students who do not pass a piano proficiency test.

57-103 Beginning Piano 3

Introductory Courses 22 units
57-150 or 57-152 Basic Harmony I or Harmony I 6
57-161 Eurhythmics I 3
57-173 Survey of Western Music History 9
57-189 Repertoire and Listening for Musicians I 1
57-189 or 57-181 Basic Solfege I or Solfege I 3

Required Theory Courses 27 units
57-151 Principles of Counterpoint 6
57-153 Harmony II 6
57-257 Orchestration I 5
57-408 Form and Analysis 6
57-612 Independent Study in Music Theory 3

Analysis Course (choose 1) 6 units
57-335 Analysis Seminar 6
57-442 Analytical Techniques 6

Minimum units required: 55
Minor in Photography, Film and Digital Imaging

The minor in Photography, Film, and Digital Imaging is an interdisciplinary minor within the College of Fine Arts.

The minor requires students to choose from one of three options:
- Photography and Film
- Photography and Digital Imaging
- Film and Digital Imaging

The Minor requires students to complete a total of 54 units. These 54 units include a total of four production courses (36 units) and two photo/film history, theory or criticism courses (18 units). Photo/Film history, theory or criticism courses taken outside of Carnegie Mellon must be pre-approved for application to the Minor. Students in the College of Fine Arts will be advised by their individual schools and students outside of the College will be advised by Jarrin Nevel in the College of Fine Arts, Room 100.

Students may choose from a list of courses. Students must complete the 54 unit requirements for ONE of the following modules:

Photography & Film

Module A: three Photo courses, one Film course, and two Photo/Film history, theory or criticism courses

or

Module B: three Film courses, one Photo course, and two Photo/Film history, theory or criticism courses

Photography & Digital Imaging

Module C: three Photo courses, one Digital Imaging course, and two Photo/Film history, theory or criticism courses

or

Module D: three Digital Imaging courses, one Photo course, and two Photo/Film history, theory or criticism courses

Film & Digital Imaging

Module E: three Film courses, one Digital Imaging course, and two Photo/Film history, theory or criticism courses

or

Module F: three Digital Imaging courses, one Film course, and two Photo/Film history, theory or criticism courses

Course List Production - Carnegie Mellon

Courses:

15462 Computer Graphics I
18360 Intro to Computer-Aided Digital Design
24201 Engineering Graphics
48120 Introduction to Digital Media I
48125 Introduction to Digital Media II
51132 Introduction to Photographic Design
51221 Communication Design Darkroom I (mini)
51225 Communication Design Darkroom II (mini)
51246 Photo Documentation
51251 Digital Prototyping
51265 Beginning Photography
51315 Digital Imaging (mini)
51321 Photography and Communication
51330 Photo Book Design
51344 Advanced Digital Prototyping
51346 Production Prototyping
54270 Computer Applications
60210 Electronic Media Studio II
62141 Black and White Photography I
62241 Black and White Photography II
62266 The Constructed Photograph
62325 View Camera
62372 Photo Book Design
62381 Color Photography I
62382 Color Photography: Perception/Representation
70161 Intro to Graphic Communications II
70635 Desktop Publishing
70637 Interactive Media Design & Production
76269 Survey of Forms: Screenwriting

Production - Pittsburgh Filmmakers Courses:

All Courses offered at Filmmakers are 9 units.

FM-105 History of Photography I
FM-218 Advanced Screenplay Workshop
FM-161 Black & White Photography I
FM-219 Animation Basics
FM-162 Black & White Photography II
FM-269 Writing Short Scripts
FM-163 Elements of Film
FM-270 Film Genres
FM-164 Filmmaking I
FM-271 Acting for the Camera
FM-166 Film Genre: Women in Animated Media
FM-301 Advanced Filmmaking
FM-167 Introduction to Digital
FM-302 Digital Possibilities
FM-169 Introduction to Screenwriting
FM-306 Cinematography
FM-170 American Film History
FM-307 Scripting & Pre-Production
FM-171 History of Photography II
FM-308 Advanced Non-Lineare Script
FM-172 Film Genre: Women in Animated Media
FM-309 Sound for Film
FM-173 Contemporary European Cinema
FM-310 Lighting for Film and Video
FM-175 History of Photography II
FM-311 Advanced Digital Imaging
FM-176 International Film History
FM-314 Independent Study
FM-177 International Film Theory Criticism
FM-315 Technical Directing
FM-200 Intermediate Filmmaking
FM-316 View Camera Techniques
FM-201 Black & White Photography III
FM-317 Advanced Video Production
FM-202 Color Photography I (formerly Video Production II)
FM-203 Color Photography II
FM-318 Screenwriter's Master Class
FM-209 Experimental Film/Video Art
FM-334 Producing for Film/Video
FM-210 Studio Lighting
FM-335 Directing Actors
FM-211 Photoshop for Photographers
FM-345 Digital Effect Compositions
FM-212 Script Analysis
FM-360 Advanced Sound
FM-213 Contemporary European Cinema
FM-290 Advanced Non-Lineare Editing
FM-215 Video Production
FM-404 Digital Non-Lineare Editing (formerly Video Production I)
FM-407 Senior Film Production I
FM-216 Web Design
FM-408 Senior Film Production II

Photo/Film History, Theory or Criticism - Carnegie Mellon

51271 Design History I
51272 Design History II
54245 History of Clothing (1st half mini)
54246 History of Clothing (2nd half mini)
54281 History of Drama
57399 Music, Cinema, Culture
62148 Art and Culture
62248 Music in American Society
74246 Shakespeare and Film
76239 Intro to Film Studies
76339 American Cultural Visions in Hollywood Cinema (Course title changes each semester)
79238 Film and the Production of History
79246 The 1920's & 1930's in Film
79247 America in Film: The 1940's -1960's
79248 World War II and the Cold War in Film
79249 Contemporary America in Film
79303 Visual Anthropology
79304 The Uses of History in Film
79306 East Asians in Film
79313 History of Photography, 1920- Present
79361 The Film Festival: Rock & Roll
82491 Literature, Politics and Film in East Europe & Russia
88314 Politics Through Film: Tyranny and Resistance

Courses subject to change by semester. Actual listing available in the Dean’s Office, CFA 100.

Minimum units required: 54
### School of Architecture

Laura Lee, FAIA, Head
Office: CFA 201

The mission of the School of Architecture is to educate outstanding professionals with design creativity, social responsibility, historical perspective, technological innovation, and global environmental consciousness.

**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 503 units is required for graduation.

*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 two 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

<table>
<thead>
<tr>
<th>Semester</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>48-100 Architecture Design Studio: Form</td>
</tr>
<tr>
<td></td>
<td>48-120 Introduction to Digital Media I</td>
</tr>
<tr>
<td></td>
<td>48-130 Architectural Drawing I: A Tactile Foundation</td>
</tr>
<tr>
<td></td>
<td>21-114 Calculus for Architecture (mini 2)</td>
</tr>
<tr>
<td></td>
<td>64-100 Critical Histories of the Arts</td>
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<tr>
<td></td>
<td>99-101/102/103 Computing Skills Workshop (mini 1)</td>
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#### Second Year

<table>
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<th>Semester</th>
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<tr>
<td>Fall</td>
<td>48-105 Architecture Design Studio: Space</td>
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<tr>
<td></td>
<td>48-115 Physics for Architecture</td>
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<td></td>
<td>48-125 Introduction to Digital Media II</td>
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<td>48-135 Architectural Drawing II: Appearance</td>
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<td></td>
<td>76-101 Interpretation and Argument</td>
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#### Third Year

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<th>Semester</th>
<th>Units</th>
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<tbody>
<tr>
<td>Fall</td>
<td>48-300 Architecture Design Studio: Site</td>
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<tr>
<td></td>
<td>48-312 Site Engineering and Foundations</td>
</tr>
<tr>
<td></td>
<td>48-315 Environment I: Climate and Energy</td>
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<tr>
<td></td>
<td>48-xxx Architectural History II</td>
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<td></td>
<td>xx-xxx University Elective</td>
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#### Fourth Year

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<th>Semester</th>
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<tr>
<td>Fall</td>
<td>48-400 Architecture Design Studio: Occupancy</td>
</tr>
<tr>
<td></td>
<td>48-410 Environment II: Acoustics and Light</td>
</tr>
<tr>
<td></td>
<td>48-412 Environment III: Mechanical Systems</td>
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<tr>
<td></td>
<td>48-xxx Architecture Elective</td>
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<td>xx-xxx University Elective</td>
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#### Fifth Year

<table>
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<tr>
<th>Semester</th>
<th>Units</th>
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<tbody>
<tr>
<td>Fall</td>
<td>48-500 Architecture Design Studio: The Urban Lab</td>
</tr>
<tr>
<td></td>
<td>48-550 Issues of Practice</td>
</tr>
<tr>
<td></td>
<td>48-xxx Architecture Elective</td>
</tr>
<tr>
<td></td>
<td>xx-xxx University Elective</td>
</tr>
</tbody>
</table>

#### Fundamental University Courses

(5 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.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>21-114</td>
<td>Calculus for Architecture</td>
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<td>48-115</td>
<td>Physics for Architecture</td>
</tr>
<tr>
<td>64-100</td>
<td>Critical Histories of the Arts</td>
</tr>
<tr>
<td>76-101</td>
<td>Interpretation and Argument</td>
</tr>
<tr>
<td>99-101/102/103</td>
<td>Computing Skills Workshop</td>
</tr>
</tbody>
</table>

#### 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: form, space, composition, materials, site construction, occupancy, systems integration, and urban design. Studio X is intended to allow for study abroad 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, with the first, second and third year studios located in Margaret Morrison Hall. Fourth and fifth year studios are located on the second floor of the College of Fine Arts Building. Studios provide a faculty to student ratio of 1:12.

48-100 Architecture Design Studio: Form
48-105 Architecture Design Studio: Space
48-200 Architecture Design Studio: Composition
48-205 Architecture Design Studio: Materials
48-300 Architecture Design Studio: Site
48-305 Architecture Design Studio: Advanced Construction
48-400 Architecture Design Studio: Occupancy
48-405 Architecture Design Studio: Systems Integration
48-500 Architecture Design Studio: The Urban Lab
48-505 Studio X

History (1+3 courses)
In addition to Critical Histories of the Arts, taken during the first year, three core courses in architectural history are required for the Bachelor of Architecture degree. All second 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. It is highly recommended that the two additional core history requirements be completed prior to the fifth year.

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.

64-100 Critical Histories of the Arts
48-240 Architectural History I: Historical Survey of World Architecture and Urbanism
48-xxx Architectural History
48-xxx Architectural History

Drawing and Media (5 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, and Architectural Drawing III in the second year. Thereafter students may elect to take further drawing and media courses during years three, four and five in fulfillment of the school elective requirements.

48-120 Introduction to Digital Media I
48-125 Introduction to Digital Media II
48-130 Architectural Drawing I: A Tactile Foundation
48-135 Architectural Drawing II: Understanding Appearance
48-230 Architectural Drawing III: Perspective

Technology: Building, Materials, and Structures (4 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.

48-210 Statics
48-215 Materials and Assemblies
48-217 Structures
48-312 Site Engineering and Foundations

Technology: Environment/Sustainability (4 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 and Energy
48-410 Environment II: Acoustics and Light
48-412 Environment III: Mechanical Systems
48-415 Advanced Building Systems

Professional Practice, Ethics, Management (4 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 processes, multi-disciplinary team design decision 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
48-452 Real Estate Design and Development
48-550 Issues of Practice
48-551 Ethics and Decision Making in Architecture

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 the 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 and in engineering at the various schools 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 two minors within the subject of architecture. These are the Minor in Architectural History and the Minor in Building Science. 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 several areas of architectural science and for those who are interested in gaining advance placement into the graduate M.S. programs offered by the School in the areas of Building Performance and Diagnostics or Computational Design.

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, knowledge concerning state-of-the-art approaches to building systems integration and total building performance. The program 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 Masters of Urban Design (MUD) aims to develop physical design expertise critical to establishing responsible and sustainable community design and policy. As a joint program with the H. John Heinz III School of Public Policy and Management, students collaborate in multidisciplinary teams to create sensitive, sustainable solutions that can encourage the revitalization of neighborhoods, cities, and regions. Upon receiving their Masters from Carnegie Mellon, Students have the option to continue their studies at Oxford University, where they will work towards generating case-specific databases guidelines for achieving sustainable cities and regions.

Masters of Science in Sustainable Design
The Master of Science (MS) program in Sustainable Design is intended to educate building professionals in the rapidly expanding field of sustainable design and to prepare them for careers in sustainable design and green building. As a collective process, Sustainable Design research focuses on ways to achieve new levels of ecological balance between the built environment and nature. Through such work, the final goal is to humanize architecture, while increasing its long-term viability.

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 progress within the university if a change is desired. Subsequent reviews monitor and ensure continued progress in all sequences of the program.

Scholarships and Awards
The School has eight scholarships and traveling fellowships available for outstanding students. These are the Stewart L. Brown Scholarship from the Pittsburgh Chapter of the American Institute of Architects, John Knox Shear Memorial Traveling Fellowship, Louis F. Valentour Traveling Scholarship Fund, Burdett Assistantship, Lusher Lashmit Award, Richard M. Gensert Memorial Scholarship, IDC-CH2M Scholarship, and Jan Junge Award.

Study Abroad and Summer Abroad Program
The School of Architecture conducts an officially recognized exchange program for fourth year students to study abroad at: the EPFL in Lausanne, Switzerland; ITESM in Monterrey, Mexico; the National University of Singapore and the Henry van de Velde Institute in Antwerp, Belgium. Students are welcome to seek out other study abroad opportunities where course work is equivalent to studies at CMU at a maximum of 45 transfer units per semester. Students present study abroad plans to the School for review at the beginning of the third year. To receive credit for courses taken abroad, the student must have a C or better (not C-) in the course and have an official transcript sent to the School of Architecture.

In addition, the school offers a study-abroad program each summer. The locations of these programs vary from year to year. Recent offerings have included the Czech Republic, Austria, the Netherlands, China, Rome, Barcelona, and the Middle East. Students entering their fourth and fifth years of the Bachelor of Architecture program are eligible to apply.

Summer Courses
Students can receive credit for passing comparable courses at other institutions with advance approval from the School.
Faculty

ÖMER AKIN, Professor of Architecture — RA, Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977—.

STEPHANIE BARTOS, RA, Associate Teaching Professor of Architecture — M. Arch., Massachusetts Institute of Technology; Carnegie Mellon, 1997—.

MARSHA BERGER, AIA, Marsha Berger Architect, Adjunct Associate Professor of Architecture — M. Arch., Carnegie Mellon University; Carnegie Mellon, 1995—.

DEE BRIGGS, Adjunct Assistant Professor of Architecture — M. Arch., Yale University; Carnegie Mellon, 2003—.

TERESA BUCCO, RA, Adjunct Assistant Professor of Architecture — M. Arch., North Carolina State University; Carnegie Mellon University; Carnegie Mellon, 2004—.

WALTER BOYKOWYCZ, AIA, Adjunct Professor of Architecture — M. Urban and Regional Planning, University of Pittsburgh, M. Arch., Carnegie Mellon University; Carnegie Mellon, 1979—.

DAVID BURNS, Adjunct Assistant Professor of Architecture — M. Arch., Columbia University; Carnegie Mellon, 2003—.

LEE CALISTI, AIA, Adjunct Assistant Professor of Architecture — B. Arch., Kent State University; Carnegie Mellon, 2002—.

GARY CARLOUGH, AIA, EDGE Architecture, Adjunct Professor of Architecture — B. Arch., University of Arizona; Carnegie Mellon, 1988—.

DOUGLAS COOPER, Andrew Mellon Professor of Architecture — B. Arch., Carnegie Mellon University; Carnegie Mellon, 1976—.

GERARD DAMIANI, AIA, Studio d’Arc, Adjunct Associate Professor of Architecture — B. Arch., Syracuse; Carnegie Mellon, 1997—.

JEFF DAVIS, AIA, Davis Gardner Gannon Pope Architects, Adjunct Associate Professor of Architecture — B. Arch., University of Illinois Urbana Champaign; Carnegie Mellon, 1996—.

KEN DOYNO, AIA, Rothschild/Doyno Architects, Adjunct Associate Professor of Architecture — B. Arch., Carnegie Mellon University; Carnegie Mellon, 2003—.

SARAH DRAKE, AIA, Adjunct Assistant Professor of Architecture — M. Arch., North Carolina State University; Carnegie Mellon, 2002—.

RAMI EL SAMAHY, Adjunct Assistant Professor of Architecture — M. Arch, Harvard University; Carnegie Mellon, 2006—.

ERIC FISHER, Fisher Architecture, Adjunct Professor of Architecture — M. Arch., Harvard University; Carnegie Mellon, 2001—.

MATT FINEOUT, AIA, EDGE Architecture, Adjunct Assistant Professor of Architecture — M. Arch., Southern California Institute of Architecture; Carnegie Mellon, 2003—.

KEVIN GANNON, AIA, Davis Gardner Gannon Pope Architects, Adjunct Associate Professor of Architecture — M. Arch., Yale University; Carnegie Mellon, 1993—.

SHELDON GOETTEL, AIA, Perifdo Weiskopf Goettel Architects, Adjunct Professor of Architecture — M. Arch., Carnegie Mellon, 1990—.

KAI GUTSCHOW, Assistant Professor of Architecture — Ph.D., Columbia University; Carnegie Mellon University, 1998—.

MARK GROSS, Professor of Architecture — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2004—.

VOLKER HARTKOPF, Professor of Architecture — Dr. Ing., Architecture, University of Stuttgart; Carnegie Mellon, 1972—.

KELLY HUTZELL, Caste Visiting Assistant Professor of Architecture — M.S., Architecture and Urban Design, Columbia University; Carnegie Mellon, 2005—.

CASIMIR KAWECKI, Adjunct Assistant Professor of Architecture — M. Arch., University of Virginia, MBA, Carnegie Mellon University; Carnegie Mellon, 2005—.

JEFF KING, AIA, EDGE Architecture, Adjunct Assistant Professor of Architecture — M. Arch., Tulane University; Carnegie Mellon, 2005—.

JONATHAN KLINE, Adjunct Assistant Professor of Architecture, — B. Arch., Carnegie Mellon University; Carnegie Mellon, 2002—.

RAMESH KRISHNAMURTI, Professor of Architecture — Ph.D. Systems Design, University of Waterloo; Carnegie Mellon, 1989—.

KRISTIN KURLAND, Associate Teaching Professor in Architecture and Heinz School of Public Policy and Management, —B.S., University of Pittsburgh; Carnegie Mellon, 1996—.

KHEE POH LAM, RIBA, Professor of Architecture— Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003—.

LAURA LEE, FAIA, Head, Professor of Architecture — M. Arch., University of Michigan; Carnegie Mellon, 1991—.

STEPHEN R. LEE, AIA, Professor of Architecture — M. Arch., Carnegie Mellon University; Carnegie Mellon, 1981—.

DAVID LEWIS, FAIA, Distinguished Teaching Professor of Urban Design — M. Arch., Leeds College of Architecture; Carnegie Mellon, 1982—.

VIVIAN LOFTNESS, FAIA, University Professor of Architecture — M. Arch., Massachusetts Institute of Technology; Carnegie Mellon, 2003—.


ANNE-MARIE LUBENAU, AIA, Adjunct Assistant Professor of Architecture — B. Arch., Carnegie Mellon University; Carnegie Mellon, 2005—.

JENNIFER LUCCHINO, AIA, Adjunct Assistant Professor of Architecture — M. Arch., Rice University; Carnegie Mellon, 2003—.

GERALD MATTERN, Adjunct Professor of Architecture — B.E., Rose Polytechnic Institute; Carnegie Mellon, 1982—.

DUTC MACDONALD, EDGE Architecture, Adjunct Assistant Professor of Architecture — B. Arch., Carnegie Mellon University; Carnegie Mellon, 1999—.

CHRIS MINNERLY, AIA, The Design Alliance Architects, Adjunct Assistant Professor of Architecture — M. Arch., Cornell University; Carnegie Mellon, 1997—.

JASON MORRIS, AIA, Adjunct Assistant Professor of Architecture — M. Arch., Illinois Institute of Technology; Carnegie Mellon, 2005—.

CHRISTINE MONDOR, AIA, Assistant Professor of Architecture — B. Arch., Carnegie Mellon University; Carnegie Mellon, 1999—.

IRVING OPPENHEIM, Professor of Architecture and Civil Engineering — Ph.D., Cambridge University; Carnegie Mellon, 1973—.

MATTHEW PLEUTY, MLA, Adjunct Assistant Professor of Architecture — M. Arch., MLA, Virginia Tech; Carnegie Mellon, 2006—.

LUIS RICO-GUTIERREZ, Special Faculty in Architecture & Associate Dean of the College of Fine Arts — M.S., Carnegie Mellon University; Carnegie Mellon, 1998—.

CHARLES ROSENBLOM, Adjunct Assistant Professor of Architecture — M.A., University of Virginia; Carnegie Mellon, 1998—.

PAUL ROSENBLATT, AIA, Springboard Architecture and Design, Adjunct Associate Professor of Architecture — M. Arch., Yale; Carnegie Mellon, 1987—.

DAN ROTHSCILD, AIA, Rothschild/Doyno Architects, Adjunct Assistant Professor of Architecture — M. Arch., North Carolina State University; Carnegie Mellon, 2000—.

RAYMUND RYAN, Adjunct Assistant Professor — M. Arch., Yale; Carnegie Mellon, 2005—.

SCOTT SMITH, Shop Director — M.F.A., Cranbrook Institute; Carnegie Mellon, 1984—.

DIANE SHAW, Associate Professor of Architecture — Ph.D., University of California Berkeley; Carnegie Mellon, 1996—.

KENT SUHRBIER, AIA, Bohlin Cywinski Jackson, Adjunct Assistant Professor of Architecture — B. Arch., Carnegie Mellon University; Carnegie Mellon, 2004—.

SPIKE WOLFF, Adjunct Assistant Professor of Architecture — M. Arch., Southern California Institute of Architecture; Carnegie Mellon, 2003—.
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 extensive contemporary studios 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 University Center Gallery, The Miller Gallery, and the Frame Gallery, which is managed entirely by art students.

The progressive curriculum requires that students attain high levels of knowledge, skill and commitment. The four-year undergraduate program offers one degree, the Bachelor of Fine Arts (B.F.A.) degree 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. One Concept Studio is offered each semester for a total of eight courses. Students are required to complete six of the eight, but may enroll in all eight semesters. In the second semesters of the sophomore and junior years, Concept Studios are 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, context/community affiliation, and senior project.

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 Art-in-Context Concept Studio, is devoted entirely to context-related issues and art that engages a variety of communities. In the senior year, the Concept Studios, titled Senior Project, are devoted to a single student-generated project.

**II. Media Studios**

The Media Studios can be viewed as the foundation courses for the program. Students take two Media Studios each semester during the freshman and sophomore years for a total of eight courses. 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 during the freshman year, and painting and printmaking during the sophomore year. Electronic Media Studios introduce computer-related work during the freshman year, and video in the sophomore year. Three-Dimensional Media Studios introduce ceramics, welding and wood during the freshman year, and foundry, metals, and construction during the sophomore year.

**III. Advanced Studios**

Students take a total of eight Advanced Studio elective courses during the junior and senior years. These courses address specialized studio work in one of the three artistic concentration areas in the school, which are:

- Painting, Drawing, and Printmaking (PD)
- Sculpture, Installation, and Site Work (SIS)
- Electronic and Time-Based Work (ETB)

A minimum of four courses must be taken in one of these concentration areas. One of the eight 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, 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):** Pre-Industrial Visual Cultures to 1789
- **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:

- Computer Skills Workshop, World History, and Interpretation and Argument
### 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 sophomore year, students have more options regarding the sequencing and selection of their coursework.

#### First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-101</td>
<td>Concept Studio I</td>
</tr>
<tr>
<td>60-110</td>
<td>Electronic Media Studio I: Computer Art</td>
</tr>
<tr>
<td>60-150</td>
<td>2D Media Studio I: Drawing</td>
</tr>
<tr>
<td>60-104</td>
<td>Contemporary Issues Forum</td>
</tr>
<tr>
<td>99-103</td>
<td>Computer Skills Workshop</td>
</tr>
<tr>
<td>76-101</td>
<td>Interpretation and Argument</td>
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Spring

<table>
<thead>
<tr>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>48</td>
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<th>Units</th>
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<tbody>
<tr>
<td>60-102</td>
<td>Concept Studio II</td>
</tr>
<tr>
<td>60-130</td>
<td>3D Media Studio I: Ceramics, Welding, Wood</td>
</tr>
<tr>
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<td>2D Media Studio II: Drawing</td>
</tr>
<tr>
<td>60-105</td>
<td>Pre-Industrial Visual Cultures to 1789</td>
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<tr>
<td>79-104</td>
<td>World History</td>
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#### Second Year

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<th>Units</th>
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</thead>
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<td>Concept Studio III</td>
</tr>
<tr>
<td>60-230</td>
<td>3D Media Studio II: Foundry, Metals, Construction</td>
</tr>
<tr>
<td>60-250</td>
<td>2D Media Studio III: Painting</td>
</tr>
<tr>
<td>60-205</td>
<td>Modern Visual Culture: 1789-1945</td>
</tr>
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Spring

<table>
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<th>Units</th>
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<td>48</td>
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<table>
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<tr>
<th>Fall</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>60-4xx</td>
<td>Advanced Studio Elective</td>
</tr>
<tr>
<td>60-210</td>
<td>Electronic Media Studio II: Video Art</td>
</tr>
<tr>
<td>60-251</td>
<td>2D Media Studio IV: Printmaking</td>
</tr>
<tr>
<td>60-206</td>
<td>Contemporary Visual Culture: 1945 to the Present</td>
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<table>
<thead>
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<th>Spring</th>
<th>Units</th>
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#### Third Year

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<thead>
<tr>
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<th>Units</th>
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</thead>
<tbody>
<tr>
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<td>Advanced Studio Elective</td>
</tr>
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<td>60-4xx</td>
<td>Advanced Studio Elective</td>
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<table>
<thead>
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<th>Units</th>
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<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
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<td>Art-in-Context, or Advanced Studio</td>
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</tr>
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<td>60-4xx</td>
<td>Advanced Studio Elective</td>
</tr>
<tr>
<td>60-xxx</td>
<td>Academic Art Elective</td>
</tr>
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<td>Academic Elective</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
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<td>48</td>
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#### Fourth Year

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<tr>
<td>xx-xxx</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td></td>
</tr>
</tbody>
</table>

**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 an artist preparing to enter a career in art.

### Art Majors Minoring or Double Majoring in Another Department

About a third of current B.F.A. Art students pursue a minor or a second major. If students are contemplating this option, they must discuss their plans with academic advisors from the minor or second major department as well as with the School of Art academic advisor.

### Study Abroad

Art students are encouraged to spend either a semester of their junior year, or a summer before or after their junior year, in one of many available international programs. These programs include exchange programs sponsored by the School of Art in which a student’s financial aid package remains in effect, and programs sponsored by other institutions. International exchange programs currently active include the following:

- Brazil: Escola de Comunicacoes e Artes, Universidade de Sao Paulo, Sao Paulo
- Chile: Instituto Superior de Arte y Communicacion, 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: Kuvataideakademia, Helsinki
- France: Ecole d’Aix-en Provence, Aix-en Provence
- 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 Institute of Polytechnics, Tokyo
- Korea: The Korsan 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
- Spain: Universitat Polittecnica de Valencia, Valencia
- Turkey: Bilkent University, Ankara
- Wales: University of Wales College, Newport

**Total Units for the B.F.A. Art Degree**: 384
Programs with other Pittsburgh Institutions

Art students are eligible to take courses at the nearby University of Pittsburgh’s Art History 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 (B.H.A.) Degree

Carnegie Mellon University offers a degree program that combines an Art Focus (11 courses) with a focus in the College of Humanities and Social Sciences or the Mellon College of Science. The Assistant Head of the School advises BHA and BSA majors in selecting courses in the Art Focus. A description of these programs, and a list of requirements and electives, can be found in the in the BHA and BSA section of this catalog.

Art Minors

Only 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 artmaking to the university at large, and to Pittsburgh communities. Information about this program is available at the School of Art website: http://artserver.cfa.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.

School of Art Faculty

Full-Time Tenure Track Faculty

KIM BECK, Assistant 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, Professor of Art — M.F.A. Carnegie Mellon University; Carnegie Mellon, 1986—.
RON BENNETT, Professor of Art — M.F.A. Rhode Island School of Design; Carnegie Mellon, 1975—.
BOB BINGHAM, Associate Professor of Art — M.F.A. University of California, Davis; Carnegie Mellon, 1993—.
LLOWRY BURGESS, Professor of Art — Post-Graduate Degree, Pennsylvania Academy of Fine Arts/University of Pennsylvania; Carnegie Mellon, 1989—.

JON BECKLEY, Professor of Art — M.F.A. Carnegie Institute of the Arts; Carnegie Mellon, 2006—.

CLAYTON MERRELL, Associate Professor of Art — M.F.A. Yale University; Carnegie Mellon, 1997—.

CAROL KUMATA, Professor of Art — M.F.A. University of Washington, Madison; Carnegie Mellon, 1979—.

GOLAN LEVIN, Assistant Professor of Art — M.F.A. Carnegie Mellon University; Carnegie Mellon, 2001—.

JON RUBIN, Assistant Professor of Art — M.F.A. California Institute of Technology; Carnegie Mellon, 2004—.

JAMES KANG, Professor of Art History and Theory — Ph.D. Northwestern University; Carnegie Mellon, 1981—.

JOSEPH MANNINO, Associate Professor of Art — M.F.A. University of Southern Illinois; Carnegie Mellon, 1986—.

CLAYTON MIRRELL, Associate Professor of Art — M.F.A. Yale University; Carnegie Mellon, 1999—.

AYANNA MOOR, Assistant Professor of Art — M.F.A. Tyler School of Art; Carnegie Mellon, 1999—.

MARTIN REIKOP, Professor of Art — M.F.A. Rhode Island School of Design; Carnegie Mellon, 1993—.

MELISSA RAGONE, Assistant Professor of Art — Ph.D. State University of New York at Buffalo; Carnegie Mellon, 2003—.

HILARY ROBINSON, Dean of the College of Fine Arts, Professor of Art — Ph.D. University of Leeds; Carnegie Mellon, 2005—.

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, 2001—.

SUSANNE SLAVICK, 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—.

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, 1987—.

JUDITH SCHACHTER, Professor of Anthropology, History, and Art — Ph.D. University of Minnesota; Carnegie Mellon, 1984—.

Visiting Faculty

OSMAN KHAN, Visiting Assistant Professor of Art — M.F.A. University of California, Los Angeles; Carnegie Mellon, 2006—.
CHRISTOPHER SPERANDIO, Jill Kraus Visiting Assistant Professor of Art — M.F.A. University of Illinois at Chicago; Carnegie Mellon, 2005—.

**Adjunct Courtesy Appointments**

ROBERT BECKMAN, Adjunct Assistant Professor of Art — M.F.A. Kent State University; Carnegie Mellon, 2001—.

VICKY CLARK, Adjunct Associate Professor of Art — Ph.D. University of Michigan; Carnegie Mellon, 1998—.
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 capacities 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, and the 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 and how we expand our awareness of the place of design in history and 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

<table>
<thead>
<tr>
<th>Fall Units</th>
<th>Studio</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>51-101 Design Studio I</td>
</tr>
<tr>
<td>9</td>
<td>51-121 Design Drawing I</td>
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<table>
<thead>
<tr>
<th>Fall Units</th>
<th>Ideas and Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>51-171 Human Experience in Design</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Fall Units</th>
<th>General Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>76-101 Interpretation &amp; Argument</td>
</tr>
<tr>
<td>9</td>
<td>85-101 Design Proficiency</td>
</tr>
<tr>
<td>3</td>
<td>99-101 Computer Skills Workshop</td>
</tr>
</tbody>
</table>
The Second- and Third-Year Experience: Concentration and Development

Following the first-year program, students enter one of the professional design majors: communication design or industrial design. Each option is built around six semesters of required and elective courses, covering the sophomore, junior, and senior years. The courses pose increasingly complex design problems similar to those faced by professional designers. They require students to use all of their creative, technical, and theoretical skills. In addition to studios, each option also requires a series of ideas and methods courses and a series of design studies courses covering design history, theory, and criticism as well as issues of professional practice. Students are also required to take general education courses to gain a broad vision of many disciplines and fields of knowledge that are relevant to design.

Communication Design

This is the second and third-year curriculum for students in communication design, with required courses noted in bold type and other available courses (often open to students of industrial design as well as communication design) noted in regular type. While required courses must be taken in proper sequence, other available courses may be taken later, when the student’s schedule permits. Please see the course descriptions section for a complete listing of design courses.

Second Year

Fall

<table>
<thead>
<tr>
<th>Studio</th>
<th>51-201</th>
<th>Basic Typography: CD Studio I</th>
<th>9</th>
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</thead>
<tbody>
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<td>Ideas and Methods</td>
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<td>Communication Design Computer Lab</td>
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<tr>
<td></td>
<td>51-241</td>
<td>How People Work: Human Factors</td>
<td>9</td>
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<tr>
<td></td>
<td>51-229</td>
<td>Digital Photographic Imaging</td>
<td>9</td>
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<tr>
<td>Design Studies</td>
<td>51-271</td>
<td>Design History I</td>
<td>9</td>
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<tr>
<td>General Education</td>
<td>xxx-xxx</td>
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Spring

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<thead>
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<td>Color and Communication</td>
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<td>51-224</td>
<td>Digital Prepress Production</td>
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<td>Design Studies</td>
<td>51-274</td>
<td>Design and Social Change</td>
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<tr>
<td>General Education</td>
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Third Year

Fall

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<thead>
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<th>Advanced Typography: CD Studio III</th>
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<tbody>
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<td>Ideas and Methods</td>
<td>51-321</td>
<td>Photography and Communication</td>
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<td>51-323</td>
<td>Drawing and Communication</td>
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<td>51-329</td>
<td>Designing Identities</td>
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<td></td>
<td>51-327</td>
<td>Web Design</td>
<td>9</td>
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Industrial Design

This is the second and third-year curriculum for students in industrial design, with required courses noted in bold type and other available courses (usually open to students of communication design as well as industrial design) noted in regular type. While required courses must be taken in proper sequence, other available courses may be taken later, when the student’s schedule permits. Please see the course descriptions section for a complete listing of design courses.

Second Year

Fall

<table>
<thead>
<tr>
<th>Studio</th>
<th>51-211</th>
<th>Generation of Forms: ID Studio I</th>
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<tbody>
<tr>
<td>Ideas and Methods</td>
<td>51-241</td>
<td>How People Work: Human Factors</td>
<td>9</td>
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<tr>
<td></td>
<td>51-243</td>
<td>Basic Prototype Methods (mini 1)</td>
<td>4.5</td>
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<tr>
<td></td>
<td>51-251</td>
<td>Digital Prototyping (mini 2)</td>
<td>4.5</td>
</tr>
<tr>
<td>Design Studies</td>
<td>51-271</td>
<td>Design History I</td>
<td>9</td>
</tr>
<tr>
<td>General Education</td>
<td>xxx-xxx</td>
<td>Academic Elective</td>
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Spring

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<tr>
<th>Studio</th>
<th>51-212</th>
<th>The Meaning of Forms: ID Studio II</th>
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<tbody>
<tr>
<td>Ideas and Methods</td>
<td>51-242</td>
<td>How Things Work: Mechanics and Electronics</td>
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<td></td>
<td>51-246</td>
<td>Photo-Documentation for Industrial Design</td>
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<td>51-274</td>
<td>Design and Social Change</td>
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<tr>
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<td>xxx-xxx</td>
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Third Year
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

<table>
<thead>
<tr>
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<tr>
<td>51-311</td>
<td>Product Design: ID Studio III</td>
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Ideas and Methods

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<tbody>
<tr>
<td>51-341 How Things are Made: Production Methods</td>
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<tr>
<td>51-327 Web Design</td>
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<tr>
<td>51-371-398 Topics in Design Studies</td>
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Design Studies

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<tr>
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<tbody>
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General Education

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Spring

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Ideas and Methods

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<td>51-346 Production Prototyping</td>
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<td>51-350 Visualization</td>
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Design Studies

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<tr>
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<tr>
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General Education

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</tr>
<tr>
<td>xx-xxx Free Elective</td>
<td></td>
<td>9</td>
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</table>

Other Requirements

General education courses should be selected from other departments throughout the university. Students are strongly advised to select a balanced set of general education electives—in addition to Interpretation and Argument, World History and Introduction to Intelligence—from three broad areas of study: arts and humanities, social and behavioral sciences, and natural sciences and engineering, including mathematics. Specific recommendations (and general requirements) for electives in all of these areas are available from advisors in the School of Design. The School places strong emphasis on the value of general education for personal growth as well as professional development. General education electives allow a student to obtain a minor in another department or program, such as business, engineering, professional and technical writing, or architecture.

Students may enroll for no more than 18 units of independent study courses, and no more than one independent study per semester. A minimum 3.0 GPA is required for independent study. Independent study is permitted only in the third and fourth years of the program. Proposals for independent study courses must be developed jointly by the student and a faculty advisor. Guidelines are available from the School.

A minimum GPA of 2.0 is required to maintain Professional Program status. Grades lower than "C" in required Design courses will result in academic probation, suspension, or drop from the School of Design. Full-time students are required to enroll for a minimum of 45 units per semester (typically five courses). The minimum number of units required for graduation in Design is 360.

Standards

The design curriculum adheres closely to the fundamental professional entry-level standards established by the two leading national design organizations: the American Institute of Graphic Arts (AIGA) and the Industrial Designers Society of America (IDSA). The curriculum is accredited by the National Association of Schools of Art and Design (NASAD).

Applications

The School of Design accepts applications from students who are completing secondary education or who wish to transfer from within 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, Assistant Professor of Design — M.F.A., University of Illinois; Carnegie Mellon, 2003 —.

DANIEL BOYARSKI, Professor of Design, Head, School 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—.

RICHARD BUCHANAN, Professor of Design — Ph.D., University of Chicago; Carnegie Mellon, 1992—.

SHELLEY EVENSON, Associate Professor of Interaction Design — B.S Ohio State University; Carnegie Mellon, 2003 —.


KRISTIN HUGHES, Assistant Professor of Design — M.F.A., Virginia Commonwealth University; Carnegie Mellon, 2001—.

COURTESY APPOINTMENTS

RANDY PAUSCH, Associate Professor and Co-Director of the Entertainment Technology Center — Ph.D., Carnegie Mellon University.

JONATHAN CAGAN, George Tallman Ladd Professor of Mechanical Engineering — Ph.D., University of California Berkeley.

Adjunct Faculty

MATT BEALE, Adjunct Assistant Professor — B.F.A., University of Michigan

VICTORIA CROWLEY, Adjunct Instructor — B.F.A., Carnegie Mellon University

KAREN MOYER, Adjunct Associate Teaching Professor — B.F.A., Philadelphia College of Art; Carnegie Mellon, 1978—.

EDWARD PETROSKY, Adjunct Instructor

MYRNA ROSEN, Adjunct Instructor

MATTHEW SASS, Adjunct Instructor — B.F.A., Carnegie Mellon University

LISA VITALBO, Adjunct Instructor — B.F.A., Carnegie Mellon University

DYLAN VITONE, Assistant Visiting Professor — M.F.A., Massachusetts College of Art

Special Faculty


Howard Worner, Associate Professor of Design, Emeritus.
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. Students are only asked to remain in the conservatory program if they progress in the training and show promise in relation to the demands of the profession. 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 degree in drama. The options available are: acting, music theatre, design, technical studies, performance technology and management, and directing. The continuous production of plays, a natural extension of demanding class work, constitutes one of the school’s major activities. Each semester, 15 to 25 productions, directed by faculty, guest directors, and advanced students, are presented in our two theater spaces. The productions range from completely mounted, full-length dramatic and musical works to more simply produced directing projects and one-acts. Drama programs are 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 sequenced 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 the 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 individual singing lessons, training in a variety of dance techniques (Ballet, Jazz and Tap) and music theatre styles and skills.

The School of Drama considers the Music Theatre program to be the equivalent of a double major.

**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, playwriting, 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, so necessary to the art, is the goal.

**Design Option**

Design students are expected to develop artistic ability in the conception and execution of scene, lighting, 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 three. 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 set, lighting, 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 mainstage production crews. At part of the degree work, juniors may design sets, lights, or costumes for a production in the Studio Theatre and seniors may design sets, lights, or costumes for a Master’s thesis show or a mainstage production.

**Design Option Yearly Goal Statements**

**Freshman Year (Design and PTM)**

The Freshman Year in Design/PTM introduces the student to the broader foundation skill set upon which they will build their CMU education and subsequent careers. One of the primary educational objectives of this year is for the student to develop their creative problem solving skills. Freshman Year is also designed to foster a sense of community as a member of the School of Drama ensemble through work on productions and to instill a sense of personal responsibility.

**Sophomore Year**

The Sophomore Year builds upon the skills obtained during the Freshman Year by attaching those skills to particular theatrical or storytelling applications and concepts. Student’s problem solving skills begin to be directed toward the theatrical design and
production processes. Breadth and depth of knowledge in theater and the larger world become ongoing curricular objectives. Ensemble work continues, as students get more involved in the theater making process through production. Sophomores will also choose an Option and area of focus in the Sophomore Year.

**Junior Year**
During the Junior Year the student establishes some depth in a particular area or areas of design. Design classes are rigorous and focused and encourage students to explore idea building, process and in-depth skill work. Juniors will also significantly extend their knowledge base with history classes specific to design, more skills classes and production work specific to their areas of study. Production work includes an opportunity for the first realized design and a chance to participate in crew leadership. The Junior's curricular work is broadened by an out of School of Drama elective each semester.

**Senior Year**
The Senior Year is designed to sharpen and polish the processes and skills learned in the first three years. Seniors are also involved in preparing for launching a career; resumes and portfolios will be created and any holes in the student's design process will be addressed. The core design classes continue to be intensive and even more focused. Seniors are leaders in the production process and have an opportunity to design productions supported by crews and a greater degree of material resources. The student's curricular work continues to be broadened by an out of School of Drama elective each semester.

**Production Technology and Management Program**
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 for the 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 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 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.

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, organization behavior, principles of economics, business communications and production management work. 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.

**Theatre Studies Option**
The Theatre Studies program offers students from any of the School’s conservatory areas of specialization 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 the freshmen year of the training program.

The goal of the Theatre Studies program 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 program director which reflect the students current interest. However the following requirements for core course work must also be fulfilled.

**Acting Option**

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<tr>
<th>Year 1</th>
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<tbody>
<tr>
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<tr>
<td>54-103</td>
<td>Speech I</td>
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<td>54-105</td>
<td>Voice</td>
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<td>54-107</td>
<td>Movement I</td>
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<td>Text For Actors</td>
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<tr>
<td>54-159</td>
<td>Production Preparation I</td>
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<td>54-177</td>
<td>Foundations of Drama I</td>
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<td>Critical Histories of the Arts</td>
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<td>Voice &amp; Speech II</td>
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<td>Movement II</td>
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<td>54-213</td>
<td>Singing for Actors (optional)</td>
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<tr>
<td>54-221</td>
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<td>54-259</td>
<td>Production Preparation II</td>
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<td>54-294</td>
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<td>54-303</td>
<td>Speech III Accents</td>
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<td>54-305</td>
<td>Voice III</td>
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<td>54-307</td>
<td>Movement III</td>
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<tr>
<td>54-311</td>
<td>Rehearsal &amp; Performance</td>
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<tr>
<td>54-292</td>
<td>SPIOC (optional)</td>
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<td>54-313</td>
<td>Junior Auditioning (optional)</td>
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**Spring**

<table>
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<tr>
<th>Year 1</th>
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<tbody>
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<td>Warmup</td>
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<td>Speech I</td>
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**Spring**

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<td>Auditions (optional)</td>
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**Year 4**

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<thead>
<tr>
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<tr>
<td>54-401</td>
<td>Camera Lab (mini)</td>
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<tr>
<td>54-405</td>
<td>Graduate Directing</td>
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<tr>
<td>54-407</td>
<td>Movement IV (mask/combat)</td>
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<tr>
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**Spring**

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**Music Theatre Option**

**Year 1**

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**Year 4**

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Students must complete two (2) mini semesters of History of Drama during their third and fourth year.
### Design Option

#### First Year

**Fall**
- 54-171 Basic Design 6
- 54-157 Basic PTM 6
- 54-151 Stagecraft* 15
- 54-169 Studio Craft 13
- 54-177 Foundations of Drama I 6
- TBD Arts Histories 6
- 99-101 Computing Skills Workshop 3
- 54-175 Conservatory Hour 1

**Spring**
- 54-172 Basic Design 6
- 54-158 Basic PTM 6
- 54-152 Stagecraft* 11
- 54-170 Studio Craft 8
- 54-178 Foundations of Drama II 6
- 76-101 Interpretation and Argument 9
- 54-176 Conservatory Hour 1
- Xx-xxx Non-Drama Elective ** 9

**Total:** 56

#### Second Year

**Fall**
- 54-259 Production Prep II 9
- 54-231 Design for the Stage 9
- 54-279 Introduction to Lighting Design 6
- 54-279 Production Planning 9
- 54-271 Standard Scenic Construction 6
- 54-221 Directing II 9
- 54-281 Foundations of Drama II 6

**Spring**
- 54-260 Production Prep II 12
- 54-232 Design for the Stage 9
- 54-252 Introduction to Lighting Design 6
- 54-270 Computer Apps – AutoCAD 6
- 54-330 Intro to Stage Management 6
- 54-376 Rigging Seminar 6
- 54-282 Foundations of Drama IV 6

**Total:** 51

#### Third Year

**Fall**
- Required for All Junior Design
  - 54-361 Production Prep III 12
  - 54-173 Technical Direction 9
  - 54-165 Intro to Sound in Theatre 6
  - 54-333 Production Management I 6
  - 54-475 Theatre Management 6
  - Xx-xxx Non-Drama Elective 6
  - Xx-xxx Non-Drama Elective 6
  - 54-381 History of Drama Mini if Needed (2 required)

- LIGHTING DESIGN
  - 54-349 Automated Lighting 6
  - 54-351 Lighting Design I 9
  - 54-367 Production Electrics 6
  - Xx-xxx History of Drama (if necessary) var.
  - Xx-xxx Non-Drama Elective min. 6

- COSTUME DESIGN
  - 54-341 Costume Design I 9
  - 54-343 Costume Construction I 6
  - 54-257 History of Drama (if necessary) var.
  - Xx-xxx Non-Drama Elective min. 6

- SCENE DESIGN
  - 54-237 Introduction to Scene Painting 6
  - 54-331 Scene Design I 9
  - 54-347 Figure Drawing 4
  - Xx-xxx History of Drama (if necessary) var.
  - Xx-xxx Non-Drama Elective min. 6

**Total:** 45

**Spring**
- 54-238 Introduction to Scene Painting 6
- 54-239 Scene Design I 9
- 54-xxx History of Drama (if necessary) var.
- Xx-xxx Non-Drama Elective min. 6

**Total:** 47

### Fourth Year

**Fall & Spring**
- Required for All Senior Design
  - 54-461/2 Production Preparation IV 15
  - Xx-xxx Non-Drama Elective min. 6

- LIGHTING DESIGN
  - 54-451/2 Lighting Design II 9
  - 54-xxx Drama Elective min. 6

- COSTUME DESIGN
  - 54-441/2 Costume Design II 9
  - 54-443/4 Costume Construction II 6
  - 54-xxx Drama Elective min. 6

- SCENE DESIGN
  - 54-431/2 Scene Design II 9
  - 54-xxx Drama Elective min. 6

### Directing Option

#### First Year

**Fall**
- Required for All Junior Design
  - 54-101 Acting I 9
  - 54-111 Acting II 9
  - 54-120 Acting III 9
  - 54-121 Production Planning 9
  - 54-175 Conservatory Hour 6
  - 54-177 Foundations of Drama I 6
  - 54-517* Director’s Colloquium 1
  - 64-100 Critical History of the Arts 9
  - Xx-xxx Computer Skills Workshop 3

- LIGHTING DESIGN
  - 54-012 Warmup 1
  - 54-132 Acting I 12
  - 54-210 Text Analysis 6
  - 54-122 Acting II 9
  - 54-162 Production Preparation I 9
  - 54-179 Foundations of Drama II 6
  - 54-518** Director’s Colloquium 1
  - 76-101 Interpretation and Argument (English) 9
  - Xx-xxx Non-Drama Elective min. 6

- COSTUME DESIGN
  - 54-362 Production Preparation III 6

**Total:** 49

**Spring**
- 54-012 Warmup 1
- 54-132 Acting I 12
- 54-210 Text Analysis 6
- 54-122 Acting II 9
- 54-162 Production Preparation I 9
- 54-179 Foundations of Drama II 6
- 54-518** Director’s Colloquium 1
- 76-101 Interpretation and Argument (English) 9
- Xx-xxx Non-Drama Elective min. 6

**Total:** 52

#### Second Year

**Fall**
- Required for Directors
  - 54-233 Acting for Directors 9
  - 54-221 Directing II 9
  - 54-251 Introduction to Lighting Design 6
  - 54-257 Directing: Production II, as assigned 6
  - 54-281 Foundations of Drama III 6
  - Xx-xxx Non-Drama Elective min. 6

**Total:** 51
**Spring**

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### Third Year

**Fall**

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### Fourth Year

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Total: 42

**Spring**

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<td>54-410</td>
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<tr>
<td>54-422</td>
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<tr>
<td>54-xxx</td>
<td>History of Drama (if necessary)</td>
<td>var.</td>
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<tr>
<td>54-xxx</td>
<td>One Elective</td>
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<tr>
<td>xx-xxx</td>
<td>Non-Drama Elective</td>
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Total: 36

### Theatre Studies

*(curriculum to be individually tailored)*

Units: 40 to 55 units per semester

Core Courses: History, English and CSW by the close of the sophomore year.
Electives: at least two non-drama electives per semester.
History of Drama: 6 minis required
Production: Production III & IV
Theses: 54-291/92, 9 units

### Production Assignments could involve one of the following activities:

- Production Research
- Production Promotion
- Stage Managing
- Assistant Stage Managing
- Assistant Directing
- Producing a project in corporation with another department

### Graduation Thesis

Each student will be required to give an individual creative presentation in their area of study. Any creative thesis must be thoroughly documented and formally presented. Their presentation might take many forms and could be developed through an independent study with a faculty member upon approval of the Option Head.
General Electives

The following are suggested department electives for Drama students. All other students may elect these courses only by permission of the instructor.

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<th>Course Title</th>
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<td>Introduction to Playwriting</td>
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<td>Advanced Playwriting</td>
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<td>Design for the Stage</td>
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<tr>
<td>54-239/40</td>
<td>History of Architecture and Décor</td>
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<td>54-245/46</td>
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<td>Theatre Lab</td>
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<tr>
<td>54-331/2</td>
<td>Scene Design I</td>
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<tr>
<td>54-341/2</td>
<td>Costume Design I</td>
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<tr>
<td>54-343/4</td>
<td>Costume Construction II</td>
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<td>54-431/2</td>
<td>Scene Design II</td>
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<td>54-433</td>
<td>Producing for Television</td>
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Electives for Non-Drama Department Students

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<td>54-187/8</td>
<td>Introduction to Playwriting</td>
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<td>54-189/90</td>
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<td>History of Clothing</td>
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<td>Introduction to Lighting</td>
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<td>Lighting Design I</td>
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<tr>
<td>54-475</td>
<td>Theatre Management</td>
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*Permission of Instructor Required

Faculty

BARBARA ANDERSON, Professor of Drama/Design — M.F.A., Yale University; Carnegie Mellon, 1968—.

NATALIE BAKER, Associate Professor of Voice & Speech — M.F.A. University of Pittsburgh; Carnegie Mellon, 1992—.


DICK BLOCK, Associate Head, School of Drama, Associate Teaching Professor of Design — M.F.A., Northwestern University; Carnegie Mellon, 1988—.

DAVID BOEVERS, Assistant Professor of Technical Design, Option Co-Coordinator, PTM — M.F.A. Yale University; Carnegie Mellon, 2000 —.

ELIZABETH BRADLEY, Head, School of Drama — B.F.A. Honors, York University, Toronto; Carnegie Mellon, 2001—.

JAMES CATON, Associate Teaching Professor of Dance — Carnegie Mellon, 1988—.

MICHAEL CHEMERS, Assistant Professor of Dramaturgy — Ph.D., University of Washington; Carnegie Mellon, 2004—.

JUDITH CONTE, Associate Teaching Professor of Dance — B.F.A., University of Wisconsin/ Milwaukee; Carnegie Mellon, 1978—.

THOMAS DOUGLAS, Lecturer of Music Theatre — M.M. Duquesne University; Carnegie Mellon 1991—.

JANET FEINDEL, Associate Professor of Voice/Speech/Acting/Alexander — M.F.A. in Drama, Carnegie Mellon; Carnegie Mellon, 1996—.

JED HARRIS, Associate Teaching Professor of Directing — M.F.A., Carnegie Mellon; Carnegie Mellon, 1991—.

KEVIN HINES, Lecturer of Technical Direction — M.F.A. Yale University; Carnegie Mellon, 1998—.

GEOFFREY HITCH, Associate Teaching Professor of Directing and Acting — M.F.A. Carnegie Mellon; Carnegie Mellon 1992—.

BRIAN JOHNSTON, Professor of Dramatic Literature — M.A. Honors, Cambridge University, England; Carnegie Mellon, 1986—.

MLADEN KISELOV, Professor of Directing/Acting, Option Coordinator, Directing — Honors Graduate, Moscow Theatre Institute; Carnegie Mellon, 1992—.

GARY KLINE, Associate Teaching Professor of Music Theatre — B.F.A., Carnegie Mellon; Carnegie Mellon, 1990—.


CINDY LIMAURU, Professor of Lighting Design — M.F.A., Florida State; Carnegie Mellon, 1987—.

BARBARA MacKENZIE WOOD, Associate Professor of Drama/Acting; Option Coordinator, Acting/MT — M.F.A., Carnegie Mellon; Carnegie Mellon, 1986—.

DON MARINELLI, Professor of Drama and Arts Management, Co-Director of ETC — Ph.D., University of Pittsburgh; Carnegie Mellon, 1981—.

ANTHONY LORING MCKAY, Associate Professor of Drama/Acting — B.F.A. Carnegie Mellon; Carnegie Mellon, 1985—.

CATHERINE MOORE, Associate Teaching Professor of Movement — M.F.A. University of Cincinnati, College-Conservatory of Music; Carnegie Mellon, 2000—.

ANNE MUNDELL, Associate Professor of Design; Option Coordinator, Design — M.F.A. Brandeis University; Carnegie Mellon, 1989—.

INGRID SONNICHESEN, Associate Teaching Professor of Acting — M.A. Wayne State University, Carnegie Mellon, 1995—.

MILAN STITT, Professor of Dramatic Writing, Option Coordinator, Graduate Dramatic Writing — M.F.A., Yale University; Carnegie Mellon, 1997—.

SUSAN TSU, Professor of Costume Design — M.F.A. Carnegie Mellon, 2003—

DON WADSWORTH, Professor of Drama/Voice & Speech, Associate Coordinator, Acting — M.F.A., University of Pittsburgh; Carnegie Mellon, 1989—.

KAF WARMAN, Associate Teaching Professor of Movement — M.F.A., Goddard College, Ecole
The School of Music

The mission of the School of Music is to provide an education that will produce outstanding musicians who are skilled, knowledgeable, creative and articulate. At the same time, Carnegie Mellon University offers the unique opportunity to broaden the students' educational base, while preparing them for professional careers in music. We take seriously our commitment to provide a conservatory education within a university setting. We often describe the School as The Destination for the Academically Gifted Musician.

Today's "Complete Musician" must be an entrepreneur, with a keen eye for opportunity, a solid business sense, the courage to travel around the world, and the willingness to embrace technology. We seek to create an educational environment that inspires the serious performer, composer, conductor and educator to also develop these non-musical skills.

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 Symphony Orchestra, Opera Theater, Chamber Music Society, Ballet, Mendelssohn Choir, and a host of other professional musical organizations. The Cuarteto Latinoamericano, now in its third decade in residence, has toured throughout the world and enjoys universal acclaim for its advocacy of new music. 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, Pedagogy, Music Education, Accompanying and Coaching, Diction, Acting and Movement, Literature and Repertoire, 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, Jazz Ensemble, Concert Choir, Repertory Chorus, Contemporary Ensemble, Jazz Vocal Ensemble, Opera/Music Theater Production, Repertoire Orchestra, and special orchestras devoted to Baroque and Classical repertoire. Some of the School's most outstanding and popular ensembles are instrument specific: the Percussion Ensemble, Flute Ensemble, Horn Choir, and Trombone Choir, 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, all chamber music is juried, 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 honours Philharmonic Orchestra 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, readings by the Cuarteto Latinoamericano culminating in public performance of student work, 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, and Alumni Concert Hall. 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
- Jazz Performance 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, and it can include chamber music. There are individual coaching sessions as well as practical experience in vocal studios, dance studios, 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.
Jazz Performance Minor

With an emphasis on developing the "complete musician," all performance majors are encouraged to study jazz along with their classical training. Course offerings include Jazz Studio, two Jazz Ensembles, Jazz Vocal Ensemble, Jazz Piano, Jazz Chamber Music, Jazz Ear Training, Jazz Improvisation, Jazz Arranging, Jazz Composition, Jazz History, and Jazz Transcription and Analysis. 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 - 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 century techniques, orchestration, score notation, 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, Jazz Ensemble, Concert Choir, Repertory Chorus, Jazz Vocal Ensemble, Opera/Music Theater Production, Baroque Ensemble, Contemporary Ensemble, Repertoire Orchestra, Flute Ensemble, Percussion Ensemble, Horn Choir, Trombone Choir, and various chamber groups.

5. Academics - The School of Music requires one general studies course (outside of the School) per 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 38 for jazz majors; 372 for non-major. Three units equal one credit.

Plano First Year

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<tbody>
<tr>
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<td>57-4xx Major Ensemble</td>
<td>6</td>
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<td>57-193 Skills of Accompanying I</td>
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<tr>
<td>57-152 Harmony I</td>
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<tr>
<td>57-161 Eurhythmics I</td>
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<td>57-181 Solfege I</td>
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Third Year

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**Composition**

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Dalcroze Eurhythmics Certificate 24 Units
- 57-465 Eurhythmics V 3
- 57-466 Eurhythmics VI 3
- 57-691/692 Dalcroze Pedagogy/Practice Teaching 6
- xx-xxx Creative Movement/Choreography 3
- 57-641 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

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) and have an interview with a member of the conducting faculty.

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" grades before the student can register for the advanced conducting courses.

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 36 units
- 57-152 Harmony I 6
- 57-153 Harmony II 6
- 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 I 3
- 57-192 Keyboard Studies II 3

Corequisite Course for Voice Majors 6 units
- 57-151 Principles of Counterpoint 6

Electives (choose from the following courses) 12 units
- 57-220 English Diction 3
- 57-431 Literature and Repertoire (Italian) 3
- 57-432 Literature and Repertoire (French) 3
- 57-433 Musical Theatre Literature and Repertoire 3
- 57-532 Analysis Seminar 6
- 57-533 Sound Recording 6
- 57-536 Sound Editing and Mastering 6
- 57-542 Jazz Ear Training 3

Minimum units required for Conducting Minor: 57
### Minor in Jazz Performance 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. For the audition, the student should perform two contrasting pieces and demonstrate the potential for the development of improvisatory skills.

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<table>
<thead>
<tr>
<th>Required Jazz Courses</th>
<th>24 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-xxx Jazz Ensemble or Jazz Vocal Ensemble</td>
<td>3</td>
</tr>
<tr>
<td>57-xxx Jazz Ensemble or Jazz Vocal Ensemble</td>
<td>3</td>
</tr>
<tr>
<td>57-319 Jazz Piano</td>
<td>3</td>
</tr>
<tr>
<td>57-320 Jazz Piano</td>
<td>3</td>
</tr>
<tr>
<td>57-328 Jazz Chamber Music</td>
<td>3</td>
</tr>
<tr>
<td>57-328 Jazz Chamber Music</td>
<td>3</td>
</tr>
<tr>
<td>57-450 Jazz Ear Training</td>
<td>3</td>
</tr>
<tr>
<td>57-453 Jazz Improvisation</td>
<td>3</td>
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<table>
<thead>
<tr>
<th>Required Studio Courses</th>
<th>24 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-496 Minor Studio</td>
<td>6</td>
</tr>
<tr>
<td>57-497 Minor Studio</td>
<td>6</td>
</tr>
<tr>
<td>57-498 Minor Studio</td>
<td>6</td>
</tr>
<tr>
<td>57-499 Minor Studio</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective Courses (choose 1)</th>
<th>6 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-451 Jazz Arranging</td>
<td>6</td>
</tr>
<tr>
<td>57-452 Jazz Composition</td>
<td>6</td>
</tr>
<tr>
<td>57-454 Jazz Transcription and Analysis</td>
<td>6</td>
</tr>
<tr>
<td>57-457 Jazz History I</td>
<td>6</td>
</tr>
<tr>
<td>57-458 Jazz History II</td>
<td>6</td>
</tr>
</tbody>
</table>

**Minimum units required for Jazz Performance Minor: 54**

### Minor in Music Education for Students in the School of Music

**Admission Requirements:**

1. The student should apply to the music education faculty no earlier than spring of the freshman year

<table>
<thead>
<tr>
<th>Corequisite General Courses</th>
<th>45 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-xxx Mathematics Course #1</td>
<td>9</td>
</tr>
<tr>
<td>21-xxx Mathematics Course #2</td>
<td>9</td>
</tr>
<tr>
<td>76-xxx English Literature Course</td>
<td>9</td>
</tr>
<tr>
<td>85-xxx Developmental Psychology Course</td>
<td>9</td>
</tr>
<tr>
<td>85-xxx Educational Psychology Course</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Corequisite Music Courses</th>
<th>18 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-391 Keyboard Studies V</td>
<td>3</td>
</tr>
<tr>
<td>57-392 Keyboard Studies VI</td>
<td>3</td>
</tr>
<tr>
<td>57-393 Keyboard Studies Test (education)</td>
<td>3</td>
</tr>
<tr>
<td>57-332 Introduction to Conducting</td>
<td>6</td>
</tr>
<tr>
<td>57-336 Instrumental/Choral Conducting</td>
<td>6</td>
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</table>

<table>
<thead>
<tr>
<th>General Education Courses</th>
<th>18 units</th>
</tr>
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<tbody>
<tr>
<td>57-331 Principles of Education</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Professional Education Course</td>
<td>9</td>
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</table>

<table>
<thead>
<tr>
<th>Music Education Methods Courses</th>
<th>45 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-375 Music in the Elementary School</td>
<td>6</td>
</tr>
<tr>
<td>57-356 Elementary Guided Teaching</td>
<td>3</td>
</tr>
<tr>
<td>57-376 Music in the Secondary School</td>
<td>6</td>
</tr>
<tr>
<td>57-355 Secondary Guided Teaching</td>
<td>3</td>
</tr>
</tbody>
</table>

### Applied Area Methods Courses

- 57-607 Vocal Methods | 3
- 57-359 Brass Methods | 3
- 57-361 Percussion Methods | 3
- 57-362 Woodwind Methods | 3
- 57-363 String Methods | 3
- 57-207 Secondary Studio (fretted instrument) | 3

### Band Methods Courses

- 57-334 Fundamentals of Marching Band | 3
- 57-331 Band and Choral Arranging | 6

### Music Education Teaching Courses | 15 units

- 57-608 Observation | 3
- 57-603 Practice Teaching (elementary) | 6
- 57-604 Practice Teaching (secondary) | 6

**Minimum units required for Music Education Minor: 78**

### Minor in Music Technology 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).

<table>
<thead>
<tr>
<th>Prerequisite Course</th>
<th>3 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>99-xxx Computing @ Carnegie Mellon</td>
<td>3</td>
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<table>
<thead>
<tr>
<th>Introductory Music Courses</th>
<th>18 units</th>
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</thead>
<tbody>
<tr>
<td>57-152 Harmony I</td>
<td>6</td>
</tr>
<tr>
<td>57-173 Survey of Western Music History</td>
<td>9</td>
</tr>
<tr>
<td>57-189 Repertoire and Listening for Musicians I</td>
<td>3</td>
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</table>

<table>
<thead>
<tr>
<th>Required Music Technology Courses</th>
<th>33 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-101 Introduction to Music Technology</td>
<td>6</td>
</tr>
<tr>
<td>57-337 Sound Recording</td>
<td>6</td>
</tr>
<tr>
<td>57-338 Sound Editing and Mastering</td>
<td>6</td>
</tr>
<tr>
<td>57-347 Electronic and Computer Music</td>
<td>6</td>
</tr>
<tr>
<td>57-438 Multitrack Recording</td>
<td>9</td>
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</table>

<table>
<thead>
<tr>
<th>Technical Courses (Choose 2)</th>
<th>15 units</th>
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<tbody>
<tr>
<td>Other technical courses may also be approved by the advisor for music minors.</td>
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</table>

<table>
<thead>
<tr>
<th>Required Music Technology Courses</th>
<th>66 units</th>
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</thead>
<tbody>
<tr>
<td>xx-xxx HASS Multimedia Course</td>
<td>9</td>
</tr>
<tr>
<td>15-100 Introductory/Intermediate Programming</td>
<td>10</td>
</tr>
<tr>
<td>15-229 MultiMedia Programming and Computer Science</td>
<td>9</td>
</tr>
<tr>
<td>33-114 Physics of Musical Sound</td>
<td>9</td>
</tr>
<tr>
<td>54-165 Introduction to Sound Design for Theater I</td>
<td>6</td>
</tr>
<tr>
<td>57-610 Internship</td>
<td>9</td>
</tr>
</tbody>
</table>

**Minimum units required for Music Technology Minor: 66**

### 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 24 units
57-161 Eurhythmics I 3
57-181 Solfège I 3
57-192 Harmony I 6
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)
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: 24-42

Faculty

DENNIS ABELSON, Artist Lecturer in French Horn — B.M., Duquesne University; Carnegie Mellon, 1987—.
TIMOTHY ADAMS, Associate Professor of Percussion — Carnegie Mellon, 1995—.
DOUGLAS AHLSTEDT, Associate Professor of Voice — M.M., Eastman School of Music; Carnegie Mellon, 1998—.
ALBERTO ALMARZA, Associate Professor of Flute — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991—.
EDUARDO ALONSO CRESPO, Artist Lecturer in Music History and Conducting — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1989—.
DONNA AMATO, Accompanist — Carnegie Mellon, 1998—.
EFRAIN AMAYA, Artist Lecturer in Music Theory and Resident Conductor — Carnegie Mellon, 1993—.
TOBY APPEL, Artist Lecturer in Viola — Curtis Institute of Music; Carnegie Mellon, 2002—.
LEONARDO BALADA, Professor of Composition; University Professor — Diploma, The Juilliard School of Music; Carnegie Mellon, 1970—.
JEANNE BAXTRESSER, 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 — Carnegie Mellon, 2003—.
ALVARO BITRAN, Artist-in-Residence in Cello, Cuarteto Latinoamericano — Diploma, National Conservatory of Mexico; Carnegie Mellon, 1987—.
ARON BITRAN, Artist-in-Residence in Violin, Cuarteto Latinoamericano — Diploma, National Conservatory of Mexico; Carnegie Mellon, 1987—.
SAUL BITRAN, Artist-in-Residence in Violin, Cuarteto Latinoamericano — B.M., Rubin Academy of Tel Aviv; Carnegie Mellon, 1987—.
RAY BLACKWELL, Staff Accompanist/Vocal Coach — Carnegie Mellon, 2003—.
JUDITH CAGLEY, Artist Lecturer in Solfège — Carnegie Mellon, 2006—.
GREGORY LEHANE, Professor of Drama and Music — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991—.

MIMI LERNER, Associate Professor of Voice — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1993—.

HANNA WU LI, Professor of Piano Pedagogy — M.M., Northwestern University; Carnegie Mellon, 1969—.

MARIE LIBAL-SMITH, Accompanist — M.M., Indiana University; Carnegie Mellon, 2002—.

ANTHONY LORING McKay, Professor of Drama — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1985—.

LUZ MANRIQUEZ, Associate Teaching Professor of Coaching and Accompanying — Carnegie Mellon, 1992—.

JOHN MARCINIZYN, Artist Lecturer in Guitar — Ph.D., University of Pittsburgh; Carnegie Mellon, 1991—.

SUSANNE MASEE, Artist Lecturer in Voice — Carnegie Mellon, 2000—.


WALTER MORALES, Assistant Director of Orchestral Studies — Carnegie Mellon, 2002—.

ROBERT MOYER, Artist Lecturer in Music Education — M.M., Indiana University of Pennsylvania; Carnegie Mellon, 1987—.

STEPHEN NEELY, Artist Lecturer in Eurythmics, Director of School of Music Pre-College Programs — M.M., Carnegie Mellon University; Carnegie Mellon,1998—.


JEFFREY NYTCH, Artist Lecturer in Theory — Carnegie Mellon, 2006—.

RODRIGO OJEDA, Staff Accompanist — Carnegie Mellon, 2003—.

DAVID OKERLUND, Artist Lecturer in Voice — Carnegie Mellon, 2003—.

BENJAMIN OPIE, Artist Lecturer in Music Technology — Carnegie Mellon, 2005—.

NATALIE OZES, Professor, Director of Music Education, and Associate Head, School of Music — Ed. D., University of Pittsburgh; Carnegie Mellon, 1989—.

ROBERT PAGE, Paul Mellon Professor of Music and Director of Choral and Opera Studies — M.M., Indiana University; Carnegie Mellon, 1976—.

PHILIP PANDOLFI, Artist Lecturer in Bassoon — Carnegie Mellon, 1995—.

DAVID PELLOW, Director of Jazz Studies, Lecturer in Jazz — M.M., Duquesne University; Carnegie Mellon, 1991—.

DILSHAD POSNOCK, Director, Artist Diploma Program, Artist Lecturer in Flute — Carnegie Mellon, 1999—.


DAVID PREMO, Artist Lecturer in Cello — Carnegie Mellon, 1994—.

KAREN ROETHLISBERGER, Staff Accompanist/Vocal Coach — Carnegie Mellon, 2004—.

MICHAEL RUSENOK, Artist Lecturer in Clarinet — Carnegie Mellon, 1998—.

VAHAN SARGSYGAN, Staff Accompanist — Carnegie Mellon, 2005—.

SERGEY SCHEPKIN, Associate Professor of Piano — Carnegie Mellon, 2003—.

IRENE SCHREIER, Artist Lecturer in Piano — Diploma, Konservatorium Luzern; Carnegie Mellon, 1985—.

RICCARDO SCHULZ, Associate Teaching Professor and Director of Recording Activities — M.A., University of Pittsburgh; Carnegie Mellon, 1988—.

STEPHEN SCHULTZ, Associate Teaching Professor of Music History, Conductor of CMU Baroque — Carnegie Mellon, 2002—.

FRANCO SCIANNAMO, College Distinguished Scholar in Multidisciplinary Studies — D.M., Accademia Nazionale di Santa Cecilia; Carnegie Mellon, 1990—.

LEWIS STROUSE, Associate Teaching Professor of Music Education— D.A., Ball State University; Carnegie Mellon, 1992—.

PETER SULLIVAN, Artist Lecturer in Trombone — Carnegie Mellon, 2000—.

Marilyn TAFT THOMAS, Professor of Theory and Composition — Ph.D., University of Pittsburgh; Carnegie Mellon, 1981—.

GEORGE THOMPSON, Lecturer in Dance — Carnegie Mellon, 1989—.

THOMAS THOMPSON, Associate Teaching Professor of Clarinet and Saxophone — M.M., Northwestern University; Carnegie Mellon, 1986—.

STEPHEN TOTTER, Artist Lecturer in Voice — Carnegie Mellon, 1994—.

JEFFREY TURNER, Artist Lecturer in String Bass — Carnegie Mellon, 1989—.

PAULA TUTTLE, Artist Lecturer in Cello— Carnegie Mellon, 2002—.

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—.

GEORGE VOSBURGH, Artist Lecturer in Trumpet — Carnegie Mellon, 2003—.

HAROLD WALLS, Recording Engineer — Carnegie Mellon, 1999—.

BILLIE JO MILLER WARD, Staff Accompanist — Carnegie Mellon, 1996—.

GLENN WAYLAND, Artist Lecturer in Jazz Trombone — Carnegie Mellon, 1989—.

JAMES WHIPPLE, Artist Lecturer in Theory — Carnegie Mellon, 1995—.

EARL WILD, Distinguished Artist-in-Residence — Carnegie Mellon, 1993—.

COLETTE JOUSSE WILKINS, Artist Lecturer in Solfege — First Prize, Conservatoire National de Versailles, France; Carnegie Mellon, 1974—.

DONALD WILKINS, Professor Emeritus of Organ — First Prize Paris Conservatory, Fellow American Guild of Organists, M.A., Harvard University; Carnegie Mellon, 1966—.

ANNIE MARTINDALE WILLIAMS, Artist Lecturer in Cello — Diploma, Curtis Institute of Music; Carnegie Mellon, 1987—.

JOHN WILSON, Artist Lecturer in Jazz History/Jazz Trumpet — Carnegie Mellon, 2001—.

The College of Humanities and Social Sciences
The College of Humanities and Social Sciences

John P. Lehoczky, Dean
Kristina Straub, Associate Dean
Joseph E. Devine, Associate Dean and Director, H&SS Academic Advisory Center
Undergraduate Office: Baker Hall A57
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 departments of Economics, English, History, Modern Languages, Philosophy, Psychology, Social and Decision Sciences, Statistics, and a college-wide interdisciplinary 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 180 full-time faculty.

Like its counterparts in engineering, science, computer science, business, and the fine arts, the College has three primary thrusts: undergraduate education, graduate education, and research or creative pursuits. Thus, the College shares in the University’s identity as an institution that merges first-rate, innovative research and creativity with undergraduate education. All faculty engage in both teaching and research or creative work. Undergraduates, thus, benefit from contact in the classroom with highly accomplished faculty researchers and creative artists.

For example, beginning with the College’s General Education (GenEd) program, H&SS students are taught by some of the College’s most accomplished and senior faculty. They bring with them into the classroom a contagious excitement from their active involvement at the forefront of their fields. Freshmen also select from an array of freshman seminars in which students explore exciting and topical areas of study with regular faculty in small groups of no more than 15-20 students. Sophomores and second-semester freshmen may also select a “Faculty Research Training” course which involves them in a faculty research project. These freshman/sophomore features are complemented during the junior and senior years by small elective courses, the option of overseas study, seminars and project courses, and a range of undergraduate research options (including a senior honors program) that students can pursue with regular faculty.

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.” 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 at the same time practical skills are also worthy of mastery, and of the most serious intellectual examination.

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 training. 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 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. These options provide H&SS students with a great deal of flexibility and choice in designing a program of study.

H&SS Majors

<table>
<thead>
<tr>
<th>Name of Major (Degree Options)</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economics (B.A.)</td>
<td>Economics</td>
</tr>
<tr>
<td>Economics (B.S.)</td>
<td>Economics</td>
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<tr>
<td>English (B.A.)</td>
<td>English</td>
</tr>
<tr>
<td>Creative Writing (B.A.)</td>
<td>English</td>
</tr>
<tr>
<td>Professional Writing (B.A.)</td>
<td>English</td>
</tr>
<tr>
<td>Technical Writing and Communication (B.S.)</td>
<td>English</td>
</tr>
<tr>
<td>Anthropology and History (B.A. or B.S.)</td>
<td>History</td>
</tr>
<tr>
<td>History and Policy (B.A. or B.S.)</td>
<td>History</td>
</tr>
<tr>
<td>Social and Cultural History (B.A. or B.S.)</td>
<td>History</td>
</tr>
<tr>
<td>Economics and Statistics (B.S.)</td>
<td>Interdepartmental</td>
</tr>
<tr>
<td>Environmental Policy (additional major only)</td>
<td>Interdepartmental</td>
</tr>
<tr>
<td>Ethics, History, and Public Policy (B.A. or B.S.)</td>
<td>Interdepartmental</td>
</tr>
<tr>
<td>Information Systems (B.S.) (by admission)</td>
<td>Interdepartmental</td>
</tr>
<tr>
<td>International Relations (additional major only)</td>
<td>Interdepartmental</td>
</tr>
<tr>
<td>Russian Studies (B.A.)</td>
<td>Interdepartmental</td>
</tr>
<tr>
<td>Student-Defined (B.A. or B.S.)</td>
<td>Interdepartmental</td>
</tr>
<tr>
<td>Chinese (B.A.)</td>
<td>Modern Languages</td>
</tr>
<tr>
<td>French and Francophone Studies (B.A.)</td>
<td>Modern Languages</td>
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<tr>
<td>German (B.A.)</td>
<td>Modern Languages</td>
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<tr>
<td>Hispanic Studies (B.A.)</td>
<td>Modern Languages</td>
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<tr>
<td>Japanese (B.A.)</td>
<td>Modern Languages</td>
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<td>Logic and Computation (B.S.)</td>
<td>Philosophy</td>
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<td>Philosophy (B.A.)</td>
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<td>Cognitive Science (B.S.)</td>
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<td>Psychology (B.A. or B.S.)</td>
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<tr>
<td>Psychology and Biological Sciences (B.S.)</td>
<td>Psychology</td>
</tr>
<tr>
<td>Decision Science (B.S.)</td>
<td>Social &amp; Decision Sci.</td>
</tr>
<tr>
<td>Policy and Management (B.S.)</td>
<td>Social &amp; Decision Sci.</td>
</tr>
<tr>
<td>Political Science (B.S.)</td>
<td>Social &amp; Decision Sci.</td>
</tr>
<tr>
<td>Statistics (B.S.)</td>
<td>Statistics</td>
</tr>
</tbody>
</table>
Additional Majors

Many H&SS students 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 full 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. Majors are like minors in that they consist of coherent programs of study in a department, or across departments. Minors differ from majors in the breadth and depth reflected in the number of courses required. Most H&SS majors are available as additional majors; a few are available only as additional majors. 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.

Minors

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.

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 special 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 General Education Program (GenEd) supports that expertise and ensures that students gain the well-informed perspectives 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 a complex global culture.

Broad Aims

The GenEd program provides the integrative component to a Carnegie Mellon education and extends through the entire undergraduate experience. It sets crucial cornerstones and draws important connections among different facets of the students' education. Its distinctive emphases and directions foster intellectual curiosity and encourage students to gain: wide, historically informed appreciation of the arts and humanities and sciences, broad understanding of mathematics and the experimental method, critical openness to ethical reflection and social responsibility, and an acute global and environmental awareness.

It differs sharply from more traditional liberal arts or general education programs in its emphasis on integration, not only 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 crucially 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 problems challenging our future.

Categories

To transcend narrow disciplinary confines, the program isolates five broad intellectual activities - 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 activities together with the broad indications are the bases for 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 intellectual core 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 whole, integrative educational experience: students gain expertise in their chosen discipline and exercise the integrative skills within them.

The program includes a rich variety of courses. Some classes 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. Here are, more explicitly, the themes for the different categories.

Categories

1. Communicating: Language and Interpretations - 18 units minimum (76-101 required in the 1st year)

2. Reflecting: Societies and Cultures - 18 units minimum (79-104 required in the 1st year)

3. Modeling: Mathematics and Experiments - 27 units minimum (9 from Mathematics, 9 units from Natural Science, 9 from any course listed in Modeling)

4. Deciding: Social Sciences and Values - 18 units minimum (36-201 required in the 1st year)

5. Creating: Designs and Productions - 18 units minimum

6. Plus 18 additional units from any Category

7. Computing Skills Workshop – 3 units minimum (99-101, 99-102 or 99-103 required in the 1st semester)

8. Freshman Seminar Requirement (FSR) (completed in the 1st year)

Only 18 units may be counted toward any other requirement (ex., majors, minors); courses that are listed as “prerequisites” for major and/or minor requirements are exempt from this rule. Five courses are required to be completed in the 1st year: 76-101, 79-104, 36-201, Freshman Seminar Requirement (FSR) and Computing Skills Workshop (CSW). The Freshman Seminar Requirement may not double-count toward a GenEd Category or any other requirement (ex., majors, minors). No more than 45 units may be completed in the junior/senior years (minimum 72 units completed in 1st two years).

GenEd Category 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.

76-101 Interpretation and Argument – REQUIRED – 1st year (various topics by section)

When a score of 5 on either English Advanced Placement examination is achieved, approved substitutions for 76-101 will be listed for each semester (courses may not be double-counted toward any other requirement). Non-native English speakers who are placed into 76-100, Reading and Writing in a Multicultural Setting (1st semester, 1st year) use this course as the second Category 1 course, but are required to complete 76-101, Interpretation and Argument (2nd semester, 1st year).

76-100 Reading and Writing in a Multicultural Setting
76-272 Talking Across Difference
76-318 Communicating in the Global Marketplace
76-355 The Rhetoric of Making a Difference
76-377 The Rhetoric of Fiction
76-378 Community Literacy and Intercultural Interpretation
76-387 Sociolinguistics
76-393 Rhetorical Traditions
80-180 The Nature of Language
80-181 Language and Thought
80-280 Linguistic Analysis: Syntax
80-380 Philosophy of Language *
82-101/102 Elementary French I & II *
82-103/104 French I & II online *
82-121/122 Elementary German I & II *
82-123 Directed Language Study: Elementary German I & II
82-131/132 Elementary Chinese I & II *
82-133 Elementary Chinese I online*
82-135 Intensive Elementary Chinese
82-141/142 Elementary Spanish I & II *
82-143/144 Elementary Spanish I & II online *
82-147 Accelerated Elementary Spanish
82-161/162 Elementary Italian I & II
82-170/172 Elementary Japanese I & II *
82-191/192 Elementary Russian I & II *
82-201/202 Intermediate French I & II *
82-203/204 Intermediate French I & II online *
82-221/122 Intermediate German I & II *
82-231/232 Intermediate Chinese I & II *
82-235 Intensive Intermediate Chinese *
82-241/242 Intermediate Spanish I & II *
82-243/244 Intermediate Spanish I & II online *
82-261/262 Intermediate Italian I & II *
82-271/272 Intermediate Japanese I & II *
82-291/292 Intermediate Russian I & II *
82-334 Structure in Chinese *
82-337/388 Chinese for Oral Communication I & II *
82-371/372 Advanced Japanese I & II *
82-373 Structure of the Japanese Language
82-374 Technical Japanese *
82-399 Special Topics in Russian *
82-429 German Reading and Translation Workshop *
82-442 Analysis of Spoken Spanish *
82-443 Spanish Reading and Translation Workshop *
82-444 The Structure of Spanish *
82-477 Japanese Conversation Analysis *
* co-requisite and/or prerequisite

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.

79-104 Introduction to World History – REQUIRED – 1st year
51-274 Design and Social Change
66-301 Science and Christianity: A Multidisc. Approach
76-221 Books You Should Have Read by Now
76-230 19th Century American Literature and Culture
76-231 20th Century American Literature and Culture
76-232 African-American Studies
76-233 Post-Colonial Literature
76-235 British Literature and Culture Before 1800
76-241 Introduction to Gender Studies
76-246 Media Revolutions
76-319 Environmental Rhetoric
76-330 Medieval Literary and Cultural Studies
76-331 Renaissance Literary and Cultural Studies
76-332 African American Studies
76-333 Postcolonial Studies
76-334 19th Century Literary and Cultural Studies
76-335 20th Century Literary and Cultural Studies
76-338 The American Cinema
76-343 South Asian Literature and Film
76-347 American Literature and Culture
76-349 The Lost Generation
76-353 Advanced Gender Studies
79-113 Culture and Identity in American Society
79-201 Introduction to Anthropology
79-206 Development of American Culture
79-207 Development of European Culture
79-216 The Roots of Rock and Roll
79-219 The Holocaust in Historical Perspective
79-237 Cities in History: London and Delhi
79-241/242 African-American History I & II
79-250 Europe’s Two Revolutions: Dynamics of Change
79-253 The Development of Caribbean Culture
79-256 Intro. to African History: 18th Century to Neo-Col.
79-259 Introduction to Religion
79-270 Chinese Culture and Society
79-277 Introduction to Global Agriculture (CL 99-234)
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, for example, psychology and computer science. The interactions between theorizing and experimenting (observing) can be understood within an intellectual framework that invites comparative assessment.

Mathematics (Required: complete 9 units)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-110</td>
<td>Problem Solving in Recreational Mathematics</td>
</tr>
<tr>
<td>21-111</td>
<td>Calculus I</td>
</tr>
<tr>
<td>21-112</td>
<td>Calculus II</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>21-121</td>
<td>Integration and Differential Equations</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations &amp; Approximation</td>
</tr>
<tr>
<td>21-123</td>
<td>Calculus of Approximation (5 units)</td>
</tr>
<tr>
<td>21-127</td>
<td>Concepts of Mathematics</td>
</tr>
<tr>
<td>21-256</td>
<td>Multivariate Analysis and Approximation</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus of Three Dimensions</td>
</tr>
</tbody>
</table>

* co-requisite and/or prerequisite
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.

6. University Requirement (UR) (3 units)

This course is a 3 unit mini-course, pass/no credit, completed in the 1st semester.

8. Freshman Seminar Requirement (FSR) (9 units)

This requirement ensures that all first year students entering H&SS have a small-group course experience in their first year. These seminars consist of substantive academic content drawn from the faculty members’ expertise, as well as providing a supportive environment for the enhancement of academic skills. Required of all first year H&SS students (to be completed in the first year) according to assignment by AAC Academic Advisor in the fall semester.

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

Joseph E. Devine, Associate Dean and Director
Deborah L. Gerhardt, Assistant Director and Academic Advisor
Shannon L. Young, Academic Advisor
Emily M. McCall, Academic Advisor
Office: Baker Hall A57
www.hss.cmu.edu/departments/deans_office/aac/default.html

The Academic Advisory Center (AAC) for the College of Humanities and Social Sciences 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 (GenEd) program requirements, and the various majors and minors available. Most important, advisors also support students in making a successful transition to university life. 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 it is preferred that individual appointments be made. The Center’s hours are 8:30 a.m. to 5:00 p.m., Monday through Friday.
Carnegie Mellon Children’s School
Sharon Carver, Director
Office: Margaret Morrison Carnegie Hall 17
http://www.psy.cmu.edu/childrensschool/index.html

The Children’s School is the laboratory school for Carnegie Mellon’s Psychology Department. Its goals and responsibilities include:
1) development and management of laboratories for research in developmental psychology;
2) training of undergraduate and graduate students in child development theory, research, and related applications;
3) implementation of a model half-day preschool and full-day kindergarten program for children ages 3-6;
4) provision of resources to parents;
5) provision of resources to the community of early childhood educators, and
6) training of students earning teaching certificates (in collaboration with other local colleges and universities).

The Children’s School’s approach to preschool and kindergarten education is based on theories and research in Developmental Psychology. It uses its developmental goals as a systematic framework for focusing its program and assessment design. It strives to recruit a diverse student population, both ethnically and socioeconomically, to provide a diverse subject pool for the research, broad experiences for psychology students and student teachers, and an enriched learning environment for the children and their families.

Carnegie Mellon University Press
Gerald Costanzo, Director
Office: Baker Hall 233

The Carnegie Mellon University Press was founded in 1975 by English Professor Jerry Costanzo, who runs the press with the help each year of five to seven student interns from his editing and publishing course. Two U.S. poet laureates and four Pulitzer Prize winners for poetry either started or spent some portion of their careers with the university press. In 1986, Carnegie Mellon published poet Rita Dove’s “Thomas and Beulah,” which was awarded the Pulitzer the following year. Numerous Carnegie Mellon students have launched publishing careers as a result of having worked for the press.

Since its inception, the press has published 500 books, and it currently publishes about 20 titles each year including poetry, short fiction and scholarly works authored by Carnegie Mellon faculty.

Center for the Advancement of Applied Ethics and Political Philosophy
Robert Cavalier, Director
Office: Baker Hall 15SC
http://caae.phil.cmu.edu/caae/index.html

The Center is an interdisciplinary program dedicated to advancing the field of applied ethics and political philosophy through the integration of first-quality theoretical scholarship and a discerning engagement with the practical settings in which important ethical issues arise. Research foci of the Center span a wide range of issues with special emphasis on emerging ethical issues in Bioethics and the ethical conduct of scientific research involving human subjects, business ethics, conflict resolution, and improving the responsiveness of democratic institutions to the interests of citizens with practical tools for effectuating deliberative democracy.

Recently, the Center has expanded not only its name, but its faculty and interests. Remaining firmly grounded in the interdisciplinary environment of the Philosophy Department and the University, it continues to be a leading research center. Its areas of intellectual activity now include political philosophy and social choice theory, moral theory and methodology as well as the theoretical foundations of Bio-ethics and Research ethics.

Center for Arts and Society
Director: Judith Schachter
Office: Baker Hall 242D
http://www.hss.cmu.edu/cas/

The mission of the Center for the Arts in Society is to investigate the sources of creativity and innovation in the arts in diverse societies. Scholars in the humanities and the arts collaborate to examine the impact of social, political, and technological developments on creativity and innovation in the arts and to analyze the impact of the arts on social, political, and technological developments. The Center connects the arts to one another and to the humanities as the basis for interdisciplinary theory and practice, forming an institutional hub for work that combines disciplines, fields, and approaches to the arts and humanities.

The Center for the Arts in Society has three main goals. The first is the development of new models for research in the humanities and the arts that are designed to have an impact on the current models for graduate education and professional training. The second involves establishing a theoretical framework and standards of practice through which scholarship in the arts and the humanities can transcend cultural boundaries. The third is to broaden the audience for critical and innovative work in the arts and the humanities, including citizens as well as practitioners in diverse fields.

We implement these goals by introducing new curricular programs, including a minor, and a Critical Histories of the Arts foundation course; providing material support for innovative research endeavors; and sponsoring projects that encourage dialogue among a wide range of constituents.

Center for Business, Technology, and the Environment
Joel A. Tarr, Director
David Hounshell, Associate Director
Office: Baker Hall 236C
http://www.hss.cmu.edu/departments/history/research/btectr.html

The Center for Business, Technology, and the Environment was founded in 1993 to foster interdisciplinary research in areas of economic development. The Center provides historical perspectives on critical issues facing our society. It builds upon the strong belief-reflected in both the graduate and undergraduate programs in History and Policy-that history greatly enriches our understanding of current societal problems. The Center draws upon departmental strengths in the history of technology, business history, and environmental history and brings focus to the work of its faculty and graduate students in these areas. In addition, the Center draws upon the resources of Carnegie Mellon in such related departments and professional schools as engineering, public policy, architecture, and business administration.

The Center seeks out domains and projects in which the application of historical research can help in diagnosing problems and solving them. Initial projects have addressed the economic impact of the railroad in western Pennsylvania; science and technology in the Cold War; the history of urban revitalization efforts in Pittsburgh; the history of the RAND Corporation; environmental problems stemming from the abandonment of industrial sites; the growth, decline, and realignment of industrial R&D in the Pittsburgh region; and the creation of environmental indicators for the Pittsburgh region. Financial support has come from the Sloan Foundation, the U.S. National Park Service, the National Science Foundation, the Heinz Foundation, and Duquesne Light and Power.

Center for Cognitive Brain Imaging
Marcel Just, Director
Office: Baker Hall 237H
http://coglab.psy.cmu.edu/

Our Center investigates high-level cognition such as language comprehension, problem-solving, visual thinking, and executive processes through the use of fMRI and related approaches. The general research goal is to develop a unified theory of cognition that is grounded in and accounts for brain activation in the cortex, at the level of large scale neural networks that perform cognitive
computations. In other words, the goal is to explain how thought emerges from brain function.

Our fMRI studies use state-of-the-art scanners to capture brain images during high-level cognitive processes and use computational modeling techniques (4CAPS) to explain the complex dynamic systems. The investigations also include several other approaches used in conjunction with fMRI studies, most notably, behavioral studies, eye fixation studies, and therapy studies of people with brain damage. The main applications are to the understanding and treatment of brain damage and to the enhancement of human performance in high-technology environments. The CBBI is located at Carnegie Mellon, but much of the work is collaborative between Carnegie Mellon and the University of Pittsburgh.

Center for History and Policy
Carolyn Acker, Director
Office: Baker Hall 246B
http://www.hss.cmu.edu/departments/history/research/hispolctr.html

Founded in 1990, the Center for History and Policy has played an important role in stimulating research opportunities for students in both the History and Policy and Social and Cultural History programs. More recently, the Center has introduced collaboration with community-based groups to create learning opportunities for students and research products of immediate use in the community, such as neighborhood epidemiological data, to help in public health planning. The Center also provides internship opportunities for undergraduates.

Center for the Neural Basis of Cognition
Jay McClelland, Director
Office: Mellon Institution 115
http://www.cnbc.cmu.edu/

The Center for the Neural Basis of Cognition (CNBC) is dedicated to the investigation of the neural mechanisms that give rise to human cognitive abilities, broadly construed. The outstanding faculty of the CNBC includes researchers investigating normal processes and disorders of cognition, and there is a great deal of interest in learning and development. We stress the convergent use of a wide range of methods to investigate topics ranging from sensory processing and motor control to language, semantic cognition, and reasoning.

The CNBC is a joint project of the University of Pittsburgh and Carnegie Mellon, integrating the strengths of the University of Pittsburgh in basic and clinical neuroscience with the strengths of Carnegie Mellon in psychology, computer science, biological sciences, and statistics. The Center sponsors an interdisciplinary graduate training program in collaboration with several affiliated Ph.D. programs. Our training program attracts outstanding students from around the world, and our graduates have been highly successful in finding academic research positions. The CNBC also maintains a full schedule of scientific activities, including a colloquium series, annual retreat, and internal student and faculty presentation series.

Educational Computing
Kimberly Jordan Daboo, Director of Computing
Office: Baker Hall 154

H&SS has its own Director of Computing, houses a number of its own computer facilities, and sponsors a number of educational computing initiatives. Together these represent the College’s commitment to the effective use of computers as essential tools in instruction, research, and administration. Facilities accessible to students consist of personal computers, some of which are connected to one or more local networks, and all of which are also connected to the University’s centrally supported campus network. These central systems connections include “Andrew,” the computing environment jointly developed by Carnegie Mellon University and IBM. The College’s Director of Computing is responsible for communicating with the College community about the information and skills necessary to utilize available computing resources; advising students and members of the faculty on the use of computers; training; solving problems; suggesting programs, applications, and data possibilities; and staying abreast of new developments in the field of educational computing in general and the Carnegie Mellon campus in particular. These activities are coordinated with related programs of the University’s Academic Services Division, Office of Technology Education, Computing Services, the School of Computer Science, the Statistics Department, the Psychology Department, and the Laboratory for Computational Linguistics.

H&SS Honors Program
Office of the Associate Dean
Office: Baker Hall A57
www.hss.cmu.edu/aac/honors

From its inception in 1982, the H&SS 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 QPA of at least 3.50 in the major and 3.25 overall, departmental recommendation, and endorsement by a faculty sponsor. Honors Students enroll in an honors course for both the Fall and Spring semesters of the senior year. Upon successful completion of the honors thesis, an H&SS Honors 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. The annual growth in the number of student participants in the program, the diversity of the topics investigated and the breadth of interest across departments attest to the popularity and impact of the program. In the opportunity it provides to demonstrate one’s abilities for achievement at this level, it comprises an experience that helps significantly in presenting oneself to prospective employers or graduate programs.

Humanities Center
David Shumway, Director
Office: Baker Hall 145D
http://www.hss.cmu.edu/humanitiescenter/

The Humanities Center at Carnegie Mellon University supports and encourages study, research, and interest in the humanities, the disciplines that study human culture and its products. The center sponsors lectures, colloquia, panel discussions, and other events designed to promote understanding and knowledge of the humanities in the Carnegie Mellon community. Interdisciplinary conferences and research seminars allow for the production and dissemination of original research and new approaches to the humanities. It is particularly interested in sponsoring work that spans the divide between the humanities and the sciences. In the future, the Center expects to offer internal and external fellowships.

The Humanities Center is one part of the Humanities Initiative, an ambitious plan by the College of Humanities and Social Sciences to develop and expand the humanities at Carnegie Mellon. Humanities Center programs often augment the curriculum of the Humanities Scholars Program, a rigorous, four-year interdisciplinary program open by invitation to H&SS applicants. It also collaborates with the Center for the Arts in Society.

Humanities Scholars Program
Timothy Haggerty, Director
Office: Baker Hall 154R
http://www.hss.cmu.edu/hsp/

The Humanities Scholars Program (HSP) is an undergraduate initiative to foster superior academic work within the College of Humanities and Social Sciences. Program officers work with admissions and advising to select a cohort of scholars who have a special interest or affinity in the humanities as they are conceptualized at the university. These scholars are invited into a program that includes a shared set of classes as well as a residential component during the first year.
As practiced within its four departments - English, history, philosophy and modern languages - the humanities at Carnegie Mellon provide broad reflexive 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 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 humanities and disciplinary approaches (representative HSP seminars can be viewed on the website). The program projects, rather than replaces, a major or minor course of study, and HSP courses help fulfill breadth requirements, including the freshman seminar requirement and selected General Education requirements within the college.

While in the program, scholars also participate in extracurricular events on campus and in the community that may include talks by visiting scholars, theater performances, conferences, and exhibits that highlight the importance of humanistic inquiry and its relevance in public discourse.

In their third year at the university, scholars fulfill a methodology requirement in their major or minor that can be applied to the humanities. This requirement familiarizes scholars with critical issues in different disciplines and exposes them to the processes through which knowledge is created and conserved. In addition, scholars are expected to begin conceptualizing a capstone project that will be completed during their last year in the program. Thanks to a generous gift, the HSP can support modest research expenses for these projects.

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 interdisciplinary standpoints.

The Laboratory for Symbolic and Education Computing Fellowships

Contact: Dr. Joseph Ramsey
Office: Baker Hall 135
http://www.hss.cmu.edu/philosophy/labs-lsec.php

Each year The Laboratory for Symbolic and Education Computing (LSEC) supports several Carnegie Mellon undergraduates interested in participating in LSEC projects. Such participation can take place over the summer or during the academic year. If appropriate progress is made, projects beginning in the summer can be extended through (parts of) the following academic year, and projects begun in the fall can be extended through the spring and summer.

LSEC Fellows can elect to receive either course credit for independent research or a stipend. Applicants must have an appropriate faculty sponsor for their projects, and we highly recommend collaborating with a faculty member on the application.

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 an innovative program that is designed to enable talented students to develop an undergraduate curricular 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 base from which students can select a major in either the College of Humanities and Social Sciences or the Mellon College of Science.

Some 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

The College of Humanities and Social Sciences and the Mellon College of Science share a common commitment to providing students with professional experiences through independent studies or research with distinguished faculty members. Both share an interest in fostering the interdisciplinary, critical thinking and problem-solving skills that lead to success.

Study Abroad Scholarships
http://www.hss.cmu.edu/departments/deans_office/aac/scholarships_studyabroad.html

The Dean's Office for the College of Humanities and Social Sciences is pleased to offer the following scholarships to encourage study abroad.

The Brona Stein Buerger Scholarship

These annual scholarships will provide funds for up to one or 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 will receive preference. This award has been given in memory of Brona Stein Buerger, Margaret Morrison class of 1962.

The Hannah Estermann Bergman Travel Fund

This annual scholarship will provide funds for up to one H&SS student who is currently studying Spanish. Preference will be 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.

Alumni Travel Scholarship

Multiple scholarships are awarded each year to H&SS, BHA, and SHS students to be used toward a semester or full year of study in an accredited program of study abroad. Current sophomores and juniors will receive preference. These funds are generously provided by H&SS Alumni.

H&SS Summer Internship Opportunity Grants
http://www.hss.cmu.edu/departments/deans_office/aac/scholarships_summer.html

H&SS encourages students to find and undertake interesting internship opportunities for their summer employment. We understand that many of these opportunities are unpaid, or, at best, provide minimal pay. Yet it is often these very positions that provide students with first-rate, challenging work experiences that are invaluable in helping them define and move forward to their career goals.

We have instituted the H&SS Summer Internship Opportunity Grants Program to make it more possible for students to take
advantage of less remunerative, worthwhile internship opportunities. Grants of up to $2,000 per internship are available.

Who is eligible? Undergraduates with primary majors in H&SS, BHA and SHS and strong academic records are encouraged to apply. Current sophomores and juniors will receive preference. NOTE: Graduating seniors are not eligible to compete.

How to locate internship opportunities? Students are expected to find their own internships. There are many available resources open to them through the Career Center and TartanTrak; in their own particular schools and departments; and through experiences to 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**

Connie Angermeier, Advisor
Office: Porter Hall 208

As part of its internship offerings, Carnegie Mellon is one of a number of universities throughout the nation which participate in "The Washington Semester Program," a cooperative arrangement with The American University in Washington, D.C. Students are selected by each of the participating colleges to spend a semester in the nation's capital. The program consists of study through a seminar; an elective course or an individual research project; and an internship at one of the hundreds of Washington-based organizations. Programs are available in the following areas: American Politics; Economic Policy; Foreign Policy; International Business and Trade; International Environment and Development; Journalism; Justice; Law Enforcement; Peace and Conflict Resolution; Public Law; and Transforming Communities. More information can be found on their website: www.american.edu/washingtonsemester/

**Academic Standards and Regulations**

**Transferring into H&SS**

All undergraduate students in other Carnegie Mellon colleges who wish to transfer into H&SS must first declare their intent to enroll and meet the minimum semester and cumulative requirements for good academic standing. Students are encouraged to apply early as admissions are based on individual student performance and are not determined purely by formula. Thus, a student who achieves a 2.00 quality point average may be placed on probation for a very erratic performance; and in special circumstances, College Council may drop or suspend a student without prior probation.

**Academic Actions**

In order to maintain good academic standing, students in the College must meet the minimum semester and cumulative requirements 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.

The relation indicated above between probation, suspension and drop is not automatic in all cases. These "academic actions" are based on individual student performance and are not determined purely by formula. Thus, a student who achieves a 2.00 quality point average may be placed on probation for a very erratic performance; and in special circumstances, College Council may drop or suspend a student without prior probation.

**H&S Dean’s Honor List**

Each semester the College recognizes those students who have attained outstanding academic records by naming them to the College’s Dean’s List. H&S students are eligible for the Dean’s List who complete a minimum of 45 factorable units of work with a quality point average of at least 3.50 and with no conditional grades (I, X) at the time final grades are recorded.

Students who attain a minimum semester GPA of 3.50 through 3.74 are named to the Dean’s List, with Honors; students who attain a minimum semester GPA of 3.75 or higher are named to the Dean’s List, with High Honors.

Those who have completed 36 to 45 factorable units and attain a minimum semester GPA of 3.75 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; it usually means registering for more than 50 units per semester. Eligibility for overloading is defined as having a GPA of 3.00 (or higher) in the last completed semester and a current cumulative GPA of 3.00 (or higher). Eligibility does not automatically allow the student to register for more than 50 units; eligible students must be granted special permission through completing a Petition to Carry an Overload.

H&S students form and meeting with the student’s primary academic advisor to discuss overloading. If approved, online processing of the unit increase is through the academic advisor.
All petitions approved before the posting of final grades for the semester preceding the overload semester are subject to revocation if the student does not achieve a 3.00 semester QPA (or higher). It is the student's responsibility to discuss this matter with their academic advisor.

Physical Education, StuCo and Military Science Courses
A maximum combination of nine units of credit for Physical Education, StuCo and all Military Science courses may be counted for credit toward graduation as free electives in any H&SS program. 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.”

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: Freshman Seminar courses 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 by 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 official QPA.

Internships-for-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.

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 may be able to earn academic credit. Each department in the College that allows its majors to earn academic credit for an internship has a statement that describes its internship policies and practices. Each department has a coordinator (or a committee) that approves, administers and monitors departmentally sponsored internships. Each department determines how (and if) an internship may be applied to its curriculum for fulfilling course requirements (i.e., whether as a required course, 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)

A H&SS student may not earn more than 18 units of internship credit during a semester or count more than 27 units of internship credits toward fulfilling graduation requirements. An internship-for-credit is a graded experience. Each department, through its monitoring committee, 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 off campus 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 student 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 these courses in the H&SS General Education Program:

- 76-101, Interpretation and Argument (or 76-100) from H&SS GenEd Category 1
- 79-104, Introduction to World History from H&SS GenEd Category 2
- 30-201, Statistical Reasoning from H&SS GenEd Category 4
- FSR, Freshman Seminar
- CSW, Computing Skills Workshop

Exceptions
These limits do not apply to credits approved through Advanced Placement Examinations, International Baccalaureate Examinations, Cross-Registration through PCHE, Washington Semester program, Study-Abroad, or Exchange and Education-Abroad courses. Exceptions to these restrictions may be made only by way of written petition to the H&SS College Council (c/o the Academic Advisory Center).

Grades
Courses taken elsewhere must be taken for a grade of A, B or C (not Pass/Fail). A “C-” grade is not a transferable when it is equivalency is below a 2.00 or 70%. Grades do not transfer and do not affect the Carnegie Mellon semester or cumulative QPA.

External Transfer Students
For students entering CMU/H&SS as external transfers, the same five course limit applies until and unless their transfer credits reach the 180 unit ceiling stipulated by college policy. The college has a residency requirement of a minimum of 180 CMU units. If a degree have 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 into H&SS.

Students on Suspension
Students on 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. Clearance to take these courses for credit should be approved in advance.

H&SS Department Limits
H&SS academic departments do not exceed these college limits, but may impose stricter limits regarding courses 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, the College permits double-counting requirements 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.
The College requires that an additional major be based on at least six independent courses, excluding prerequisites, and a minor based on at least five independent courses ("independent courses" are courses not counted toward any other program requirement).

Graduation Requirements
Eligibility for graduation in H&SS requires that a student:

1) complete all General Education (GenEd) 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 after the 1st year,
4) complete 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 no more than eight years from the date units completed toward the undergraduate degree were earned.

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 (application required) qualify for graduation with "H&SS College Honors."

Student-Defined Program
Joseph E. Devine, Associate Dean
Office: Baker Hall A57, H&SS Academic Advisory Center

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 (c/o the H&SS Academic Advisory Center). 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.
H&SS Interdepartmental Majors

The Major in Economics and Statistics

Faculty Advisor: Oded Meyer.
Office: Baker Hall 232C

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 to advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics. Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills - especially those in economics, finance, education, and public policy.

Curriculum

I. Prerequisites - 65 units

1. Writing Prerequisite 9 units
Choose one:
73-270 Professional Writing for Economics
76-270 Writing in the Professions
76-271 Intro to Professional and Technical Writing

2. Mathematical Foundations 38 units
21-120 Differential and Integral Calculus
21-122 Integration, Diff Equations, and Approximations
21-256 Multivariate Analysis and Approximation
21-241 Matrix Algebra

3. Statistical Foundations 18 units
36-201 Introduction to Statistical Reasoning and Practice*
and one of the following:
36-202 Introduction to Statistical Methods
36-208 Regression Analysis (cross listed as 70-208)
36-309 Experimental Design for Behavioral & Social Sciences

* Acceptable equivalents for 36-201 are 36-207, 36-220, 36-247.

II. Disciplinary Core 108 units

1. Economics Core 36 units
73-150 Introduction to Micro Economics
73-200 Macroeconomics
73-251 Economic Theory
73-261 Econometrics

2. Statistics Core 36 units
36-225 Introduction to Probability and Statistics I
36-226 Introduction to Probability and Statistics II
36-401 Modern Regression
36-402 Advanced Data Analysis (Project Course)

3. Economics Electives 18 units
Choose two courses.

4. Statistics Electives 18 units
Choose two courses at the 36-300 level or above.

Total number of units for the major 173 units
Total number of units for the degree 360 units

Sample Program

The following sample program illustrates one (of several) 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 comment following the schedule).

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>21-120</td>
<td>21-122</td>
</tr>
<tr>
<td></td>
<td>36-201</td>
<td>36-202</td>
</tr>
<tr>
<td></td>
<td>-----</td>
<td>73-150</td>
</tr>
<tr>
<td>Sophomore</td>
<td>21-256</td>
<td>21-241</td>
</tr>
<tr>
<td></td>
<td>36-225</td>
<td>36-226</td>
</tr>
<tr>
<td></td>
<td>73-200</td>
<td>73-251</td>
</tr>
<tr>
<td>Junior*</td>
<td>36-401</td>
<td>36-402</td>
</tr>
<tr>
<td></td>
<td>73-261</td>
<td>Stats Elective</td>
</tr>
<tr>
<td></td>
<td>Writing Req.</td>
<td>Econ Elective</td>
</tr>
<tr>
<td>Senior</td>
<td>Stats Elective</td>
<td>Econ Elective</td>
</tr>
</tbody>
</table>

* 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.
Interdepartmental majors are administered by the academic department of the major's faculty advisor.

Additional Major in Environmental Policy

Peter Madsen, Faculty Director
Office: Baker Hall 161F

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 students as an additional major. It is administered by an interdepartmental commit-tee, with Peter Madsen, of the Philosophy Department, 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 47-56 units

Two courses in calculus (e.g., 21-111/112 or 21-121/256)
Two courses in statistics (e.g., 36-201 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 courses are recommended, although not required, to complete: 73-100 Principles of Economics or 88-110 Experiments in Economics.

Research and Analytical Methods 18 units

79-200 Historical Evidence and Interpretation
or
85-340 Research Methods in Social Psychology

73-251 Economic Theory

Theory and Context 54-57 units

Required 45-48 units

66-210 Science and Technology for the Environment
or
79-346 International Environmental Law and Policy
or
90-792 Environmental Decision Making
80-340 Environmental Ethics and Decision Processes

Required Electives 9-12 units

Complete one course in one of the following areas:

Science and Technology

12-100 Introduction to Civil and Environmental Engineering
12-251/252 Introduction to Environmental Engineering
12-651 Air Quality Engineering
12-651 Environmental Engineering: Air Pollution
19-101 Introduction to Engineering and Public Policy
19-321 Law and Technology
19-422 Radiation, Health, and Policy
19-448 Science, Technology, and Ethics
19-622 Sustainability (6 units)
623 Environmental Management (6 units)
24-424 Energy-Environmental Systems
(also listed as 19-424)
42-424 Biological Transport

* particularly extensive prerequisites; not to be taken by students whose primary major is in CIT

Humanities

76-319 Environmental Rhetoric
76-395 Science Writing
76-476 The Rhetoric of Science
79-384 Medicine and Society
80-244 Management, Environment and Ethics

Social Sciences

19-446 Quantitative Risk Analysis
73-251 Economic Theory
73-358 Economics of the Environment and Natural Resources
85-241 Social Psychology
88-220 Policy Analysis I (if not taken in the required category)
88-221 Policy Analysis II
88-223 Decision Analysis and Decision Support Systems
88-302 Behavioral Decision Theory
88-425 Politics of Economic Deregulation
90-765 Cities, Technology and the Environment
90-767 Climate Change, Energy Policy and Sustainable Development
90-773 Technology, Environment and Economic Development
90-789 Sustainable Community Development
90-798 Environmental Policy & Planning

Evaluation and Design 12 units

19-451 Engineering and Public Policy Projects (pre-approved sections);
or
88-222 Policy Analysis III (pre-approved sections);
or
79-410 History and Policy Project (pre-approved sections)
The Major in Ethics, History, and Public Policy

Faculty Director: Preston Covey, Department of Philosophy
Office: Baker Hall 150A

Preparing students for leadership positions is a vital goal of colleges and universities in every democratic and technologically advanced society. The intellectual challenges facing public and private sector leaders expand dramatically each year, and there will be a compelling need in 21st century America for broadly educated, ethically sensitive, and technically skilled public servants. They will have to demonstrate sophisticated interdisciplinary knowledge, historical understanding of how modern-day problems have evolved, and an operational grasp of clear, rational criteria for ethical decisionmaking. The major in Ethics, History, and Public Policy seeks to provide students with a solid humanistic and social-scientific foundation for developing such high-level leadership capabilities. It also provides ample room for specialization, technical skill development, and internship experience in a wide range of policy areas.

Curriculum

Offered jointly by the Departments of History and Philosophy, the Ethics, History, and Public Policy major is offered for either a B.A. or a B.S. degree, or as an Additional Major (see below). The requirements for either degree or for an additional major include a minimum of 117 units (thirteen 9-unit courses) divided into History and Philosophy Core Courses (72 units) and Elective Track courses (45 units). An Internship Option may be taken Pass/Fail for 9 units of academic credit by students who qualify (with a 3.0 overall QPA, a 3.25 QPA in their EHPP major, and with pre-approval by the Internship Coordinator). Students interested in an internship for academic credit should consult the policy and information at http://www.hss.cmu.edu/departments/history/under/internships.html. No Pass/Fail course (e.g. 79-505) may count toward any major requirement. Only one course for an EHPP major may double count toward another major or minor. Two courses for an EHPP major may double count towards the 2004 H&SS General Education requirements.

Bachelor of Science Option 18 units

Complete two of the following courses. None may double count for an H&SS General Education requirement.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-257</td>
<td>Models &amp; Methods for Optimization</td>
<td>(Prerequisite 21-256)</td>
</tr>
<tr>
<td>36-303</td>
<td>Samplings, Surveys, &amp; Society</td>
<td>(Prerequisites include 36-201)</td>
</tr>
<tr>
<td>36-207</td>
<td>Probability &amp; Statistics for Business</td>
<td>(Prerequisites: 21-116 or 21-121)</td>
</tr>
<tr>
<td>36-208</td>
<td>Regression Analysis</td>
<td>(Prerequisites: 36-207 or 21-116 or 21-121)</td>
</tr>
<tr>
<td>80-222</td>
<td>Measurement &amp; Methodology</td>
<td>(Prerequisite: 21-228)</td>
</tr>
<tr>
<td>80-305</td>
<td>Rational Choice</td>
<td>(Prerequisites: 36-226 or 36-202 or 36-217)</td>
</tr>
<tr>
<td>80-316</td>
<td>Pragmatic &amp; Artificial Intelligence</td>
<td>(Prerequisites: none)</td>
</tr>
</tbody>
</table>

Or: Any Gen Ed 3. Modelling: Mathematics & Experiments course option not used to fulfill that requirement.

Internship Option 9 units

79-505 Undergraduate Internship Pass/Fail Only

For an internship to receive academic credit it must be pre-approved by the History Department Internship Coordinator. Consult the policy and information on internships at http://www.hss.cmu.edu/departments/history/under/internships.html.

History Core Courses 36 units

1) Complete one of the following courses in American history.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-204</td>
<td>20th Century America</td>
</tr>
<tr>
<td>79-206</td>
<td>Development of American Culture</td>
</tr>
<tr>
<td>79-240</td>
<td>Recent United States History, 1945-Present</td>
</tr>
</tbody>
</table>

2) Complete one of the following courses in policy history/social history.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-202</td>
<td>The History of Public Policy in the United States</td>
</tr>
<tr>
<td>79-230</td>
<td>Technology in American Society</td>
</tr>
<tr>
<td>79-242</td>
<td>African American History II</td>
</tr>
<tr>
<td>79-256</td>
<td>Biology and Society</td>
</tr>
<tr>
<td>79-309</td>
<td>The Politics of American Military Recruitment: Historical Perspective</td>
</tr>
<tr>
<td>79-331</td>
<td>Crime and Punishment in American Society</td>
</tr>
<tr>
<td>79-332</td>
<td>Juvenile Delinquency: Images, Realities &amp; Shaping Public Policy</td>
</tr>
<tr>
<td>79-333</td>
<td>History of Biomedical Research</td>
</tr>
<tr>
<td>79-335</td>
<td>Drug Use &amp; Drug Policy</td>
</tr>
<tr>
<td>79-336</td>
<td>Epidemic Disease &amp; Public Health</td>
</tr>
<tr>
<td>79-338</td>
<td>Childhood, Education, &amp; Social Reform in American History</td>
</tr>
<tr>
<td>79-345</td>
<td>American Environmental History</td>
</tr>
<tr>
<td>79-384</td>
<td>Medicine &amp; Society</td>
</tr>
<tr>
<td>79-205</td>
<td>20th Century Europe</td>
</tr>
<tr>
<td>69-207</td>
<td>Development of European Culture</td>
</tr>
<tr>
<td>79-233</td>
<td>The United States &amp; the Middle East Since 1945</td>
</tr>
<tr>
<td>79-253</td>
<td>Development of Caribbean Culture</td>
</tr>
<tr>
<td>79-258</td>
<td>Intro to African History: 18th Century to Neocolonialism</td>
</tr>
<tr>
<td>79-271</td>
<td>Modern China</td>
</tr>
<tr>
<td>79-281</td>
<td>Russian History: From Communism to Capitalism</td>
</tr>
<tr>
<td>79-288</td>
<td>Bananas, Baseball, &amp; Borders: Latin America &amp; the U.S. from the Alamo to the Drug Wars</td>
</tr>
<tr>
<td>79-289</td>
<td>Society &amp; Culture in South Asia</td>
</tr>
<tr>
<td>79-290</td>
<td>Between Revolutions: The Development of Modern Latin America</td>
</tr>
<tr>
<td>79-383</td>
<td>African History: From the Slave Trade to the Present</td>
</tr>
<tr>
<td>79-397</td>
<td>Religion &amp; Politics in the Middle East</td>
</tr>
</tbody>
</table>

3) Complete one of the following courses in international history

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-422</td>
<td>Radiation, Health, &amp; Policy</td>
</tr>
<tr>
<td>19-424</td>
<td>Energy &amp; the Environment</td>
</tr>
<tr>
<td>19-426</td>
<td>Environmental Decision Making</td>
</tr>
</tbody>
</table>

4) Complete one other course from the options under (2) or (3).

Philosophy Core Courses 36 units

1) Complete one of the following ethics courses.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-130</td>
<td>Introduction to Ethics</td>
</tr>
<tr>
<td>80-230</td>
<td>Ethical Theory</td>
</tr>
<tr>
<td>80-256</td>
<td>Modern Moral Philosophy</td>
</tr>
</tbody>
</table>

2) Complete one of the following courses in political philosophy

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-135</td>
<td>Introduction to Political Philosophy</td>
</tr>
<tr>
<td>80-235</td>
<td>Political Philosophy</td>
</tr>
<tr>
<td>80-256</td>
<td>Moral Philosophy</td>
</tr>
</tbody>
</table>

3) Complete one of the following courses in applied philosophy/applied ethics.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-136</td>
<td>Social Structure, Public Policy, &amp; Ethical Dilemmas</td>
</tr>
<tr>
<td>80-221</td>
<td>Philosophy of Social Science</td>
</tr>
<tr>
<td>80-236</td>
<td>Philosophy &amp; Law</td>
</tr>
<tr>
<td>80-241</td>
<td>Professional Ethics</td>
</tr>
<tr>
<td>80-242</td>
<td>Conflict &amp; Dispute Resolution</td>
</tr>
<tr>
<td>80-246</td>
<td>The American Criminal Justice System: Ideals &amp; Realities</td>
</tr>
<tr>
<td>80-247</td>
<td>Health, Development, &amp; Human Rights</td>
</tr>
<tr>
<td>80-321</td>
<td>Causation and Social Policy</td>
</tr>
<tr>
<td>80-346</td>
<td>Value, Fact, &amp; Policy</td>
</tr>
</tbody>
</table>

4) Complete one other course from any of the options above.

Elective Tracks 45 units

Complete 45 units (five 9-unit courses) from one of the two Elective Tracks below: Social Policies; or, Business & Economic Policies. New or other courses similar to those below might be offered that may be counted with the permission of your advisor.

Social Policies Track

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-319</td>
<td>Law &amp; the Engineer</td>
</tr>
<tr>
<td>19-321</td>
<td>Law &amp; Technology</td>
</tr>
<tr>
<td>19-422</td>
<td>Radiation, Health, &amp; Policy</td>
</tr>
<tr>
<td>19-424</td>
<td>Energy &amp; the Environment</td>
</tr>
<tr>
<td>19-426</td>
<td>Environmental Decision Making</td>
</tr>
<tr>
<td>19-448</td>
<td>Science, Technology, &amp; Ethics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-361</td>
<td>Foundations of Law</td>
</tr>
<tr>
<td>70-363</td>
<td>Law in Modern American Society</td>
</tr>
<tr>
<td>70-413</td>
<td>Conflict Resolution: Negotiation &amp; Mediation</td>
</tr>
<tr>
<td>73-354</td>
<td>Law &amp; Economics</td>
</tr>
<tr>
<td>73-356</td>
<td>Political Economy of Public Institutions</td>
</tr>
<tr>
<td>73-357</td>
<td>Regulation: Theory &amp; Policy</td>
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</tbody>
</table>
Sample Elective Track Concentrations

Students may, if they wish, concentrate their Elective Track courses in a topical area of special interest to them. The following four sample concentrations are illustrated with course options under the Social Policies Elective Track. The Business & Economic Policies Elective Track similarly accommodates special-interest concentrations, for example concentrations emphasizing international business and economic policies, or environmental policy. Students specially interested in International Relations are well advised to pursue the International Relations additional major or minor along with the EHPP major and to choose an EHPP Elective Track and concentration consonant with their International Relations interests. Only one course taken for the EHPP major may be double counted for any additional major or minor.

**Business & Economic Policies Elective Track**

<table>
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<tr>
<td>73-358</td>
<td>Economics of the Environment &amp; Natural Resources</td>
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<tr>
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<td>Benefit-Cost Analysis</td>
</tr>
<tr>
<td>73-476</td>
<td>American Economic History</td>
</tr>
<tr>
<td>79-230</td>
<td>Technology in American Society</td>
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<tr>
<td>79-242</td>
<td>African American History II</td>
</tr>
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<td>79-243</td>
<td>A History of American Urban Life</td>
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<tr>
<td>79-244</td>
<td>Pittsburgh and the Transformation of Modern American Industry</td>
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<tr>
<td>79-256</td>
<td>Biology &amp; Society</td>
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<tr>
<td>79-268</td>
<td>Racial Violence in America</td>
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<tr>
<td>79-281</td>
<td>Modern Soviet History: From Communism to Capitalism</td>
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<tr>
<td>79-288</td>
<td>Bananas, Baseball, &amp; Borders: Latin America &amp; the United States from the Alamo to the Drug Wars</td>
</tr>
<tr>
<td>79-330</td>
<td>The American Presidency</td>
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<td>Crime &amp; Punishment in American Society</td>
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<td>79-332</td>
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<td>History of Biomedical Research</td>
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<td>79-334</td>
<td>Drug Use &amp; Drug Policy</td>
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<td>79-345</td>
<td>American Environmental History: Critical Issues</td>
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<td>80-246</td>
<td>The American Criminal Justice System: Realities &amp; Ideals</td>
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<td>80-247</td>
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<td>Rationality &amp; Values in Democracy</td>
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<td>Elections, Interest Groups, &amp; Public Policy</td>
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**Law & Social Policy Elective Track**

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<td>Public Finance</td>
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<td>Political Economy of Public Institutions</td>
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<td>73-357</td>
<td>Regulation: Theory &amp; Policy</td>
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<tr>
<td>73-358</td>
<td>Complex Technological Systems: Past, Present, and Future</td>
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<td>73-359</td>
<td>Benefit-Cost Analysis</td>
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<td>73-360</td>
<td>Industrial Organization</td>
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<td>73-371</td>
<td>International Trade</td>
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<td>73-372</td>
<td>International Money &amp; Finance</td>
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<td>International Economics &amp; Politics</td>
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<td>American Economic History</td>
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<td>79-230</td>
<td>Technology in American Society</td>
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<td>79-345</td>
<td>American Environmental History: Critical Issues</td>
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<td>79-358</td>
<td>Economics of the Environment &amp; Natural Resources</td>
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<td>Causation &amp; Social Policy</td>
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<td>Environmental Ethics &amp; Decision Processes</td>
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<td>Computers, Society, &amp; Ethics</td>
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<td>Law &amp; Public Policy</td>
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**Environmental Policy Elective Track**

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<td>Management, Environment, &amp; Ethics</td>
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<td>Health, Development &amp; Human Rights</td>
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<td>80-248</td>
<td>Health Psychology</td>
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<td>Causation &amp; Social Policy</td>
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<td>80-340</td>
<td>Environmental Ethics &amp; Decision Processes</td>
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<td>Computers, Society, &amp; Ethics</td>
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<td>Ethics &amp; Oppression</td>
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**Criminal Justice Policy Elective Track**

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<td>Juvenile Delinquency: Images, Realities, &amp; Shaping Public Policy</td>
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<tr>
<td>79-333</td>
<td>History of Biomedical Research</td>
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<td>79-334</td>
<td>Medicine &amp; Society</td>
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<td>79-335</td>
<td>Drug Use &amp; Drug Policy</td>
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**Health Policy Elective Track**

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<td>79-335</td>
<td>History of Biomedical Research</td>
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<td>79-336</td>
<td>Drug Use &amp; Drug Policy</td>
</tr>
<tr>
<td>79-337</td>
<td>Epidemic Disease &amp; Public Health</td>
</tr>
<tr>
<td>79-344</td>
<td>Medicine &amp; Society</td>
</tr>
<tr>
<td>79-350</td>
<td>The Politics of American Military Recruitment: Historical Perspective</td>
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<tr>
<td>79-331</td>
<td>Crime &amp; Punishment in American Society</td>
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<td>79-332</td>
<td>Juvenile Delinquency</td>
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<td>79-333</td>
<td>History of Biomedical Research</td>
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<td>79-334</td>
<td>Medicine &amp; Society</td>
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<td>Drug Use &amp; Drug Policy</td>
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**Biology & Society Elective Track**

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<td>Biology &amp; Society</td>
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<tr>
<td>79-336</td>
<td>Drug Use &amp; Drug Policy</td>
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<tr>
<td>79-337</td>
<td>Epidemic Disease &amp; Public Health</td>
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<td>Health, Development &amp; Human Rights</td>
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Ethics, History, and Public Policy
Sample Curriculum

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<td>Elective Track Course</td>
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<tr>
<td>Core Requirement in History or Philosophy</td>
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</table>

The above sample program is presented as a two-year (junior-senior year) plan for completing EHPP major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their 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.

Additional Major

All Ethics, History, and Public Policy requirements for an additional major are the same as those for non-B.S. degree candidates whose primary major is EHPP. Only one course may double count for both a student’s EHPP additional major and the student’s primary major.

The Major in European Studies

Beryl Schlossman, Professor of French; European Studies Advisor

Europe constitutes a vital part of our cultural heritage and has been a source of both great creativity and massive devastation in the modern era. The European Studies program seeks to enhance students’ understanding of the historical evolution and contemporary dimensions of European society, politics, and culture. It aims as well to train students in an area of growing national need and professional opportunity. It offers an interdepartmental major that furnishes students with substantive knowledge of western European society through two approaches. First, it provides a solid 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 offered as 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.

The Major in European Studies 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

Language courses are to be completed in the same language: 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 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 course in a 400-level language course 9 units
82-4xx 400-level language course

2. Core Courses in History 27 units

Required Course 9 units
79-207 Development of European Culture

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. 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

79-250 Two Revolutions: Dynamics of Change in Nineteenth Century Europe
79-261 Europe after the Black Death
79-263 Riots, Revolts, and Revolutions
79-307 The Anthropology of Europe

Modern Languages

French:
82-406 The European Union
82-415/416 Topics in French and Francophone Studies

German:
82-424 The New Germany
82-427 Nazi and Resistance Culture

Spanish:
82-441 Studies in Peninsular Literature and Culture Art
60-350 Michelangelo and Renaissance Art
60-377 Picasso and the 20th Century

English
76-231 Studies in British Literature and Culture
76-331 Renaissance Literary and Cultural Studies
76-336 Irish Writers

New courses will be added as appropriate.
European Studies (B.A.)

Sample Curriculum

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<thead>
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<td>400-level Language Course 82-4xx</td>
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<td>Pre-20th Century European Course 79-2xx/3xx</td>
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<td>Elective</td>
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</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed within two years. Students may enter their major, and begin major course requirements, as early as the start 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 223G, rweinberg@cmu.edu
Program Advisor: Stephen Pajewski
Office: Porter Hall 100B, sp4@andrew.cmu.edu
Faculty: C.F. Larry Heimann, Kevin Stolarick

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 study the organizational, technological, economic and societal aspects of computer-based information systems, and learn how these elements work together to affect real outcomes. Students completing the program will be well grounded in the fundamentals of organization theory, decision-making, teamwork and leadership, understanding and organizing complex problems, and research methods as well as develop in depth knowledge of current and emerging information systems methodologies and technologies. Graduates of the Program are ideally situated to take a leading role in managing and shaping our information-based future.

IS 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 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 organizational, managerial and societal needs for better information management and decision making.

IS students are well prepared to pursue graduate work in information systems, business administration, technology management and policy, human-computer interaction, and other related areas. Because of the broad training received within the IS fields and H&SS curricula, IS students are also positioned to pursue graduate degrees in some disciplinary fields of the social and behavioral sciences or in the humanities, as well. For students interested in master’s-degree-graduate work at Carnegie Mellon, there are various possibilities, including accelerated Masters of Information Systems Management (MISM) and Masters of Business Administration (MBA) programs. 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 five courses), students learn the basic skills necessary to analyze, design, implement and test information systems using current and emerging organizational and technological practices. Two of the Professional Core courses are project-based experiences in which small teams of students must develop and communicate solutions to real information problems.

In the Disciplinary Core (consisting of four courses), students study four areas that are fundamental to understanding and solving problems in information systems: organizations, decision sciences, research methods and professional communications. The organizations area emphasizes how groups of people can organize and coordinate their behaviors to perform complex tasks. The decision sciences area focuses on the necessary skills for understanding, structuring and computerizing decision-making at individual and organizational levels. The research methods area illuminates the process of gathering, summarizing, evaluating and presenting empirical data. The professional communications area develops skills in the most effective methods for presenting information.

IS students must also complete three courses within one Content Area. The Areas are designed to complement the depth provided by the Professional Core and the breadth provided by the Disciplinary Core by providing an opportunity to gain additional depth in a focused area. Currently, eight Content Areas are available: (1) Organizations, (2) Decision Science and Rational Choice, (3) Research Methods, (4) Professional Communications, (5) Business/Economics, (6) Computers and Cognition, (7) Technology, and (8) Global Systems.

Transfer to Information Systems

Only IS students are allowed to enroll in the Professional Core courses, and IS students have enrollment priority in all IS electives. The target class size of these courses is determined annually by the College. If the target size is not met by existing IS students, then additional students may be admitted to the IS major as transfer students and are required to begin the Professional Core courses during the next available semester. (IS students are currently admitted directly into IS as incoming freshmen.) Students who are accepted as transfers to the IS program can complete the requirements of the degree in two years with careful scheduling. Applications for admission to the major will be considered at the end of each semester. Students interested in applying for admission 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. Most students who study abroad do so in their sophomore or senior years, although study abroad is possible in the spring of the junior year as well. The only semester study abroad is difficult is the fall of junior year due to the professional core requirements of 67-271 and 67-272. 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. No course used to fulfill the requirements of the major can be used to fulfill the requirements for any other major or minor nor used more than once to meet the requirements of this major without prior approval from the Information Systems Program.

Prerequisites

The prerequisites common to all Information Systems majors are presented below. All prerequisites must be successfully completed prior to the start of fall semester, junior year.

Mathematics 20 units

Complete any of the following three calculus sequences:
- 21-111 Calculus I
- 21-112 Calculus II
- 21-120 Differential and Integral Calculus
- 21-256 Multivariate Analysis and Approximation
- 21-120 Differential and Integral Calculus
- 21-122 Integration, Differential Equations, and Approximation

Computer Programming 10-19 units

Units needed to fulfill this requirement category vary based on placement into the appropriate initial programming course from the programming placement test results.

- 15-100 Introductory/Intermediate Programming (10 units)
- 15-200 Advanced Programming/Practicum (9 units)
- 15-111 Intermediate/Advanced Programming (10 units)

Professional Core 51 units

Complete all five courses.

- 67-250 The Information Systems’ Milieux (or 67-344, Organizational Intelligence in the Information Age, used as a substitution for IS transfer students)
- 67-272 Application Design and Development (prerequisites: 67-250 or 67-344 and 15-200 or 15-111)
- 67-475 Information Systems Applications (prerequisite: 67-373)

Disciplinary Core 36 units

Complete one course from each of the four Disciplinary Core categories.

1. Organizations

The focus of this area is on how organizations, ranging from small groups of individuals to society at large, can be transformed by information technology. Students will develop a greater understanding of how to create effective information systems to meet key organizational needs, and how social policy can influence this outcome. Such knowledge can be readily applied by students pursuing careers in both the private and public sectors.

Complete one course:

- 67-344 Organizational Intelligence in the Information Age
- 70-311 Organization Behavior
- 70-341 Organizational Communication
- 70-342 Managing Across Cultures
- 70-414 Technology-Based Entrepreneurship
- 88-260 Organizations
- 88-341 Organizational Communication

2. Decision Science and Rational Choice

This area focuses on the decision making component of information systems, taking into account the social, political, and ethical issues in an information-driven society. This area builds on the analytic rigor of the social sciences and the enduring normative questions of philosophy to promote a critical understanding of the way that information technologies shape the contemporary world.

Complete one course:

- 73-251 Economic Theory
- 80-211 Arguments and Inquiry
- 80-305 Rational Choice
- 80-341 Computers, Society and Ethics
- 88-220 Policy Analysis I
- 88-223 Decision Analysis and Decision Support Systems

3. Research Methods

Understanding how data and information are acquired is an important first step to solving information problems. Moreover, discerning the patterns and trends in data can help guide an organization’s information strategy. Research methods provide a basis for students seeking to understand these fundamental issues.

Complete one course. (It is recommended that this requirement be completed by the end of the sophomore year.)

- 36/70-208 Regression Analysis
- 36-202 Statistical Methods
- 36-303 Sampling, Survey and Society
- 36-309 Experimental Design for Behavioral and Social Sciences
- 80-222 Measurement and Methodology
- 88-251 Empirical Research Methods

4. Professional Communications

These courses help information systems designers understand how the structure and presentation of information affects how well (and how easily) it can be understood and used. In addition, information systems professionals are often called to facilitate communications between software engineers and non-technical business clients; consequently, the most successful information systems professionals are typically those with strong communication skills.

Complete one course. (It is recommended that this requirement be completed by the junior year.)

- 36-315 Statistical Graphics and Visualization
- 70-340 Business Communications
- 70-343 Interpersonal Communication
- 70-345 Oral Communications
- 70-346 Written Communications
- 76-270 Writing in the Professions
Content Area: 27 units

Complete 27 units from a combination of IS Electives and one Content Area with a maximum of 9 units of IS Electives counting toward this requirement. With 9 units of IS electives, a minimum of 18 units from a Content Area are necessary, or with 6 units of IS electives, at least 21 units from a Content Area are needed. If none of the IS Electives are selected, all 27 units are to be from one of the eight Content Areas. Some courses in these Content Areas are the same as courses in the Disciplinary Core. A single course can only be used once to fulfill a Disciplinary Core or Content Area requirement.

A note on scheduling and availability: the courses listed for the Content Areas below are generally offered with some regularity. However, some courses may not be offered every year or enrollment priority may be given to declared majors or minors. Also, infrequently offered courses that would qualify for a Content Area may be available in a specific semester. Many of the courses in the Content Areas also have prerequisites. In most cases the prerequisites are also listed in the same Content Area, are part of the Disciplinary or Professional Core, are acceptable to fulfill General Education requirements, or may be taken as part of a minor or second major. Students are advised to confer with the Information Systems program advisor and maintain some flexibility in selecting courses from their Content Area.

Information Systems Electives

A maximum of 9 units of the 27 required for any of the eight Content Areas can be IS electives.

- 67-301 Networks and Telecommunications
- 67-304 Database Design and Implementation
- 67-305 Application Software Development in .NET
- 67-320 Special Topics in Information Systems
- 67-325 Global Systems Delivery Models
- 67-390 Independent Study in Information Systems
- 67-xxx Other IS Electives (as approved by the IS program)

A. Organizations

The focus of this content area is on how organizations, ranging from small groups of individuals to society at large, can be transformed by information technology. Students will develop a greater understanding of how to create effective information systems to meet key organizational needs, and how social policy can influence this outcome. Such knowledge can be readily applied by students pursuing careers in both the private and public sectors.

Complete courses to bring total to 27 units (generally three courses)

- 15-390 Entrepreneurship for Computer Science
- 45-392 Human Behavior in Organizations
- 45-453 Organizational uses of information systems
- 67-344 Organizational Intelligence in the Information Age
- 70-311 Organizational Behavior
- 70-341 Organizational Communication
- 70-342 Managing Across Cultures
- 70-414 Technology-Based Entrepreneurship
- 79-342 Technology, Organization, and Information
- 88-260 Organizations
- 88-341 Organizational Communication
- 88-354 Economics and Psychology of Organizational Communication
- 88-367 Computers and Organizations

B. Decision Science and Rational Choice

This area focuses on the decision making component of information systems, taking into account the social, political, and ethical issues in an information-driven society. We need to understand the technical complexities of economic, political, and statistical analysis, but we have also to reflect on basic moral and political values. This area builds on the analytic rigor of the social sciences and the enduring normative questions of philosophy to promote a critical understanding of the way that information technologies shape the contemporary world.

Complete courses to bring total to 27 units (generally three courses)

- 19-448 Science, Technology and Ethics
- 36-350 Data Mining
- 73-251 Economic Theory
- 80-211 Arguments and Inquiry
- 80-230 Ethical Theory
- 80-305 Rational Choice
- 80-341 Computers, Society, and Ethics
- 80-405 Game Theory
- 88-220 Policy Analysis I
- 88-223 Decision Analysis and Decision Support Systems
- 88-302 Behavioral Decision Making
- 88-385 Managerial Decision Making

C. Research Methods

Understanding how data and information are acquired is an important first step to solving information problems. Moreover, discerning the patterns and trends in data can help guide an organization’s information strategy. Research methods provide a basis for students seeking to understand these fundamental issues.

Complete courses to bring total to 27 units (generally three courses)

- 36-202 Statistical Methods
- 36/70-208 Regression Analysis
- 36-350 Data Mining
- 36-303 Sampling, Surveys, and Society
- 36-309 Experimental Design for Behavioral & Social Science
- 36-310 Fundamentals of Statistical Modeling
- 36-401 Modern Regression
- 36-410 Introduction to Probability Modeling
- 36-46x Topics Courses in Statistics
- 70-208 Regression and Forecasting
- 70-481 Market Research
- 80-222 Measurement and Methodology
- 80-316 Probability and Artificial Intelligence
- 80-321 Causation and Social Policy
- 88-251 Empirical Research Methods

D. Professional Communications

These courses help information systems designers understand how the structure and presentation of information affects how well (and how easily) it can be understood and used. Students become fluent in both electronic and print-based media and learn the fundamentals of visual, verbal, and on-line publication. In addition, information systems professionals are often called to facilitate communications between software engineers and non-technical business clients; consequently, the most successful information systems professionals are typically those with strong communication skills.

Complete courses to bring total to 27 units (generally three courses)

- 36-315 Graphics and Visualization
- 51-247 Color and Communication
- 51-251 Digital Prototyping
- 51-261/262 Communication Design Fundamentals
- 70-340 Business Communications
- 70-343 Interpersonal Communication
- 70-345 Oral Communications
- 70-346 Written Communications
- 76-270 Writing in the Professions
- 76-318 Communicating in the Global Marketplace
- 76-373 Argument
- 76-382 Multimedia Authoring I
- 76-383 Multimedia Authoring II
- 76-389 Grammar of Standard English
- 76-390 Style
- 76-391 Document Design
- 76-395 Science Writing
- 76-479 Marketing, Public Relations, and Corporate Communications
- 76-481 Writing for Multimedia
- 76-487 On-line Information Design (76-488 lab section not required)
- 76-491 Software Documentation
- 80-291 Issues in Multimedia Authoring

Registration for course requires prior acceptance into the Design Minor.
E. Business/Economics
Information systems professionals who understand the nature of business and the financial considerations facing today's companies provide great value to their organizations. The courses within this content area are designed to broaden a student's knowledge in business and economics and to allow them to be as adept working with business clients as they are with software engineers.

Complete courses to bring total to 27 units (generally three courses)

21-292 Operations Research I
21-380 Introduction to Mathematical Modeling
21-393 Operations Research II
21-420 Continuous-Time Finance
36-410 Stochastic Modeling
70-201 Professional and Service Projects
70-332 Business and Society
70-368 Intellectual Property and E-Commerce
70-371 Production and Operations Management
70-381 Marketing
70-391 Finance
70-401 Management Game
70-414 Technology-Based Entrepreneurship
70-459 Distributed Virtual Business
70-460 Mathematical Models for Consulting
70-471 Logistics and Supply Chain Management
73-251 Economic Theory
73-325 Experimental Foundations of Equilibrium
73-359 Benefit-Cost Analysis
73-469 Economics of E-commerce
79-230 Technology in American Society
79-440 The Rise of Industrial Research and Development
79-441 Science, Technology, and Business in U.S. History
80-241 Ethical Judgments in Professional Life
80-335 Philosophy, Politics, and Economics
88-223 Decision Analysis and Decision Support Systems
88-345 Rise of Industrial Research and Development

F. Computers and Cognition
The area of computers and cognition explores questions of how people think and learn, how computers affect the human learning process, and technology—it is the latter that is in the greatest state of flux. This content area allows students to focus on a particular area of technology that has special interest for them.

Complete courses to bring total to 27 units (generally three courses)

05-410 Introduction to Human-Computer Interaction Methods
05-411 Cognitive Modeling
05-430 Programming Usable Interfaces
05-431 Software Architectures for User Interfaces
15-381 Artificial Intelligence
15-482 Human Language Technologies
39-648 Wearable Computer Design
51-241 How People Work: Human Factors
51-421 Visual Interface Design
80-271 Philosophy and Psychology
80-300 Minds, Machines, and Knowledge
85-211 Cognitive Psychology
85-213 Human Information Processing and Artificial Intelligence
85-370 Perception
85-392 Human Expertise
85-393 Human Factors
85-408 Visual Cognition
85-411 Cognitive Processes & Problem Solving
85-412 Cognitive Modeling
85-417 Intelligent Computer-Assisted Instruction

† Registration for course requires prior acceptance into the Design Minor.

G. Technology
Of the three components of information systems—people, process, and technology—it is the latter that is in the greatest state of flux. This content area allows students to focus on a particular area of technology that has special interest for them.

Complete courses to bring total to 27 units (generally three courses)

03-310/410 Introduction to Computational Biology
05-331 Building Virtual Worlds
09-560 Molecular Modeling and Computational Chemistry
15-211 Fundamental Data Structures and Algorithms
15-212 Principles of Programming
15-213 Introduction to Computer Systems
15-312 Foundations of Programming Languages
15-354 Computational Discrete Mathematics
15-384 Robotic Manipulation
15-385 Computer Vision
15-410 Operating System Design and Implementation
15-411 Compiler Design
15-412 Operating System Practicum
15-415 Database Applications
15-418 Parallel Computer Architecture and Programming
15-441 Computer Networks
15-451 Algorithm Design and Analysis
15-462 Computer Graphics
15-463 Rendering and Image Processing
15-493 Special Topic: Computer Game Programming
15-499 Media Technology
15-505 Special Topic: Animation Art and Technology
15-681 Artificial Intelligence: Machine Learning
16-311 General Robotics
16-362 Mobile Robot Programming Laboratory
16-363 Advanced Mobile Robot Programming
17-651 Models of Software Systems
18-240 Fundamentals of Computer Engineering
18-447 Introduction to Computer Architecture
33-241 Introduction to Computational Physics
51-442 Integrated Product Development
60-414-422 Advanced Electronic Time-based Art
67-304 Database Design and Implementation
67-305 Application Software Development in .NET
85-419 Introduction to Parallel Distributed Processing

H. Global Systems
The rise of global project management and systems development increases the need for information systems professionals to develop skills essential for participating in the international marketplace. This content area exposes students to contemporary issues and practices facing organizations, managers and individuals working on a global scale across political, cultural, temporal and geographic boundaries.

Complete courses to bring total to 27 units (generally three courses)

15-391 Technology Consulting in the Community
15-502 Technology for Developing Communities
67-325 Global Systems Delivery Models
67-326 Global Project Management
70-365 International Trade and International Law
70-430 International Management
70-480 International Marketing
73-371 International Trade and Economic Development
73-372 International Money and Finance
76-318 Communicating in the Global Marketplace
76-386 Language and Culture
76-442 Communication across Cultures
79-270 Chinese Culture and Society
79-271 Modern China
79-288 Latin America and the United States from Alamo to Drug Wars
79-289 Society and Culture in South Asia
79-290 Between Revolutions: The Emergence of Modern Latin America: 1789-1917
79-350 Theories of International Relations
79-374 Women in Modern India
79-386 The Global Environment: Historical Perspectives and Policy Dilemmas
82-333 Introduction to Chinese Language and Culture
82-383 Introduction to Second Language Acquisition
82-433 Topics in Contemporary Culture in China
82-487 On Writing in a Second Language
85-375 Cross Cultural Psychology
88-326 International Relations
88-327 Politics of Economic Development
88-352/79-346 International Environmental Law and Policy
88-359 Globalization
88-378 International Economics
**Information Systems, B.S. Sample Curriculum**

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<thead>
<tr>
<th>Freshman Year</th>
<th>Sophomore Year</th>
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<tbody>
<tr>
<td>Fall</td>
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<tr>
<td>H&amp;SS First Year Requirement</td>
<td>Information Systems Milieux 67-250</td>
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<tr>
<td>Statistical Reasoning 36-201</td>
<td>Elective</td>
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<td>Calculus Sequence I</td>
<td>Elective</td>
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<td>Programming 15-100</td>
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<td>Comp Skills Wrkshp &amp; IS Freshman Wrkshp</td>
<td>IS Freshman Colloquium 67-101</td>
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**Junior Year**

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<td>Application Design and Development 67-272</td>
<td>Content Area Course</td>
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<td>Disciplinary Core Course</td>
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**Senior Year**

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**Information Systems, B.S. Sample Curriculum with Study Abroad Option**

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<td>IS Freshman Colloquium 67-101</td>
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**Senior Year**

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**Junior Year**

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Study abroad can also be done in either the senior year or spring of junior year, but is discouraged in the fall of junior year.
The Additional Major in International Relations

Faculty Advisor: Kiron K. Skinner
Office: Baker Hall 240

The demise of the cold war had important intellectual effects. They include a redefinition of international relations; a dissolution of disciplinary boundaries, leading to more productive discussions of international relations between social scientists and those in the humanities; a closer investigation of the interaction of politics, culture, and markets; and a focus on the role of non-state actors in international outcomes.

The International Relations Major addresses these scholarly projects by providing a set of core competencies in political science, other types of social science analysis, foreign language, and cultural analysis. Students concentrate in the social science aspects of international relations, gaining knowledge in a range of theories and methodologies, or in the cultural aspects of the field, examining the role of beliefs, culture, religion, and race in interstate and intra-state behavior.

The International Relations Major is currently available exclusively as a second major to be pursued in conjunction with a disciplinary major in H&SS or another college.

The departments of Social and Decision Sciences, History, and Modern Languages jointly offer the International Relations Major.

All students in the program are encouraged to complete one semester of study abroad. Requirements in the major will be adapted accordingly.

Curriculum

The courses listed below are offered with general regularity. Participating departments may subsequently develop and offer other courses that are deemed appropriate for this major. The Undergraduate Advisor should be consulted, especially when the schedule of courses for a given semester becomes available, to identify such additional courses.

**Core Courses** 18-27 units

Complete 79-231/88-329; 79-350/88-326; and one 200-level course in Modern Languages (unless you fulfill the language requirement via another option listed below).

**History (9 units)**

79-231/88-329 American Foreign Policy, 1945-Present

**Social and Decision Sciences (9 units)**

88-326/79-350 Theories of International Relations

**Modern Languages**

Demonstration of basic competency in a foreign language via one of the three options listed below:

1) Complete one (1) Modern Languages course at the 200 level, with a minimum grade of C, or
2) Achieve a score of 4 or higher in one foreign language Advanced Placement examination, or
3) Demonstrate equivalent proficiency to the satisfaction of the department of Modern Languages

**Track 1: Social Science** 72 units

Complete the course requirements listed below in sections A, B, and C.

**Section A (9 units)**

88-205 Comparative Politics
88-357 Comparative Foreign Policy: China, Russia, and the U.S.

**Section B (18 units)**

Complete two (2) of the courses listed below in Business Administration, Economics, History, or Social and Decision Sciences.

70-343 Managing Across Cultures
70-365 International Trade and International Law
70-370 International Management
73-371 International Trade and Economic Development
73-372 International Money and Finance
79-220 Early Christianity
79-248 History, and Theory of Property: Land, Bodies, Ideas and Information
79-256 Biology and Society: Evolution, Animal Experimentation and Eugenics
79-259 Introduction to Religion
79-263 From Soil to Oil: Energy, Ecology and Globalization
79-301 Ritual Culture and Identity
79-303 Visual Anthropology
79-308 The Politics and Culture of Memory
79-330 The American Presidency
79-336 Epidemic Disease and Public Health
79-340 History of Modern Warfare
79-342 Science, Technology and Society
79-344 Science, Technology and the Cold War
79-348 Objects of Value
79-364 Art, Anthropology and Empire
79-440 Rise of Industrial Research and Development
88-270 International Organizations
88-280 The New European Union: Old Europe, New Europe and the U.S.
88-314 Politics Through Film
88-352/79-346 International Environmental Law and Policy
88-359 Globalization
88-378 International Economics
88-382/79-365 Climate Change, Energy Policy and Environmental Protection

**Section C (45 units)**

Complete five (5) courses in non-U.S. history or international politics in two different regions of the world; minimum of two courses in each region. The aim is to achieve sufficient command of at least two different international settings to make possible well-grounded comparisons.

**Africa**

79-258 Introduction to African History: 18th Century to Neo-Colonialism
79-267/268 Pre-Colonial West African History 1100-1800 (6 units)
79-294 The Making of the African Diaspora in the New World
79-356 Introduction to African History: Earliest Times to the Origins of the Slave Trade

**Asia**

79-237 Cities in History: Delhi and London
79-253 The Development of Caribbean Culture
79-254 The Pacific Islands: History and Culture
79-261 A History of Asian Americans in the United States
79-270 Chinese Culture and Society
79-271 Modern China
79-275 Religious Identities and Religious Conflicts in Nineteenth Century Europe
79-278 China’s Environment: Past and Present
79-283 East Asia and WWII
79-289 Development of South Asian Culture and Society
79-374 Women in Modern India

**Europe**

79-205 20th Century Europe
79-214 18th Century European History
79-219 The Holocaust in Historical Perspective
79-221 Christendom Divided: The Protestant and Catholic Reformation 1450-1650
79-237 Cities in History: Delhi and London
79-250 Europe’s Two Revolutions: Dynamics of Change in 19th Century
79-251 Flesh and Spirit: Early Modern Europe, 1400-1800
79-255 Irish History
79-275 Religious Identities and Religious Conflict in Nineteenth Century Europe
79-295 Germany and World War II
79-307 The Anthropology of Europe
79-310 Modern Spain: Culture, Politics and Society
79-319 The City and the Country in Modern Europe
79-333 History of Biomedical Research
79-376 Making of the Modern Family
82-323 Germany, Austria, Switzerland in the 20th Century
82-324 Contemporary Germany, Austria, Switzerland

Latin America/Caribbean
79-253 The Development of Caribbean Culture
79-260 Mayan America
79-288 Bananas, Baseball, and Borders: Latin America and the US from Alamo to Drug Wars
79-290 Between Revolutions: The Development of Modern Latin America
82-445 U.S. Latino Literature
88-383 Latin America in the New International System

Middle East
79-233 The United States and the Middle East Since 1945
79-299 U.S. - Arab Encounters (12 units)
79-352 The Arab-Israeli Condition: War and Peace
79-397 Religion and Politics in the Middle East

Russia
79-280 Russian History from the First to the Last Tsar
79-281 Russian History: From Communism to Capitalism
79-282 The Soviet Union in World War II: Military, Political, and Social History
79-284 Family and Gender in Russian History
79-314 Nationalities and the New States of the Former USSR
79-354 Stalin and Stalinnism

Track 2: Comparative Cultures 72 units

Complete the course requirements listed on the following page in sections A, B, & C.

Section A (18 units)
Complete two courses in a foreign language at the 300-level or higher, with a minimum grade of C.

Section B (27 units)
Complete three (3) courses in non-U.S. history, international politics, or literature in a country or region of the world in which the student’s foreign language is widely spoken. The aim is to achieve in-depth command of a non-U.S. culture via study of its language, cultural and political history, and cultural products.

Africa
79-258 Introduction to African History: 18th Century to Neo-Colonialism
79-267 Pre-Colonial West African History 1100-1800 (6 units)
79-268 From the Local to the Global: Africa in the World (6 units)
79-294 The Making of the African Diaspora in the New World
79-356 Introduction to African History: Earliest Times to the Origins of the Slave Trade
82-304 The Francophone World
82-404 Francophone Realities: Africa
82-410 Advanced Research in French Francophone Studies

Asia
79-225 Religions of China
79-236 Eighteenth Century China Through Literature
79-237 Cities in History: Delhi and London
79-247 East Asians in Film
79-253 Development of Caribbean Culture
79-254 Pacific Islands: History and Culture
79-270 Chinese Culture and Society
79-271 Modern China
79-283 East Asia and WWII
79-289 Development of South Asian Culture and Society
79-374 Women in Modern India
82-273 Introduction to the Japanese Language and Culture
82-276 Japanese Literature in Translation
82-333 Introduction to Chinese Language and Culture
82-433 Topics in Contemporary Culture in China
82-434 Studies in Chinese Traditions
82-474 Topics in Japanese Studies II: Samurai, Kamikaze, Totoro

Europe
79-205 20th Century Europe
79-207 Development of European Culture
79-214 18th Century European History
79-219 The Holocaust in Historical Perspective
79-220 Early Christianity
79-221 Christendom Divided: The Protestant and Catholic Reformations, 1450-1650
79-237 Cities in History: Delhi and London
79-251 Flesh and Spirit: Early Modern Europe, 1400-1800
79-275 Religious Identities and Religious Conflicts in Nineteenth-Century Europe
79-295 Germany and World War II
79-307 The Anthropology of Europe
79-310 Modern Spain: Culture, Politics, and Society
79-318 Protest, Propaganda, and the Public Sphere, 1500-1800
79-319 The City and Country in Modern Europe
79-324 Modern Painting
79-325 Art and Religion
79-368 Poverty, Charity, and Welfare (6 units)
79-396 Making of the Modern Family
79-396 Music and Society in 19th/20th Century Europe and the U.S.
82-303 French Culture
82-305 French in Its Social Contexts
82-323 Germany, Austria and Switzerland in the 20th Century
82-324 Contemporary German, Austria and Switzerland
82-325 Introduction to German Studies
82-342 Spain: Language and Culture
82-345 Hispanic Literary and Cultural Studies
82-396 The Faust Legend at Home and Abroad
82-401 French Popular Song
82-407 The Arts in Society
82-408 Matisse, Chagall, Picasso and Their Contemporaries: Art and Museums on the Riviera
82-410 Advanced Research in French Francophone Language and Culture
82-415/416 Topics in French Francophone Studies
82-421 German Literature of the Nineteenth Century
82-422 German Literature of the Early Twentieth Century
82-424 The New Germany
82-425 Topics in German Literature and Culture
82-426 Topics in German Literature
82-427 Nazi and Resistance Culture
82-428 History of German Film
82-441 Studies in Peninsular Literature and Culture
82-444 The Structure of Spanish
82-446 Political Drama of Spain
88-314 Politics through Film

Latin America/Caribbean
79-253 The Development of Caribbean Culture
79-260 Mayan America
79-290 Between Revolutions: The Development of Modern Latin America
82-343 Latin America: Language and Culture
82-344 U.S. Latinos: Language and Culture
82-345 Hispanic Literary and Cultural Studies
82-441 Studies in Peninsular Literature and Culture
82-442 Analysis of Spoken Spanish
82-445 U.S. Latino Literature
82-450 Advanced Research in Hispanic Language and Culture
82-451 Studies in Latin American Literature and Culture
82-452 The Latin American Fin de Siglo: Modernity, Modernismo and Underdevelopment
82-453 Voices from Within: The Crisis of Latin American Identity
82-454 The Hispanic Caribbean: Rhyme, Reason and Song
82-455/456 Topics in Hispanic Studies
82-457 Contemporary Latin American Texts: Revision, Rewriting, and Representation

Middle East
79-233 United States and the Middle East Since 1945
79-299 US-Arab Encounters (12 units)
79-352 The Arab-Israeli Condition: War and Peace
79-397 Religion and Politics in the Middle East

Russia
79-280 Russian History from the First to the Last Tsar
79-281 Russian History: From Communism to Capitalism
79-282 The Soviet Union in World War II: Military, Political, and Social History
79-284 Family and Gender in Russian History
79-314 Nationalities and the New States of the Former USSR
79-354 Stalin and Stalinnism

82-293 Introduction to Russian Culture
82-294 Topics in Russian Language and Culture
**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 has been central to the history of the twentieth century, influencing 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 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 new questions in the areas of business, science, technology, national defense and international security. The end of the Cold War allows 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 administered 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.

- 79-280 Russian History from the First to the Last Tsar*
- 79-281 Modern Soviet History from Communism to Capitalism*

* Both courses are recommended.

#### 2. Required Electives in History 18 units

Complete two courses. (Substitutions be permission)

- 79-282 Soviet Union in World War II: Military and Political History
- 79-344 The Cold War and Beyond

The Language and Culture Curriculum 45 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)
- 82-192 Elementary Russian II (or demonstrated equivalent)

#### 4. Core Courses in Modern Languages 27 units

- 82-291 Intermediate Russian I
- 82-292 Intermediate Russian II
- 82-391 Advanced Russian I

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 "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
- 79-231 American Foreign Policy: 1945-Present
- 79-280 Russian History from the First to the Last Tsar
- 79-281 Russian History
- 79-282 Soviet Union in World War II: Military and Political History
- 79-344 Science and Technology and the Cold War

**Modern Languages**

- 82-296 A Century of Russian Film
- 82-392 Advanced Russian II
- 82-396 The Faust Legend at Home and Abroad
- 82-397 Russia’s Demons
- 82-399 Special Topics: Russian
- 82-491 Literature, Politics and Film in Russia & Eastern Europe Today
- 82-492 The Historical Imagination in Nineteenth-Century Russian Literature

New courses will be added as appropriate.

#### 6. Required Independent Research 3-6 units

Complete one course.

- 82-599 Russian Studies Thesis

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. 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.

<table>
<thead>
<tr>
<th>Junior Year Fall</th>
<th>Spring</th>
<th>Senior Year Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate Russian I 82-291</td>
<td>Intermediate Russian II 82-292</td>
<td>Advanced Russian I 82-391</td>
<td>Russian Studies Thesis 82-599</td>
</tr>
<tr>
<td>Core Course in History 79-280/281</td>
<td>Required Elective in History</td>
<td>Required Elective</td>
<td>Required Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Required Elective</td>
<td>Elective</td>
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</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

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.).

Student-Defined Major Program
Joseph E. Devine, Associate Dean, H&SS Academic Advisory Center
Office: Baker Hall A57

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. The procedure for establishing such a major centers on a written proposal, submitted to the College’s Dean’s Office (c/o the H&SS Advisory Center). 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. 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, 350 units of credit.

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.

Additional details and guidelines for the Student-Defined Major program are available in the College’s Academic Advisory Center, Baker Hall A57.
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 and diploma.

To declare an H&SS interdepartmental minor, students should contact the H&SS Academic Advisory Center (AAC) and the faculty advisor for that minor. Progress is monitored through the faculty advisor and completion of the minor through the H&SS AAC.

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 applied toward any other requirements for a major(s) or minor(s).

The Minor in Environmental Studies

Faculty Advisor: Peter Madsen
Office: Baker Hall 161F

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.

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
09-105 Modern Chemistry I or approved environmentally-related science courses (equivalent to at least 18 Carnegie Mellon units) 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

66-210 Science and Technology for the Environment
80-244 Management, Environment, and Ethics

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*
12-655 Water Quality Engineering
12-651 Air Quality Engineering
19-101 Introduction to Engineering and Public Policy*
19-222/ Sustainability (6 units)
223 Environmental Management (6 units)
19-448 Science, Technology and Ethics
24-297 Energy-Environmental Systems
42-424 Biological Transport

Social Sciences Area

73-357 Regulation: Theory & Policy
73-358 Economics of the Environment and Natural Resources
88-220 Policy Analysis I
88-221 Policy Analysis II
88-425 Politics of Economic Deregulation

Humanities Area

76-319 Environmental Rhetoric
79-346 International Environmental Law and Policy
79-384 Medicine and Society
80-340 Environmental Ethics and Decision Processes

Advanced Course (minimum) 9 units

Both courses listed in this category have prerequisites or, as an alternative, require instructor approval for entry.

88-222 Policy Analysis III (pre-approved sections)
or
79-410 History and Policy Project Course (pre-approved sections)
The Minor in European Studies

Faculty Advisor: Beryl Schlossman, Department of Modern Languages Office: Porter Hall 125A

Europe constitutes a vital part of our cultural heritage and has been a source of both great creativity and massive devastation in the modern era. The European Studies program seeks to enhance students' understanding of the historical evolution and contemporary dimensions of European society, politics, and culture. It aims as well to train students in an area of growing national need and professional opportunity. It offers an interdepartmental minor that furnishes students with substantive knowledge of western European society through two approaches. First, it provides a solid 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.

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

Language courses are to be completed in the same language: French, German, or Spanish.

Complete two courses in a 200-level language sequence* 18 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>82-2xx</td>
<td>200-level language course</td>
</tr>
<tr>
<td>82-2xx</td>
<td>200-level language course</td>
</tr>
</tbody>
</table>

*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 course in a 300-level language course 9 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>82-3xx</td>
<td>300-level language course</td>
</tr>
</tbody>
</table>

II. Core Courses in History 27 units

Required Course 9 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>79-207</td>
<td>Development of European Culture</td>
</tr>
</tbody>
</table>

Pre-20th Century European History 9 units

Complete one 200-level (or above) course in Pre-20th century European history.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>79-2xx/3xx</td>
<td>Pre-20th century European History course</td>
</tr>
</tbody>
</table>

European History 9 units

Complete one 300-level course in European history.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>79-3xx</td>
<td>European History course</td>
</tr>
</tbody>
</table>

The Minor in Film and Media Studies

Faculty Advisor: David Shumway
Office: 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>76-239</td>
<td>Introduction to Film Studies (prerequisite for 76-439)</td>
</tr>
</tbody>
</table>

Required Intermediate Course 9 Units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-339</td>
<td>Advanced Studies in Film and Media (May be taken up to three times and counted for additional credit toward Intermediate Courses if topics differ)</td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-361</td>
<td>Film Festival Course</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>76-238</td>
<td>Introduction to Media Studies</td>
</tr>
<tr>
<td>79-247</td>
<td>East Asians in Film</td>
</tr>
<tr>
<td>82-296</td>
<td>A Century of Russian Film</td>
</tr>
<tr>
<td>82-187</td>
<td>French Cinema</td>
</tr>
</tbody>
</table>

2. Film and Anthropology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-210</td>
<td>Picturing Others: Ethnographic Film</td>
</tr>
<tr>
<td>79-303</td>
<td>Visual Anthropology</td>
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</tbody>
</table>

3. Filmmaking

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-269</td>
<td>Study of Forms: Screenwriting</td>
</tr>
<tr>
<td>FM 200</td>
<td>Intermediate Filmmaking (please go to CFA 100 to register for this course)</td>
</tr>
</tbody>
</table>

Other 200 or 300 level courses in English, History, and Modern Languages can be counted in this category why 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.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM 301</td>
<td>Advanced Filmmaking (please go to CFA 100 to register for this course)</td>
</tr>
<tr>
<td>76-439</td>
<td>Advanced Seminar in Film and Media</td>
</tr>
<tr>
<td>76-437</td>
<td>The American Cinema</td>
</tr>
<tr>
<td>76-438</td>
<td>Stars and Celebrities</td>
</tr>
<tr>
<td>76-469</td>
<td>Screenwriting Workshop</td>
</tr>
<tr>
<td>82-491</td>
<td>Literature, Politics and Film in East Europe and Russia Today</td>
</tr>
</tbody>
</table>
## 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 subsequently develop and offer other courses that, while not listed here, are deemed appropriate for this minor. The minor faculty advisor should be consulted for approval.

#### Required Introductory Courses 18 units

Complete the following (9 units):

- 76-241 Introduction to Gender Studies

And complete one of the following (9 units)

- 79-234 Body Politics: Women and Health in America
- 79-379 Women in America

#### Elective Intermediate Courses 27 units

- 73-340 Labor Economics
- 76-241 Introduction to Gender Studies*
- 76-245 Shakespeare and the Genres
- 76-330 Medieval Literature: Women's Lives, Men's Lives
- 76-333 Histories of Sexualities
- 76-353 Advanced Gender Studies
- 79-209 Theory and Practice in Anthropology
- 79-234 Body Politics: Women and Health in America*
- 79-236 19th Century China through Literature
- 79-253 Development of Caribbean Culture
- 79-260 Mayan America
- 79-270 Chinese Culture and Society
- 79-284 History of Gender and the Family in Russia
- 79-294 The Making of the African Diaspora in the New World
- 79-308 Politics and Culture of Memory
- 79-320 Women and Power
- 79-329 Sex, Population and Birth Control
- 79-348 Objects of Value
- 79-359 History of African American Families
- 79-364 Art, Anthropology and Empire
- 79-374 Women in Modern India
- 79-379 Women in America*
- 79-382 African American Women in US History
- 80-346 Value, Fact, and Policy
- 85-221 Principles of Child Development
- 85-352 Evolutionary Psychology

*if not taken as required introductory course

#### Elective Advanced Courses 9 units

- 76-435 Gay and Lesbian Theory
- 76-435 Feminist Cultural Studies
- 79-401 Colloquium in Anthropology and History
- 79-404 Extreme Ethnography
- 82-407 The Arts in Society: French Modernism
- 82-413 The Arts in Society: Theaters of Love
- 82-415 Baudelaire and Modern French Culture
- 82-425 Writing and Viewing the Other
- 82-452 Twentieth Century and Contemporary French Literature and Cinema
- 82-451 Literature and Revolution in Central America
- 82-456 Madres, machos y más: género y sexualidad en América Latina
- 85-446 Psychology of Gender

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.

## The Minor in Health Care Policy and Management

Sponsored by:  
H. John Heinz III School of Public Policy and Management  
College of Humanities and Social Sciences  
Mellon College of Science  
Faculty Advisors: Caroline Acker, Naum Kats, and Stephanie Wallach, College of Humanities and Social Sciences  
Brenda Peyer, H. John Heinz III School  
Amy Burkert, 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 over night 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 (minimum) 60 units

Six courses (a minimum of 60 units) are required to complete this minor. Entry into the minor requires completion of 73-250, Intermediate Microeconomics or 88-220, Policy Analysis I or the equivalent by approval.

#### Required Courses 33 units

Students are required to take the following courses.

- 79-384 Medicine and Society
- 90-650 Introduction to Health Care Policy and Management
- 90-735 Health Economics

#### Elective Courses 27 units

Complete three courses totaling a minimum of 27 units.

#### Heinz School Courses (12 units each)

- 90-721 Non-Profit and Health Marketing
- 91-830 Financial Management of Health Systems
- 91-836 Legal Issues in Health Systems Management
- 91-844 Managing Quality Improvement
- 91-853 Health Care Information Systems
- 91-861 Health Policy
- 91-862 Managed Care

#### Humanities and Social Sciences Courses (9 units each)

- 76-494 Medical Communications
- 79-335 Drug Use and Drug Policy
- 79-336 Epidemic Disease and Public Health
- 80-245 Medical Ethics
- 85-241 Social Psychology
- 85-442 The Social Psychology of Health
- 85-446 The Psychology of Gender
- 85-451 The Psychology of Purpose
- 88-373 Mental Health Ideologies

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 International Relations

Faculty Advisor: Kiron K. Skinner; Undergraduate Advisor: Stephanie Wallach Office: Baker Hall 240

The International Relations Minor allows students to explore some of the most important intellectual effects of the demise of the cold war. They include the dissolution of disciplinary boundaries, which facilitates a more productive study of the interaction of politics, culture, and markets, as well as a focus on...
the role of state and non-state actors in international outcomes. The minor is designed for students with international interests including business and management, culture, history, and political science. The departments of Social and Decision Sciences, History, and Modern Languages jointly offer the International Relations Minor.

**Curriculum**

The courses listed below are offered with general regularity. Participating departments may subsequently develop and offer other courses that are deemed appropriate for this minor. The Undergraduate Advisor should be consulted, especially when the schedule of courses for a given semester becomes available, to identify such additional courses.

**Core Courses**

27-36 units

Complete 79-231/88-329; 88-326/79-350; 88-205 OR 88-357; plus one 200-level course in Modern Languages (unless you fulfill the language requirement via another option listed below).

**History (9 units)**

79-231/88-329 American Foreign Policy, 1945 to Present

**Social and Decision Sciences (18 units)**

88-326/79-350 Theories of International Relations (required)

AND

88-205 Comparative Politics

OR

88-357 Comparative Foreign Policy: China, Russia, and the US

**Modern Languages**

Demonstration of basic competency in a foreign language via one of the three options listed below:

1) Complete one (1) Modern Languages course at the 200 level, with a minimum grade of C, or

2) Achieve a score of 4 or higher in one foreign language Advanced Placement examination, or

3) Demonstrate equivalent proficiency to the satisfaction of the Department of Modern Languages

**Regional Specialization**

27 units

Complete three (3) courses in non-U.S. history, international politics, or literature in a single region of the world from the regions listed below. The aim is to achieve in-depth command of a non-U.S. culture via study of its language, cultural and political history, and cultural products.

**Africa**

79-258 Introduction to African History: 18th Century to Neo-Colonialism

79-267 Pre-Colonial West African History 1100-1800 (6 units)

79-268 From the Local to the Global: Africa in the World (6 units)

79-294 The Making of the African Diaspora in the New World

79-356 Introduction to African History: Earliest Times to the Origins of the Slave Trade

82-304 The Francophone World

82-404 Francophone Realities: Africa

82-410 Advanced Research in French and Francophone Language and Culture

82-415/416 Topics in French and Francophone Studies

**Asia**

79-225 Religions of China

79-236 Eighteenth Century China Through Literature Cities in History: Delhi and London

79-247 East Asians in Film

79-253 The Development of Caribbean Culture

79-254 The Pacific Islands: History and Culture

79-261 A History of Asian Americans in the United States

79-270 Chinese Culture and Society

79-271 Modern China

79-275 Religious Identities and Religious Conflicts in Nineteenth Century Europe

79-278 China’s Environment: Past and Present

79-283 East Asia and World War II

79-289 Development of South Asian Culture and Society

79-374 Women in Modern India

82-273 Introduction to Japanese Language and Culture

82-278 Japanese Literature in Translation

82-333 Introduction to Chinese Language and Culture

82-433 Topics in Contemporary Culture of China

82-434 Studies in Chinese Traditions

82-474 Topics in Japanese Studies II: Samurai, Kamikaze, Totoro

**Europe**

79-205 20th Century Europe

79-207 Development of European Culture

79-214 18th Century European History

79-219 The Holocaust in Historical Perspective

79-220 Early Christianity

79-221 Christensen Divided: The Protestant and Catholic Reformations, 1450-1650

79-251 Flesh and Spirit: Early Modern Europe, 1400-1800

79-275 Religious Identities and Religious Conflicts in Nineteenth-Century Europe

79-295 Germany and World War II

79-307 The Anthropology of Europe

79-310 Modern Spain: Culture, Politics, and Society

79-318 Protest, Propaganda, and the Public Sphere, 1500-1800

79-319 The City and the Country in Modern Europe

79-324 Modern Painting

79-325 Art and Religion

79-333 History of Biomedical Research

79-368 Poverty, Charity, and Welfare (6 units)

79-376 Making of the Modern Family

79-396 Music and Society in 19th/20th Century Europe and US

82-303 French Culture

82-305 French in its Social Contexts

82-323 Germany, Austria and Switzerland in the 20th Century

82-324 Contemporary Germany, Austria and Switzerland

82-325 Introduction to German Studies

82-342 Spain: Language and Culture

82-345 Hispanic Literary and Cultural Studies

82-396 The Faust Legend at Home and Abroad

82-401 French Popular Song

82-407 The Arts in Society

82-408 Matisse, Chagall, Picasso and Their Contemporaries: Art and Museums on the Riviera

82-410 Advanced Research in French and Francophone Literature and Culture

82-415/416 Topics in French and Francophone Studies

82-421 German Literature of the Nineteenth Century

82-422 German Literature of the Early Twentieth Century

82-424 The New Germany

82-425 Topics in German Literature and Culture

82-426 Studies in German Literature

82-427 Nazi and Resistance Culture

82-428 History of German Film

82-441 Studies in Peninsular Literature and Culture

82-444 The Structure of Spanish

82-446 Political Drama of Spain

88-205 Comparative Politics

88-314 Politics through Film

**Latin America/Caribbean**

79-253 The Development of Caribbean Culture

79-260 Mayan America

79-288 Bananas, Baseball, and Borders: Latin America and the US from Alamo to Drug Wars

79-290 Between Revolutions: The Development of Modern Latin America

82-343 Latin America: Language and Culture

82-344 U.S. Latinos: Language and Culture

82-345 Hispanic Literary and Cultural Studies

82-445 U.S. Latino Literature

82-450 Advanced Research in Hispanic Language and Culture

82-451 Studies in Latin American Literature and Culture

82-452 The Latin American Fin de Siglo: Modernity, Modernismo and Underdevelopment

82-453 Voices from Within: The Crisis of Latin American Identity

82-454 The Hispanic Caribbean: Rhythm, Reason and Song

82-455/456 Topics in Hispanic Studies

82-457 Contemporary Latin American Texts: Revision, Rewriting and Representation

88-383 Latin America in the New International System

**Middle East**

79-233 The United States and the Middle East Since 1945

79-299 US-Arab Encounters (12 units)

79-352 The Arab-Israeli Condition: War and Peace
The Minor in Linguistics

Faculty Advisor: Mandy Simons  
Office: Baker Hall 155E

Linguistics is the study of human language. It aims not merely to describe particular languages, but to characterize and account for the nature of language and for the human ability to learn and use it. Linguists address the phenomenon of language from a variety of perspectives. Some are concerned with the computational implementations of linguistic theory for both practical and theoretical purposes. In all cases, a central question for linguists is to understand not only the wonderful variety of the world’s languages but also what these languages have in common: what it is that makes a human language human. The study of language thus contributes vitally to our understanding of human society, human culture, and human minds.

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  
54 units

Linguistics Minors must complete six linguistics related courses. Of the six, three must be selected from the five core courses listed below. The remaining three courses may be selected from among any of the linguistics related courses taught in the four H&SS departments or the LTI.

Students in the minor may choose to take advantage of the full range of approaches to the study of language represented here, or may choose to focus on a particular aspect of language study. Note, however, that some of the elective courses have particular core courses as prerequisites. Students should take this into account when they select their core courses.

Core Courses

76-386 Language and Culture  
80-280 Linguistic Analysis  
82-383 Second Language Acquisition  
85-421 Language and Thought (Psychology)  
11-582 Language Technologies

Note: If more than three courses are taken from this set, the additional ones will count as electives.

Elective Courses

Students must complete three electives, of which two must be 300+ level courses. No 100 level courses are admissible as electives, with the exception of linguistics-related Freshman Seminars. A listing of possible electives is given below, but this list is not intended to be exhaustive. Other courses or seminars on linguistic topics will generally be approved for inclusion. (Students should consult with the Faculty Advisor.)

The Minor in Minority Studies

Faculty Advisor: Joe Trotter,  
Undergraduate Advisor: Naum Kats, Office: Baker Hall 240

The word “minority” suggests issues of cultural, racial, ethnic, and linguistic diversity within a broad geographical and historical context. The term points to the problems of inequality and discrimination which are part of the experience of many minority groups in the United States, in other industrialized nations, and in the Third World. The situations that minority groups face vary with time and place; nevertheless, there are problems of power and powerlessness, and access to political and economic resources that are common to all such groups. Courses organized around the concept of “minority” emphasize issues of historical, political, theoretical, and pragmatic kinds which should be central to the definition of knowledge on a modern university campus. These issues constitute the central intellectual matter of this minor.

Courses included in the minor have as their primary focus the examination of minority-group culture, history, political strategies, and linguistic distinctiveness. Methodological and theoretical courses indicate ways in which a concern with minority groups and minority status impinge upon method and theory in a discipline or a research endeavor. Courses in the minor include primary readings that examine the experiences of one or more minority groups in an historical or contemporary context. Student assignments include written analysis of some facet of minority experience, based on appropriate use of source material and of conceptual frameworks.

NOTE: Courses taken to fulfill requirements in other major or minor programs may not be applied to the Minority Studies minor requirements (and vice versa).

Curriculum  
54 units

Every student will be required to take the core course 79-113, Culture and Identity in American Society. This course is offered one semester each year, and introduces the themes, approaches and methods that are crucial for this minor. This course is followed by a selection of intermediate courses, and by an advanced seminar in which advanced techniques can be applied to a minority issue. At the intermediate level, the minor requires that at least 9 of the 36 units focus on issues of race in America. The advanced course will allow students to develop their own interest in minority studies, using the content, arguments, and methods that have been part of preceding courses.

The courses listed below are offered with at least general regularity. Participating departments, including departments in the College of Fine Arts, 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>79-113</td>
<td>Culture and Identity in American Society</td>
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<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>79-201</td>
<td>Introduction to Anthropology</td>
</tr>
</tbody>
</table>

**Intermediate Courses**  36 units

Intermediate courses are divided into four groups (a., b., c., and d.). Students must select at least one course from group a., and the remaining three courses in any combination from groups a. through d.

**a. Minority groups in the United States.**

These courses look at minority groups in the United States, in terms of their own histories, encounters with the more powerful surrounding society, and strategies for maintaining a distinct cultural identity within a pluralistic society.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>79-112</td>
<td>Race, Nationality, and Culture in American Society</td>
</tr>
<tr>
<td>79-113</td>
<td>Culture and Identity in American Society*</td>
</tr>
<tr>
<td>79-201</td>
<td>Introduction to Anthropology*</td>
</tr>
<tr>
<td>79-241</td>
<td>African-American History I*</td>
</tr>
<tr>
<td>79-242</td>
<td>African-American History II*</td>
</tr>
<tr>
<td>79-258</td>
<td>Introduction to African History: 18th Century to Neo-Colonialism</td>
</tr>
<tr>
<td>79-356</td>
<td>Introduction to African History: Earliest Times to the Origins of the Slave Trade</td>
</tr>
</tbody>
</table>

*Unless chosen for another course category

**b. Social problems, social structures, and minority groups.**

These courses focus on issues of conflict and controversy that arise from differentials of power and position among minority groups and the dominant, surrounding society. Different approaches to such conflicts are presented and critically assessed.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>73-340</td>
<td>Labor Economics</td>
</tr>
<tr>
<td>79-253</td>
<td>The Development of Caribbean Culture</td>
</tr>
<tr>
<td>79-254</td>
<td>The Pacific Islands: History and Culture</td>
</tr>
<tr>
<td>79-290</td>
<td>Between Revolutions: The Development of Modern Latin America*</td>
</tr>
<tr>
<td>80-136</td>
<td>Social Structure, Public Policy and Ethical Dilemmas</td>
</tr>
<tr>
<td>85-241</td>
<td>Social Psychology</td>
</tr>
</tbody>
</table>

*Unless chosen for another course category

**c. Presentations, portrayals, and self-representations.**

These courses consider minority groups from the point of view of how they present themselves, how they are portrayed by others, and the implications of such portrayals for social action and change.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>76-339</td>
<td>Advanced Studies in Film</td>
</tr>
<tr>
<td>79-201</td>
<td>Introduction to Anthropology*</td>
</tr>
<tr>
<td>79-210</td>
<td>Picturing Others: Ethnographic Film</td>
</tr>
<tr>
<td>79-303</td>
<td>Visual Anthropology</td>
</tr>
</tbody>
</table>

*Unless chosen for another course category

**d. Minority groups in comparative geographical perspective.**

This cluster of courses considers the problems of minority groups in specific social and cultural areas, noting the historical developments and processes of change in those areas. A comparative perspective is presented as well.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>79-241</td>
<td>African-American History I*</td>
</tr>
<tr>
<td>79-242</td>
<td>African-American History II*</td>
</tr>
<tr>
<td>79-290</td>
<td>Between Revolutions: The Development of Modern Latin America*</td>
</tr>
</tbody>
</table>

*Unless chosen for another course category

**Advanced Course**  9 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tr>
<td>76-4xx*</td>
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</table>

*Consult the faculty minor advisor regarding other appropriate advanced course options.

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**The Minor in Multimedia Production**

Faculty Advisor: Robert Cavalier
Office: Baker Hall 155 C

Computers are increasingly being used to present information in non-traditional forms. Of special note is the use of computers for multimedia presentations in which text, graphics, video, and sound are combined, often in interactive formats.

Multimedia applications are expanding as information providers attempt to deliver their message via computers - educators and software developers develop video and graphics applications to supplement and enhance more traditional textual materials, businesses allow browsing and on-line ordering of their products, libraries allow the searching and perusal of their holdings, and organizations promote themselves on the Internet. In fact, multimedia applications on the Internet are so prevalent that World Wide Web addresses can be found throughout the traditional forms of communication - including print, television, and film - directing their audiences to additional, and presumably "enhanced," multimedia materials.

This Minor is specifically designed for undergraduate Liberal Arts majors (including BHA Majors). Its objective is to introduce students in these areas of study to the philosophical and technical aspects of Multimedia Authoring. The three core courses of the Minor will provide Liberal Arts students with the major issues and basic skills necessary to understand and appreciate this new aspect of communication.

Students interested in pursuing this minor must consult the faculty advisor for this minor prior to registering for any of the core courses.

**Curriculum**  59 units

**Required Courses**  45 units

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>15-111</td>
<td>Introductory/Intermediate Programming (10 units)</td>
</tr>
<tr>
<td>76-270</td>
<td>Writing in the Professions (9 units)</td>
</tr>
<tr>
<td>76-382</td>
<td>Multimedia Authoring I (9 units)</td>
</tr>
<tr>
<td>76-383</td>
<td>Multimedia Authoring II (9 units)</td>
</tr>
<tr>
<td>80-291</td>
<td>Issues in Multimedia Authoring (9 units)</td>
</tr>
</tbody>
</table>

**Elective Courses**  18 units

In general, relevant electives for the Minor in Multimedia Production will be similar to the core courses and electives of the following University Programs:

- The Human-Computer Interaction Major
- The Communication and Design Core of the Information Systems Major
- The GSIA track in Graphic Communications Management
- The Graduate Program in Entertainment Technology

With the advice and approval of the minor faculty advisor, students may propose courses other than those listed, provided they can show that these courses will enhance their knowledge of issues relating to multimedia production.

**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 counted to also 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.

79-259 Introduction to Religion

**Distribution Requirements 18 units**

Complete two courses that are not from the same disciplinary "Approaches" listed below. 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.

**Historical Approaches**

79-222 Religion and American Society
79-225 Religions of China
79-397 Religion and Politics in the Middle East

**Anthropological Approaches**

79-301 Ritual, Cultural and Identity

**Sociological Approaches**

79-388 Sociology of Religion

**Philosophical Approaches**

80-151 God in the West
80-276 Philosophy of Religion

**Textual Approaches**

79-325 Art and Religion
76-330 Medieval Literary and Cultural Studies
76-332 Renaissance and Literary and Cultural Studies

**Elective Courses (minimum) 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.

66-301 Science and Christianity
79-219 The Holocaust in Historical Perspective
79-220 Early Christianity
79-221 Christendom Divided: The Protestant and Catholic Reforms, 1450-1650

Students may cross-register for relevant electives at other Pitts-burgh institutions with the permission of the faculty advisor for the religious studies minor.

**The Minor in Russian Studies**

Faculty Advisor: Charlene Castellano, Department of Modern Languages Program Office: Baker Hall 160

The relationship between Russia and the West has been central to the history of the twentieth century, influencing politics throughout the globe. The rise in fascism, World War II, the Cold War, revolutions in Cuba, Korea, China and Vietnam, and decolonization struggles in Africa cannot be understood apart from Russian influence. The 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 new questions in the areas of business, science, technology, national defense and international security. The end of the Cold War allows 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 untied 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 administered 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 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.

79-280 Russian History from the First to the Last Tsar
79-281 Russian History

* Both courses are recommended.

2. **Required Electives in History 9 units**

Complete one course. Substitutions by permission.

79-282 Soviet Union in World War II: Military and Political History
79-344 The Cold War and Beyond

**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)
82-192 Elementary Russian II (or demonstrated equivalent)

4. **Core Courses in Modern Languages 18 units**

82-291 Intermediate Russian I
82-292 Intermediate Russian II

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: Collapse and Renewal
79-231 American Foreign Policy: 1945-Present
79-280 Russian History from the First to the Last Tsar
79-281 Modern Soviet History: From Communism to Capitalism
79-282 Soviet Union in World War II: Military and Political History
79-344 The Cold War and Beyond

**Modern Languages**
82-392 Advanced Russian II
82-396 The Faust Legend at Home and Abroad
82-397 Russia’s Demons
82-399 Special Topics: Russian
82-491 Literature, Politics and Film in Russia & Eastern Europe Today
82-492 The Historical Imagination in Nineteenth-Century Russian Literature
82-493 Joseph Brodsky in Context

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.

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 expoloration 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 each of Areas 1, 2 and 3. For a listing of approved courses, consult the description of the Minor in Science, Technology and Society on the College of Humanities and Social Science’s webpage (http://www.hss.cmu.edu/index.html), or contact the Faculty Advisor directly at aronson@andrew.cmu.edu.

Area 1. Language and Rhetoric in Science and Technology
Area 2. History, Philosophy and Social Studies of Science and Technology
Area 3. Disciplines, Practices, Economics and Constituencies in Science and Technology
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.

The Minor in Sociology
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.

Core Courses 18 units
a. Organizations
Complete one course.
70-311 Organizational Behavior
88-260 Organizations

b. Methodology
Complete one course.
36-202 Statistical Methods
70-208 Regression Analysis
85-340 Research Methods in Social Psychology
88-251 Empirical Research Methods

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 faculty advisor for more information.

1. Sociology of Gender, Family, and Culture
66-250 Introduction to Religion
70-342 Managing Across Cultures
79-270 Chinese Culture and Society
79-303 The Politics of American Military Recruitment: Historical Perspective
79-320 Women and Power
79-329 Sex Population and Birth Control
79-338 Childhood, Education and Social Reform in American History
79-359 History of African-American Families
79-374 Women in Modern India
79-375 Children In America
79-379 Women in American History
79-382 African-American Women is US History
79-384 Medicine & Society
80-230 Ethical Theory
80-245 Medical Ethics
80-342 Ethics and Oppression
85-241 Social Psychology
85-446 Psychology of Gender
88-356 Rational Choice

2. Sociology of Work, Organizations, and Technology

70-332 Business, Society, and Ethics
70-414 Technology-Based Entrepreneurship
79-230 Technology in American Society
80-300 Minds, Machines, and Knowledge
88-222 Policy Analysis III
88-341 Organizational Communication
88-347 Complex Technological Systems

Note: Some courses have additional prerequisites.

The Minor in Global Systems and Management

Faculty Advisor: Steve Pajewski, sp4g@andrew.cmu.edu
Office: PH 100B

This minor 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. The minor exposes students to contemporary issues and practices facing organizations, managers and individuals working on a global scale across political, cultural and temporal boundaries. The minor 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 to reflect their specific interests.

Curriculum 54 units

The Minor in Global Systems and Management 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 that students complete a series of three core courses. The core IS courses do not require prerequisites, the other core courses have minimal prerequisites, and all are offered at least once per year. In addition, minors are required to take at least one course 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 the third core course requirement (76-442, 76-483 or 85-375). The minor faculty 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 a substitute for the minor requirement.

Courses taken to fulfill requirements in other major or minor programs may not be applied to the Global Systems and Management 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 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. Additionally, students may develop and submit to the faculty 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 embarking on a customized course of study.

Required Courses 18 units

Complete three courses.

67-325 Global Systems Delivery Models (6 units)
67-326 Global Project Management (3 units)

One of the following *:

76-386 Language and Culture
76-442 Communication across Cultures
85-375 Cross Cultural Psychology

*Course may be substituted with an approved course(s) completed as part of a semester abroad. The course taken to fulfill this requirement can only be counted once toward completion of the minor.

Communications 9 units

Complete one course.

76-270 Writing for the Professions
76-318 Communicating in the Global Marketplace
76-386 Language and Culture
76-442 Communication across Cultures

Humanities, Heritage and Culture 9-18 units

Complete courses totaling 9-18 units (generally 1 or 2 courses).

79-270 Chinese Culture and Society
79-271 Modern China
79-288 Latin America and the United States from Alamo to Drug Wars
79-289 Society and Culture in South Asia
79-290 Between Revolutions: The Emergence of Modern Latin America: 1789-1917
79-350 Theories of International Relations
79-374 Women in Modern India
79-386 The Global Environment: Historical Perspectives and Policy Dilemmas
79-440 The Rise of Industrial Research and Development
82-304 The Francophone World
82-323 Germany, Austria and Switzerland in the 20th Century
82-333 Introduction to Chinese Language and Culture
82-383 Introduction to Second Language Acquisition
82-433 Topics in Contemporary Culture in China
82-480 Social and Cognitive Aspects of Bilingualism
82-487 On Writing in a Second Language
85-375 Cross Cultural Psychology

International Management 9-18 units

Complete courses totaling 9-18 units (generally 1 or 2 courses).

70-342 Managing Across Cultures
70-365 International Trade and International Law
70-430 International Management
70-480 International Marketing
73-371 International Trade and Economic Development
73-372 International Money and Finance
88-326 International Relations
88-327 Politics of Economic Development
88-352/79-346 International Environmental Law and Policy
88-359 Globalization
88-378 International Economics
Undergraduate Economics Program

Dennis Epple, Program Head
http://www.tepper.cmu.edu/undergraduatecon/home

In our fast changing world, economists analyze and develop useful solutions to a wide range of important and interesting problems. They are active participants in the processes and institutions through which society addresses matters of current interest. Economists help political bodies, businesses and other organizations make better decisions through the development of market strategies, the implementation of regulatory structures, and the adoption of appropriate government policies. Increasingly, economists are taking advantage of new technologies, enabling them to directly design and implement new and emerging markets.

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 the full support and services. Through this unique arrangement, our students benefit from the best of the liberal arts and professional approaches to education.

Degree Options

In order to accommodate students’ wide variety of goals, three degree options are available: Bachelor of Arts in Economics, Bachelor of Science in Economics, and Bachelor of Science in Quantitative Economics. All three have been designed to provide students with a solid understanding of the central ideas of economics, while maintaining the flexibility necessary to meet the needs of a diversity of career paths. Graduates of the 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, finance, and related fields. For students who are majors in other departments, the program offers both a second major and a minor in economics.

Concentrations

Economics majors may elect to do a concentration in a particular area of economics. A concentration consists of a menu of courses from which the student is required to complete a minimum number (usually three or four). Of these courses, at most two can be used toward other major requirements. Since the particular courses may vary, students should contact the Undergraduate Economics Program for an up-to-date list of concentrations and their associated course lists. Presently, the program offers the following concentrations:

- Innovative Markets and Technology
- Economics and Strategy
- Economics of Financial Markets
- Economics of Social Issues
- Economics in the Global Marketplace

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 a B.S. in Economics (including the H&SS general education requirements). 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 more. Interested students should meet with an economics advisor.

Honors Programs

Outstanding students are eligible for the honors programs in both the Tepper School of Business and the College of Humanities and Social Sciences. Invited students demonstrate and further develop their skills in economic analysis and research through the completion of a senior honors thesis. The students present their work at Carnegie Mellon’s annual undergraduate research symposium Meeting of the Minds and graduate with “College Honors”. Students may contact the individual colleges for eligibility requirements.

Accelerated Master’s Degree Programs

These programs enable exceptional students to earn both an undergraduate degree and a masters degree by remaining one additional year at Carnegie Mellon. The Tepper School offers qualified students two accelerated professional degree options – one culminating in a Master of Science in Quantitative Economics, the other in a Master of Business Administration. Interested students should consult with their economics advisor for further information.

Degree Requirements

In addition to completing at least 360 units and the H&SS General Education requirements, recipients of an undergraduate degree in economics must complete courses in mathematics, probability & statistics, writing, economics theory, and economic analysis, as well as a set of advanced electives and other specialized courses. Specific requirements for the B.S., B.A., and B.S.Q.E. degrees are as follows.

B.S. in Economics

Mathematics Prerequisites 29 Units
Complete all of following:
21-120 Differential and Integral Calculus 10
21-122 Integration, Differential Equations, and Approximation 10
21-256 Multivariate Analysis and Approximation 9

Programming Prerequisites 10 Units
15-100 Introductory/Intermediate Programming 10

Probability Requirement 9 Units
Choose one:
73-207 Probability Theory for Economists 9
36-217 Probability Theory and Random Processes 9
36-225 Introduction to Probability and Statistics I 9

Writing Requirement 9 Units
Choose one:
73-270 Professional Writing for Economists 9
76-270 Writing in the Professions 9
76-271 Introduction to Professional and Technical Writing 9

Economic Theory Requirements 30 Units
Complete all of following:
73-150 Microeconomics 9
73-200 Macroeconomics 9
73-252 Advanced Microeconomic Theory 6
73-253 Advanced Macroeconomic Theory 6

Economic Analysis Requirements 18 Units
Complete all of following:
73-252 Quantitative Economic Analysis 9
73-261 Econometrics 9

Advanced Economics Electives 45 Units

Students must take five advanced elective course, at least two of which have 73-252 or 73-253 as a prerequisite. 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.
B.A. in Economics

Mathematics Prerequisites 19 Units
Complete all of following:
21-120 Differential and Integral Calculus 10
21-256 Multivariate Analysis and Approximation 9

Probability Requirement 9 Units
73-207 Probability Theory for Economists 9

Writing Requirement 9 Units
Choose one:
73-270 Professional Writing for Economists 9
76-270 Writing in the Professions 9
76-271 Introduction to Professional and Technical Writing 9

Economic Theory Requirements 27 Units
Complete all of following:
73-100 Principles of Economics 9
73-150 Microeconomics 9
73-200 Macroeconomics 9

Economic Analysis Requirements 18 Units
Complete all of following:
73-226 Quantitative Economic Analysis 9
36-303 Sampling, Survey, and Society 9

Economic History Requirement 9 Units
73-310 History of Economic Issues and Analysis 9

Advanced Economics Electives 36 Units
Students must take four advanced elective course. 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 list of courses designated as special electives is maintained and revised from time to time by the Undergraduate Economics Program.

B.S. in Quantitative Economics

Mathematics Prerequisites 29 Units
21-131 Analysis I 10
21-132 Analysis II 10
21-259 Calculus in Three Dimensions 9

Programming Prerequisite 10 Units
15-100 Introductory/Intermediate Programming 10

Probability Requirement 9 Units
21-325 Probability 9

Writing Requirement 9 Units
Choose one:
73-270 Professional Writing for Economists 9
76-270 Writing in the Professions 9
76-271 Introduction to Professional and Technical Writing 9

Economic Theory Requirements 30 Units
Complete all of following:
73-150 Microeconomics 9
73-200 Macroeconomics 9
73-252 Advanced Microeconomic Theory 6
73-253 Advanced Macroeconomic Theory 6

Economic Analysis Requirements 27 Units
Complete all of following:
73-226 Quantitative Economic Analysis 9
73-261 Econometrics 9
73-426 Advanced Quantitative Economic Analysis 9

Advanced Economics Electives 36 Units
Students must take four advanced elective course, at least three of which have 73-252 or 73-253 as a prerequisite. 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.

Sample Course Schedules

First Year
Fall 49 Units
21-120 Differential and Integral Calculus 10
36-201 Statistical Reasoning 9
73-100 Principles of Economics 9
73-101 1st Year Seminar in Economics 9
99-101 Computing Skills Workshop 3
xx-xxx elective 9

Spring 46 Units
15-100 Introductory/Intermediate Programming 10
21-256 Multivariate Analysis and Approximation 9
73-150 Microeconomics 9
xx-xxx elective 9
xx-xxx elective 9

Second Year
Fall 46 Units
21-122 Integration, Differential Equations, and Approximation 10
73-200 Macroeconomics 9
73-207 Probability Theory for Economists 9
xx-xxx elective 9
xx-xxx elective 9

* Although not a requirement for the degree, students considering an economics major are encouraged to meet their H&SS Freshman Seminar requirement by taking the 1st Year Seminar in Economics.
### Sample Schedule for B.A. in Economics

**First Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>49 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>36-201 Statistical Reasoning</td>
<td>9</td>
</tr>
<tr>
<td>73-100 Principles of Economics</td>
<td>9</td>
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<tr>
<td>73-101 1st Year Seminar in Economics</td>
<td>9</td>
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<tr>
<td>99-101 Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td>xx-xxx elective</td>
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</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>46 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-100 Introductory/Intermediate Programming</td>
<td>10</td>
</tr>
<tr>
<td>21-256 Multivariate Analysis and Approximation</td>
<td>9</td>
</tr>
<tr>
<td>73-150 Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
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</table>

* Although not a requirement for the degree, students considering an economics major are encouraged to meet their H&S Freshman Seminar requirement by taking the 1st Year Seminar in Economics.

**Second Year**

<table>
<thead>
<tr>
<th>Fall</th>
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<tbody>
<tr>
<td>73-200 Macroeconomics</td>
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<tr>
<td>73-207 Probability Theory for Economists</td>
<td>9</td>
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<tr>
<td>xx-xxx elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>45 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-226 Quantitative Economic Analysis</td>
<td>9</td>
</tr>
<tr>
<td>73-310 History of Economic Issues and Analysis</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
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</table>

**Third Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>45 Units</th>
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</thead>
<tbody>
<tr>
<td>36-303 Sampling, Survey, and Society</td>
<td>9</td>
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<tr>
<td>73-270 Writing for Economists</td>
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<tr>
<td>xx-xxx Advanced Economics Elective</td>
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</tr>
<tr>
<td>xx-xxx elective</td>
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</table>

### Sample Schedule for B.S. in Quantitative Economics

**First Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>49 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-100 Introductory/Intermediate Programming</td>
<td>10</td>
</tr>
<tr>
<td>21-131 Analysis I</td>
<td>10</td>
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<tr>
<td>73-100 Principles of Economics</td>
<td>9</td>
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<tr>
<td>73-101 1st Year Seminar in Economics</td>
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<tr>
<td>99-101 Computing Skills Workshop</td>
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<tr>
<td>xx-xxx elective</td>
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</table>

<table>
<thead>
<tr>
<th>Spring</th>
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<tbody>
<tr>
<td>21-325 Probability</td>
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<tr>
<td>73-200 Macroeconomics</td>
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<tr>
<td>xx-xxx elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
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**Second Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>45 Units</th>
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<tbody>
<tr>
<td>73-261 Econometrics</td>
<td>9</td>
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<tr>
<td>73-270 Writing for Economists</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Advanced Economics Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>47 Units</th>
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<tbody>
<tr>
<td>73-226 Quantitative Economic Analysis</td>
<td>9</td>
</tr>
<tr>
<td>73-252/3 Advanced Microeconomic Theory</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
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</table>

* A semester-long sequence consisting of two mini-courses, 73-252 Advanced Microeconomic Theory and 73-253 Advanced Macroeconomic Theory.

**Third Year**

<table>
<thead>
<tr>
<th>Fall</th>
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<tbody>
<tr>
<td>73-426 Advanced Quantitative Economic Analysis</td>
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<tr>
<td>xx-xxx Advanced Economics Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
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### Third Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>45 Units</th>
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<tbody>
<tr>
<td>73-226 Quantitative Economic Analysis</td>
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<tr>
<td>xx-xxx Advanced Economics Elective</td>
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<tr>
<td>xx-xxx elective</td>
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<tr>
<td>xx-xxx elective</td>
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### Fourth Year

<table>
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<tr>
<td>73-497 Senior Project</td>
<td>9</td>
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<tr>
<td>xx-xxx Advanced Economics Elective</td>
<td>9</td>
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<td>xx-xxx elective</td>
<td>9</td>
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<tr>
<td>xx-xxx elective</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>45 Units</th>
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<tbody>
<tr>
<td>xx-xxx Advanced Economics Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx elective</td>
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<tr>
<td>xx-xxx elective</td>
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**Fourth Year**

<table>
<thead>
<tr>
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<tr>
<td>73-497 Senior Project</td>
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<tr>
<td>xx-xxx Advanced Economics Elective</td>
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<tr>
<td>xx-xxx Special Elective</td>
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<td>xx-xxx elective</td>
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<table>
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<tr>
<th>Spring</th>
<th>45 Units</th>
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<tbody>
<tr>
<td>xx-xxx Advanced Economics Elective</td>
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<td>xx-xxx elective</td>
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<td>xx-xxx elective</td>
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<tr>
<td>xx-xxx elective</td>
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</tbody>
</table>

**Additional Major in Economics**

The requirements for an 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. Interested students should meet with an economics advisor. Concentrations are not available for additional majors.

**Minor in Economics**

The requirements for a minor in Economics consist of mathematics requirements, a statistics requirement, and six economics courses, as follows:

**Mathematics Requirements** 19 Units

- 21-120 Differential and Integral Calculus 10
- Choose one:
  - 21-256 Multivariate Analysis and Approximation 9
  - 21-259 Calculus in Three Dimensions 9

**Statistics Requirements** 18 Units

- Choose one:
  - 36-201 Introduction to Statistical Methods 9
  - 36-207 Probability and Statistics for Business Applications 9
  - 36-220 Engineering Statistics and Quality Control 9
- or any course from the statistics requirement for B.S. in Economics.

- 36-208 Regression Analysis 9
- 36-226 Introduction to Probability and Statistics I 9
- 73-226 Quantitative Economic Analysis 9
- 88-250 Regression Methods in the Social Sciences 9

* 36-207 is equivalent to 70-207.

* 36-208 is equivalent to 70-208.

* Only open to students who met their statistics requirement by taking 36-225.

**Economics Requirements** 54 Units

Complete all of following:

- 73-100 Principles of Economics 9
- 73-150 Microeconomics 9
- 73-200 Macroeconomics 9
- 73-xxx Advanced Economics Elective 9
- 73-xxx Advanced Economics Elective 9
- 73-xxx Advanced Economics Elective 9

* Advanced elective courses are those numbered 73-300 through 73-495.

**Faculty**

DANIELLE COEN PIRANI, Assistant Professor of Economics—Ph.D., University of Rochester; Carnegie Mellon, 2000—.

W. ROBERT DALTON, Associate Teaching Professor of Economics Emeritus—Ph.D., University of Missouri; Carnegie Mellon, 1985—.

ROBERT M. DAMMON, Professor of Financial Economics—Ph.D., University of Wisconsin; Carnegie Mellon, 1984—;

KENNETH B. DUNN, Dean, Professor of Financial Economics—Ph.D., Purdue University; Carnegie Mellon, 2003—;

DENNIS N. EPPEL, Thomas Lord Professor of Economics; Head, Economics Programs—Ph.D., Princeton University; Carnegie Mellon, 1974—.

MARIA FERREYRA, Assistant Professor of Economics—Ph.D., University of Wisconsin; Carnegie Mellon, 2002—.

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MARTIN GAYNOR, E.J. Barone Professor of Economics and Health Policy—Ph.D., Northwestern University; Carnegie Mellon, 1995—.

RONALD L. GOETTLER, Associate Professor of Economics—Ph.D., Yale University; Carnegie Mellon, 1997—.

LIMOR GOLAN, Assistant Professor of Economics—Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2002—.

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RICHARD C. GREEN, Richard M. and Margaret S. Cyert Professor of Economics and Management; Chair, Ph.D. Program—Ph.D., University of Wisconsin; Carnegie Mellon, 1982—.

PAUL J. HEALY, Assistant Professor of Economics—Ph.D., California Institute of Technology; Carnegie Mellon, 2005—.

BURTON HOLLIFIELD, Associate 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 Science—Ph.D., Cornell University; Carnegie Mellon, 1980—.

FINN KYDLAND, Professor of Economics—Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977—.

LESTER B. LAVE, Harry B. and James H. Higgins Professor of Economics and University Professor; Director, Carnegie Mellon Green Design Initiative; Co-Director, Carnegie Mellon Electricity Industry Center—Ph.D., Harvard University; Carnegie Mellon, 1963—.

ADAM LERRICK, The Friends of Allan H. Meltzer Chair in Economics; Director of The Gailliot Center for Public Policy—Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2001—.

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—.

JOHN MILLER, Department Head, Social and Decision Sciences, Professor of Economics—Ph.D., University of Michigan; Carnegie Mellon, 1989—.

ROBERT A. MILLER, Professor of Economics and Strategy—Ph.D., University of Chicago; Carnegie Mellon, 1982—.

JOHN R. O’BRIEN, Associate Professor of Accounting and Experimental Economics—Ph.D., University of Minnesota; Carnegie Mellon, 1984—.

DUANE J. SEPP, Professor of Financial Economics—Ph.D., University of Chicago; Carnegie Mellon, 1986—.

HOLGER SIEG, Professor of Economics—Ph.D., University of Pittsburgh; Carnegie Mellon, 1995—.

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CHESTER S. SPATT, Mellon Bank Professor of Finance; Director, Center for Financial Markets (On Assignment AY 2004-2006 - Chief Economist, Securities and Exchange Commission) — Ph.D., University of Pennsylvania; Carnegie Mellon, 1979—.

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STEPHEN E. SPEAR, Professor of Economics — Ph.D., University of Pennsylvania; Carnegie Mellon, 1982—.

CHRIS I. TELMER, Associate Professor of Financial Economics — Ph.D., Queen's University (Canada); Carnegie Mellon, 1992—.

WILLIAM B. VOGT, Assistant Professor of Economics and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1996—.

SEVIN YELTEKIN, Assistant Professor of Economics — Ph.D., Stanford University; Carnegie Mellon, 2005—.

STANLEY E. ZIN The Richard M. Cyert and Morris H. DeGroot Professor of Economics and Statistics; Professor of Economics and Finance, — Ph.D., University of Toronto; Carnegie Mellon, 1988—.
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 non-fiction, 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 works 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 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 Wolff, Stanley Kunzit 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 5 to 7 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.

English Department Core:

2 courses, 18 units
Complete both courses.

76-26x Survey of Forms (Creative NonFiction, Fiction, Poetry, or Screenwriting)
76-294 Interpretive Practices

The English Department Core is designed to introduce students to various genres of writing, to the fundamental concepts and techniques of fiction and non-fiction, and to a conceptual understanding of how texts are produced and interpreted. In the Survey of Forms courses, students learn how to use language to express experience through poetic and narrative forms. In Interpretive Practices, students are introduced to basic concepts, methods, and practices of literary and rhetorical approaches to texts and their social and cultural contexts.

Core Requirements for the Specific Major:

5 to 7 courses, 45 to 63 units
Complete five to seven 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 the department's 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 experience expression through poetic and narrative forms.

Beyond these English Department core 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.

Research in English Studies (76-294) is also required of students in the B.A. in English. This course 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 independent research. 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 76-294 is not a prerequisite 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 76-294 is a prerequisite.

EBA majors also complete three English Electives, one at the 200 or above level and two at the 300 or 400 level. Electives at the 200 level allow students to sample introductory courses in special topics -- such as gender and media studies -- within rhetorical, literary, and cultural studies, or genre courses in the novel or comedy. Electives at the 300 and 400 level encourage students to explore more advanced study in the various offerings within the department. In choosing their electives, EBA students are encouraged to sample courses from across the department.

**Curriculum**

In addition to satisfying all of the H&SS degree requirements for B.A. candidates, English B.A. majors must complete 11 courses in the following areas:

**English Department Core:** 2 courses, 18 units

Complete both courses:
- 76-26x Survey of Forms (Creative NonFiction, Fiction, Poetry, or Screenwriting)
- 76-294 Interpretive Practices

**EBA Core Requirements:** 6 courses, 54 units

Complete six required courses.
- 76-394 Research in English Studies

**Rhetoric Requirement**

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.

**Two 300-level Courses**

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 Literary and Cultural Studies
- 76-331 Renaissance Literary and Cultural Studies
- 76-332 African American Studies
- 76-334 Narratives of Profession
- 76-335 20th Century Literary and Cultural Studies
- 76-339 Advanced Studies in Media
- 76-347 American Literary & Cultural Studies
- 76-353 Advanced Gender Studies
- 76-386 Language and Culture
- 76-387 Sociolinguistics
- 76-392 Rhetoric and Public Policy
- 76-393 Rhetorical Traditions

**"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 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.

**Two 400-level Seminar Courses**

Complete two 400-level seminar courses, including one Senior Seminar (76-450), generally taken in the spring of the senior year, 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, 76-294: Interpretive Practices is a prerequisite and 76-394: Research in English Studies is pre- or co-requisites. Among current course offerings, examples include but are not limited to the following:
- 76-431 Advanced Seminar in British Literary and Cultural Studies
- 76-433 Postcolonial Literature and Theory
- 76-441 Chaucer
- 76-444 Enlightenment Sexualities
- 76-439 Advanced Seminar in Film Studies
- 76-451 Topics in Language Studies
- 76-457 Topics in Rhetorical Study
- 76-476 Rhetoric of Science
- 76-482 Comparative Rhetoric
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 76-201, 76-205, and 76-206, all of which are 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&S S may declare a major as early as mid-semester of the spring of their first year and begin major requirements the following fall. 76-294 Interpretive Practices should generally be taken in the sophomore year and before 76-394.

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<tr>
<th>Junior Year</th>
<th>Senior Year</th>
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<tr>
<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
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<tr>
<td>Survey of Forms 76-26x</td>
<td>400-level EBA course* 76-4xx</td>
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<tr>
<td>Interpretive Practices 76-294</td>
<td>300-level EBA course* 76-3xx</td>
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<tr>
<td>Research in English Studies 76-394</td>
<td>English Elective 76-3xx/4xx</td>
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* 76-294 is a prerequisite for 300-level EBA courses

** 76-294 is a prerequisite and 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 prose 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&S S 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 and non-fiction 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 Poetry (76-265), Fiction (76-260), and Screenwriting (76-269). 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 non-fiction. 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 reading 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 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 submit their work for publication to The Oakland Review, a Carnegie Mellon University-sponsored annual journal, and The Tartan (the weekly student newspaper where they often serve in editorial positions). 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, and the Carnegie Mellon University Press Prizes in poetry and fiction. In addition, the Gladys Schmitt Scholarship Fund and the Gladys Schmitt Student Enhancement Fund provide support for creative writing majors.

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, most Creative Writing majors have gone 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&S S degree requirements for B.A. candidates, Creative Writing majors must complete 11 courses in the following areas:

**English Department Core:**
2 courses, 18 units

Complete both courses.

- 76-26x Survey of Forms (Creative Non-Fiction, Fiction, Poetry, or Screenwriting)*
- 76-294 Interpretive Practices

* 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 also who receives a grade of C. In a Survey of Forms course may enroll in a related workshop only with the permission of the workshop professor. A student who receives a D or R in Survey of Forms may not take a workshop in that genre.

**Creative Writing Core:**
5 courses, 45 units

A Second Survey of Forms Course *

Complete one of the following courses in addition to the 76-26x course completed for the English Department Core requirement.

- 76-260 Survey of Forms: Fiction
- 76-261 Survey of Forms: Creative Nonfiction
- 76-265 Survey of Forms: Poetry
- 76-269 Survey of Forms: Screenwriting

Four Creative Writing Workshops
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
- 76-460 Beginning Fiction Workshop
- 76-461 Personal Essay
- 76-462 Advanced Fiction Workshop
- 76-465 Advanced Poetry Workshop
- 76-469 Screenwriting Workshop
- 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 76-201, 76-205, and 76-206, which are 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 following fall.

Junior Year

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<tr>
<td>Survey of Forms 76-26x</td>
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<td>Interpretive Practices 76-294</td>
<td>Creative Writing Workshop 76-3xx/4xx</td>
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<td>English Elective 76-2xx-3xx</td>
<td>Creative Writing Workshop 76-3xx/4xx</td>
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<th>Senior Year</th>
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<td>Creative Writing Workshop 76-3xx/4xx</td>
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<td>English Elective 76-3xx/4xx</td>
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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, law, community advocacy, the non-profit sector, education, corporate communications, and the arts. The major is designed to develop articulate and reflective writing professionals with both the professional skills needed to negotiate current work contexts (including writing for the web and for multimedia) and the analytic and problem-solving skills needed to understand and keep pace with cultural and technological change.

Professional Writing majors take the English Department Core and then a cluster of advanced rhetoric, language studies, and writing courses designed to integrate theory with practice. Through special topics courses—journalism, on-line information design, advocacy writing, document design, science writing, corporate communications, writing for multimedia—students have the opportunity to study with faculty who are experts and practicing professionals in these fields. They also gain experience in working on client-based projects and develop a portfolio of polished writing samples that they can use in applying for internships and employment. Through courses in Rhetoric, Creative Writing, and Literary and Cultural Studies, students gain additional practice in the careful reading, writing, and analysis of literary and non-fictional texts and important insights into how texts function in their historical and contemporary contexts.

While the major appeals to students with strong professional interests, elective requirements encourage writers to develop the broad intellectual background one expects from a university education. In choosing their elective courses beyond Department requirements, 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 their subjects. 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 business, organizational behavior, graphic design, the arts, psychology, economics, modern languages, and computer programming. Because the major in Professional Writing is deliberately structured to allow 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 and fellowships for academic credit, and writing-related employment on and off campus. Professional Writing majors frequently write for The Tartan, the student-run weekly newspaper, and have served as editor-in-chief, section editors, and reporters. Students serve similar functions on The Carnegie Pulse, Carnegie Mellon’s first exclusively online student-run news source, founded by majors in the English Department in February 2004. Majors can also serve on the editorial staff of The Oakland Review, a Carnegie Mellon journal that publishes work by undergraduate writers from across the US and The Triple Helix, an international undergraduate journal of science, society, and law, which has an active chapter on the Carnegie Mellon campus. 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 non-fiction, The Alan and Gloria Siegel Awards in Professional Writing, 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 during the summer. Opportunities in advertising, newspaper and magazine writing, medical communication, publishing, technical writing, public service organizations, web design, and public relations 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 taken place in organizations such as Magnet Communications, Women & Girls’ Foundation of SW PA, Pittsburghlive.com, JFK Center for the Performing Arts, Software Engineering Institute Communications, WPLJ Radio, Sinuate Media, The Pittsburgh Mediation Center, WQED Magazine, KOKA Television, WIXI Television, Pittsburgh Children’s Museum, Pittsburgh Post Gazette, Creative Non-Fiction (a professional journal), the Heinz Family Foundation, the Silver Eye Photography Studio, and Bayer Polymers.

Seniors also have the opportunity to complete a Senior Project or Honors Thesis in Rhetoric or Professional Writing under the direction of a faculty member. Ideas and guidance for choosing internships, courses, summer employment, and possible career paths are provided through a 3-unit course, 76-300 Professional Seminar, 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:

**English Department Core:** 2 courses, 18 units
Complete both courses.
76-26x Survey of Forms (Creative NonFiction, Fiction, Poetry, or Screenwriting)
76-294 Interpretive Practices

**Professional Writing Core:** 7 courses, 63 units
Complete seven courses.

**Foundations Courses**
76-271 Introduction to Professional & Technical Writing
76-373 Argument
76-390 Style

**Rhetoric/Language Studies Requirement**
Complete one course from designated Rhetoric courses offered and advertised each semester by the Department. Rhetoric courses study language and the varied and specific ways it is used in both everyday and professional contexts. These courses emphasize the relationships among specific language purposes, contexts, and meaning within a variety of specific contexts and provide explicit techniques for analyzing and understanding language use that are extremely useful to all writers.

**Three Advanced Writing/Rhetoric Courses**
Complete three courses at the 300- or 400-level. Options for these courses include but are not limited to the following list. Additional courses that fulfill these requirements are advertised on a semester-by-semester basis. For help in choosing which of the possible options is most appropriate for various professional options – journalism, writing for new media, editing and publishing, public relations/corporate communications, or technical writing – consult your English Department advisor and the “Options for PW Majors” advising sheet available through the English Department.

- 76-318 Communicating in the Global Marketplace
- 76-319 Environmental Rhetoric
- 76-357 Language, Power & the Law
- 76-372 Contemporary Journalism
- 76-375 Magazine Writing
- 76-378 Literary: Educational Theory & Community Practice
- 76-380 Research for Writers
- 76-385 Introduction to Discourse Analysis
- 76-386 Language and Culture
- 76-387 Sociolinguistics
- 76-389 Grammar of Standard Written English
- 76-391 Document Design
- 76-392 Rhetoric and Public Policy
- 76-395 Science Writing
- 76-396 Writing and the Public Interest
- 76-397 Instructional Development & Design
- 76-420 Processes of Reading and Writing
- 76-451 Topics in Language Study
- 76-452 Topics in Rhetorical Study
- 76-460 Literary Journalism
- 76-472 Advanced Journalism
- 76-476 Rhetoric of Science
- 76-479 Marketing, PR & Corporate Communications
- 76-481 Writing for Multimedia
- 76-485 Going Public
- 76-487 On-line Information Design
- 76-491 Software Documentation
- 76-494 Healthcare Communications
- 39-605/6 Product Design

* Courses that have prerequisites. Check course descriptions for specific details.

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**English Electives:** 3 courses, 27 units
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, and rhetoric 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 76-201, 76-205, 76-206, 76-270, and 76-272, all of which are designed primarily for non-majors. 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 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.

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**Sample Junior Year**

<table>
<thead>
<tr>
<th>Fall</th>
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<tbody>
<tr>
<td>Intro to Professional &amp; Technical Writing 76-271</td>
<td>Argument 76-373</td>
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<tr>
<td>Survey of Forms 76-26x</td>
<td>Rhetoric Course 76-3xx/4xx</td>
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<table>
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<th>Fall</th>
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<tbody>
<tr>
<td>Style 76-390</td>
<td>Advanced Writing/ Rhetoric Course 76-3xx/4xx</td>
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<th>Fall</th>
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**Sample Senior Year**

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<tr>
<td>English Elective 76-3xx/4xx</td>
<td>English Elective 76-3xx/4xx</td>
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<td>Elective</td>
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**The B.S. in Technical Writing & Communication**

The B.S. in Technical Writing & Communication (TWC) is one of the oldest undergraduate technical communication degree programs in the country, and still one of the few that is a B.S. rather than a B.A. degree. The program is specifically designed to prepare students for successful careers involving scientific, technical, and computer-related communication.

The B.S. in Technical Writing reflects changes taking place in the technical communication field. 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 to 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.

Students majoring in Technical Writing & Communication 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.

Students have the options of doing internships for academic credit during their junior or senior year. These internships provide a minimum of 120 hours of professional experience as well as exposure to broad 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, Claritech, Janus Technologies, 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, Data General, NCR Corporation, Cisco Systems, and Mellon Financial.

The Technical Communication, or TC Track
The Technical Communication track (TC) prepares students for careers in the rapidly changing areas of computer-based communication. 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 learn to design information for a range of specialist and non-expert audiences. The TC tracks 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 courses, 9-10 units
Complete one of the following:
21-111 Calculus I
21-120 Differential and Integral Calculus

Statistics Prerequisite:
1 course, 9 units
Complete one course
36-201 Statistical Reasoning

Computer Science Prerequisites:
1-2 courses, 10-19 units
Complete either:
15-100 Introductory/Intermediate Programming (10 units)
and
15-200 Advanced Programming/Practicum (9 units)
or
15-111 Intermediate/Advanced Programming (10 units)*

* The 15-100 and 15-200 sequence is specifically designed and paced for students in the Technical Communication and similar degrees who have not had prior programming experience. Students with some prior programming experience (functions, loops, arrays) should consider taking 15-111. If you are unsure which option to choose, consult with your English Department advisor and the undergraduate advisor in the School of Computer Science, both of whom can provide appropriate guidance. Students with little or no prior experience with computer science or programming might also consider taking 15-105 Concepts of Computation as one of their Technical Communication Electives and may find it useful to do so before taking 15-100.

Beyond these prerequisites, students in both TC and SMC tracks of the Technical Writing and Communication degree take the 2 English Core Courses required of all English majors and a common set of 4 TWC Core Requirements in 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.

The Scientific and Medical Communication, or 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 SMC degree
All Scientific and Medical 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 courses, 9-10 units
Complete one of the following:
21-111 Calculus I
21-120 Differential and Integral Calculus

Statistics Prerequisite:
1 course, 9 units
Complete one course
36-201 Statistical Reasoning

Computer Science Prerequisites:
1-2 courses, 10-19 units
Complete either:
15-100 Introductory/Intermediate Programming (10 units)
and
15-200 Advanced Programming/Practicum (9 units)
or
15-111 Intermediate/Advanced Programming (10 units)*

* The 15-100 and 15-200 sequence is specifically designed and paced for students in the Technical Communication and similar degrees who have not had prior programming experience. Students with some prior programming experience (functions, loops, arrays) should consider taking 15-111. If you are unsure which option to choose, consult with your English Department advisor and the undergraduate advisor in the School of Computer Science, both of whom can provide appropriate guidance. Students with little or no prior experience with computer science or programming might also consider taking 15-105 Concepts of Computation as one of their Technical Communication Electives and may find it useful to do so before taking 15-100.

Beyond these prerequisites, students in both TC and SMC tracks of the Technical Writing and Communication degree take the 2 English Core Courses required of all English majors and a common set of 4 TWC Core Requirements in 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

**English Department Core:**

2 courses, 18 units

Complete both courses.

- 76-26x Survey of Forms (Creative NonFiction, Fiction, Poetry, or Screenwriting)
- 76-294 Interpretive Practices
- 76-290 Style
- 76-391 Document Design *
- 76-487 On-Line Information Design **

*T prerequisite = 76-271
** prerequisite = 76-271 + 76-391

**TWC Core Requirements**

4 courses, 42 units

Complete all 4 courses.

- 76-271 Introduction to Professional & Technical Writing
- 76-390 Style
- 76-397 Instructional Design * or 39-605/6 Product 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 Elective MUST be from this set (and all three should be strongly considered as options)

- 76-491 Software Documentation * (new course beginning spring 07)
- 76-481 Writing for Multimedia *
- 76-397 Instructional Design * or 39-605/6 Product Design

**Additional Options**

- 76-318 Communicating in the Global Marketplace *
- 76-476 Rhetoric of Science
- 76-395 Science Writing *
- 76-380 Research Methods for Writers
- 76-385 Intro to Discourse Analysis
- 76-386 Language & Culture
- 76-387 Intro to Sociolinguistics
- 76-389 Grammar
- 76-392 Rhetoric & Public Policy
- 76-419 Communication Revolutions & Technologies
- 76-301 Internship *

* Courses with prerequisites. Check course descriptions for details.

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
- 05-413 Human Factors
- 05-499 Social Issues in Computing
- 15-105 Concepts in Computation
- 15-xxx Computer Science courses beyond the 2 required
- 19-211 Computer and Society
- 19-403 Policies of Wireless Systems and the Internet
- 19-448 Science, Technology, and Ethics
- 36-203 Sampling, Surveys, and Society
- 36-309 Experimental Design for Behavioral and Social Sciences
- 36-350 Data Mining
- 51-261/2 Communication Design Fundamentals
- 51-263/4 Industrial Design Fundamentals

70-311 Organizational Behavior
70-332 Business, Society, and Ethics
70-342 Managing Across Cultures
70-209 Theory & Practice in Anthropology
70-212 Technology and the Environment in Global Historical Context
70-230 Technology in American Society
70-358 Complex Technological Systems: Past, Present, Future
80-220 Philosophy of Science
80-221 Philosophy of Social Science
80-241 Ethical Judgments in Professional Life
80-242 Conflict Dispute Resolution
80-243 Business Ethics
80-244 Environment, Management and Ethics
80-291 Issues in Multimedia Authority
80-300 Minds, Machines, and Knowledge
80-341 Computers, Society, and Ethics
80-300 Minds, Machines, and Knowledge
85-211 Cognitive Psychology
85-213 Human Information Processing and Artificial Intelligence
85-241 Social Psychology
85-370 Perception
85-392 Human Expertise
85-395 Applications of Cognitive Psychology
85-413 Human Factors
85-417 Cognitive Modeling and Intelligent Tutoring Systems
88-223 Decision Analysis & Decision Support Systems
88-260 Organizations
88-341 Organizational Communication
88-366 Social Issues in Computing

Scientific & Medical Communication Track

**English Department Core:**

2 courses, 18 units

Complete both courses.

- 76-26x (Creative NonFiction, Fiction, Poetry, or Screenwriting)
- 76-294 Interpretive Practices

**Core Requirements for TWC:**

4 courses, 42 units

Complete all 4 courses.

- 76-271 Introduction to Professional & Technical Writing
- 76-390 Style
- 76-391 Document Design *
- 76-487 On-Line Information Design **

* prerequisite = 76-271
** prerequisite = 76-271 + 76-391

**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 Elective MUST be from this set (and all three should be strongly considered as options)

- 76-476 Rhetoric of Science
- 76-395 Science Writing *
- 76-494 Healthcare Communications *

**Additional Options**

- 76-481 Writing for Multimedia *
- 76-478 Communicating in the Global Marketplace *
- 76-419 Communication Revolutions & Technologies
- 76-301 Internship *
- 76-380 Research Methods for Writers
- 76-385 Intro to Discourse Analysis
- 76-386 Language & Culture
- 76-387 Intro to Sociolinguistics
- 76-389 Grammar
- 76-392 Rhetoric & Public Policy
- 76-419 Communication Revolutions & Technologies
- 76-301 Internship *
- 36-203 Sampling, Surveys, and Society
36-309 Experimental Design for Behavioral and Social Sciences
79-234 Body Politics: Women and Health in America
79-334 Health Policy: Historical Perspectives
79-335 Drug Use and Drug Policy
79-358 Complex Technological Systems: Past, Present, Future
79-384 Medicine and Society
79-385 History of Biomedical Research
80-220 Philosophy of Science
80-225 History and Philosophy of Science I
80-244 Management, Environment, and Ethics
80-245 Medical Ethics
88-223 Decision Analysis & Decision Support Systems

* English Department courses that have prerequisites. Course options in other departments may also have prerequisites. Please check appropriate departmental course listings for details. Additional options may be available and will be announced on a semester-by-semester basis.

Natural Sciences & Engineering:
3 courses, 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
03-321/2 Biochemistry
09-105 Modern Chemistry I
09-106 Modern Chemistry II
09-221 Lab I: Intro to Chemical Analysis
33-111 Physics for Science Students I
33-112 Physics for Science Students II
42-101 Introduction to Biomedical and Health Engineering
42-202 Physiology
76-341 Intro to Biomechanics
42-347 Rehabilitation Engineering
42-444 Medical Devices

TWC / TC Track
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.

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<th>Senior Year Fall</th>
<th>Spring</th>
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<tr>
<td>Intro to Professional &amp; Technical Writing 76-271</td>
<td>Style 76-390</td>
<td>Document Design 76-391</td>
<td>On-Line Information Design 76-487+488*</td>
</tr>
<tr>
<td>Interpretive Practices 76-294</td>
<td>Survey of Forms 76-26x</td>
<td>Theory/ Specialization Course - Recommended Option</td>
<td>Theory/ Specialization Course</td>
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<tr>
<td>TC Elective</td>
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* Because of prerequisites and course scheduling, it is critical that these courses be taken in this order and in the semester (fall or spring) indicated in order to complete the degree in two years.

Technical Writing & Communication, SMC Track
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.

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<td>On-Line Information Design 76-487+488*</td>
</tr>
<tr>
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<td>Survey of Forms 76-26x</td>
<td>Natural Science/ Engineering Course</td>
<td>TC Elective</td>
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<tr>
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</tbody>
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Elective
Elective
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* Because of prerequisites and course scheduling, it is critical that these courses be taken in this order and in the semester (fall or spring) indicated in order to complete the degree in two years.
Completing an Additional Major in English

Students with interests that include more than one of the department’s degrees have the option of completing a double major within the department. Students may double major in any combination 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 B.A. in Professional Writing and the B.S. in Technical Writing for a double major 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 two courses of the English Department Core — Interpretive Practices and Survey of Forms — need to be taken only once to 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 double-majoring in the B.A. in English and the B.A. in Creative Writing would take the 4 English Electives required for Creative Writing. Because the two English Department Core courses 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 English major by completing 5 to 6 additional courses. For example, a student who has fulfilled all 11 requirements for the BA in English can complete the BA in Creative Writing by adding the 5 courses of the Creative Writing Core: one additional Survey of Forms course plus 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 an additional 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 degree. 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 an additional 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 a minor in English, with concentrations in Creative Writing, English Studies, Professional Writing, and Technical Writing. The minor requires a minimum of five courses (45 units), plus completion of (or credit for) 76-101 or an equivalent requirement. The minor in English is 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 Concentration

Complete 6 courses, including 76-101 as a prerequisite.

76-101 Interpretation & Argument (or credit for equivalent course)
76-294 Interpretive Practices (prerequisite for 300- and 400-level courses)

76-3xx Two 300-level courses in Literature, Cultural Studies or Rhetoric
76-3xx/4xx One additional 300-level course or a 400-level seminar in Literature, Cultural Studies, or Rhetoric *
76-xxx One 200-level or above English Elective **

* Note that at least some 400-level seminars have 76-394: Research in English Studies as a pre- or co-requirement. Students planning to take a 400-level seminar to fulfill this requirement should plan to take 76-394 as one of their 300-level courses.

** The English Elective may be any course offered by the English Department except 76-201, 76-205, and 76-206, all of which are designed primarily for non-majors.

Creative Writing Concentration

Complete 6 courses, including 76-101 as a prerequisite.

76-101 Interpretation & Argument (or credit for equivalent course)
76-260/ 265 Survey of Forms: Fiction* or Poetry *
76-36x /
46x Two Fiction or Poetry Workshop courses
76-xxx One 200-level or above Literature Course
76-xxx One 200-level or above English Elective **

* 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 F 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 76-201, 76-205, and 76-206, all of which are designed primarily for non-majors.

Professional Writing Concentration

Complete 6 courses, including 76-101 as a prerequisite.

76-101 Interpretation & Argument (or credit for equivalent course)
76-270 Writing in the Professions or
76-271 Introduction to Professional & Technical Writing
76-3xx/4xx Two 300- or 400-level Writing courses *
76-3xx/4xx One Rhetoric/Language Studies course
76-xxx One 200-level or above English elective **

* 76-270 or 76-271 is generally the prerequisite for these 300- and 400-level courses. Options include 76-318, 76-319, 76-372, 76-375, 76-391, 76-395, 76-396, 76-397, 76-461, 76-472, 76-479, 76-481, 76-487, 76-491, 76-494, and other options advertised on a semester-by-semester basis.

** The English Elective may be any course offered by the English Department except 76-201, 76-205, and 76-206, all of which are designed primarily for non-majors.

Technical Writing Concentration

Complete 6 courses, including 76-101 as a prerequisite.

76-101 Interpretation & Argument (or credit for equivalent course)
76-271 Introduction to Professional & Technical Writing
76-3xx/4xx Two 300- or 400-level courses* from these options:
76-318 Communications in the Global Marketplace
76-383 Multimedia Authoring II
76-385 Introduction to Discourse Analysis
76-390 Style
76-391 Document Design
76-397 Instructional Design
76-392 Rhetoric and Public Policy
76-480 Document Design
76-487 On-Line Information Design
76-476 Rhetoric of Science
76-481 Writing for Multimedia
76-491 Software Documentation
76-494 Healthcare Communication

76-3xx/4xx One Rhetoric/Language Studies course
76-xxx One 200-level or above English Elective **
The MAPW 4+1 Program

Undergraduate majors in any of the department's four programs may apply for admission to the Master of Arts in Professional Writing (MAPW) during their junior or senior year. Students in any of the undergraduate majors in English who have taken undergraduate courses in Rhetoric and Professional or Technical Writing that match requirements in the MAPW program may, upon evaluation of their undergraduate courses by the Director of the MAPW program, receive credit for up to four courses, or one full semester of work toward the M.A. requirements. Such credit will reduce the coursework requirements for the MAPW program from the usual three semesters to two (plus the summer internship required of all MAPW students). Students, including Bachelor of Humanities and Arts (BHA) students with concentrations in English, who are interested in applying to the 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.

Faculty

MARIAN AGUIAR, Assistant Professor of English and Literary and Cultural Studies — Ph.D., University of Massachusetts; Carnegie Mellon, 2002 —.

STEPHANIE BATISTE, Assistant Professor of English and Literary and Cultural Studies — Ph.D., The George Washington University; Carnegie Mellon, 2003 —.

JANE BERNSTEIN, Professor of English and Creative Writing — M.F.A., Columbia University; Carnegie Mellon, 1991 —.

ANTHONY BUTTS, Associate Professor of English and Creative Writing — Ph.D., University of Missouri-Columbia; Carnegie Mellon, 2001 —.

CLAUDIA CARLOS, Assistant Professor of English — 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 —.

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 —.

TERRANCE HAYES, Professor of 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. KAUPER, Professor of English and Rhetoric; Head of the English Department — Ph.D., University of Wisconsin; Carnegie Mellon, 1980 —.

ALAN KENNEDY, Professor of English — Ph.D., University of Edinburgh; Carnegie Mellon, 1989 —.

JON KLANCHER, Associate Professor of English — Ph.D., University of California at Los Angeles; Carnegie Mellon, 1999 —.

PEGGY A. KNAPP, Professor of English — 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 — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983 —.

KATHLEEN NEUMAN, Associate Professor of English and Literary and Cultural Studies — Ph.D. Yale University; Carnegie Mellon, 1997 —.

ANDREEA RITIVOI, Associate Professor of English — 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 of English and Rhetoric — Ph.D., New York University; Carnegie Mellon, 1946 —.

KRISTINA STRAUB, Professor of English and Associate Head of the English Department — Ph.D., Emory University; Carnegie Mellon, 1987 —.

DANIELLE WETZEL, Lecturer and 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. SUNY—Stoneybrook; Carnegie Mellon, 2004 —.

MICHAEL WITMORE, Associate Professor of English and Literary and Cultural Studies — Ph.D., University of California—Berkeley; Carnegie Mellon, 1999 —.

** 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 conduct 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; nonprofit and public service organizations; public relations, advertising, and marketing firms; software and technology companies; and hospitals and medical communication concerns.

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 76-101. Internships generally carry 3-9 units of credit. A 9-unit internship is the standard and requires a minimum of 120 hours (8-10 hours per week) 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.
JAMES WYNN, Assistant Professor of English a — Ph.D.,
University of Maryland—Berkeley; Carnegie Mellon, 2006—.
Undergraduate programs in History focus on new ways to understand the past and new ways to use what we know. The programs all deal with connections between past and present and the ways historical understanding facilitates the assessment of social, cultural, and policy change. The programs emphasize analysis and empirical methods in developing conceptual understanding. In addition, specific research skills relevant to many types of jobs as well as to further professional training are taught. The Department’s mission also includes courses introducing students to various societal settings and diverse types of controversial public issues, thus contributing actively to students’ liberal and professional development.

Each of the History programs combines a structured sequence, training in research methods and relevant theory, and a considerable amount of electives. Each program stems from the teaching and research strengths of a department that has led in the formulation of a number of innovative approaches to the study of social and policy change. Carnegie Mellon’s Department of History is nationally known for its strength in three broad areas: Social and Cultural History, History and Policy, and Anthropology and History. Social and Cultural History is the effort to understand the past as it was experienced and shaped by people at various levels, from lower class to elite. Social historians do research in such areas as how families and communities developed, how people’s work lives were organized and how they used their leisure time, what they believed and felt, and how they related to the authority of the state and other sources of power in their particular society. History and Policy uses historical explanation and analysis to inform the interpretation and formulation of policy in both the public and private sectors. Policy historians bring to contemporary social issues a perspective on change and innovation that others (for example, legislators or operations researchers) often lack. Anthropology and History takes advantage of the fruitful interaction between theories and methodologies elaborated in both disciplines to provide a more profound analysis of social processes or cultures of the people that they study.

The History Department supports several research centers to coordinate sponsored research by faculty and graduate students. The research centers include the Center for History and Policy (Caroline Acker, Director); the Center for Business, Technology, and the Environment (Joel A. Terr, Director; David A. Hounshell, Associate Director); and the Center for African American Urban Studies and the Economy (CAUSE) (Joe W. Trotter, Director; Tera Hunter, Associate Director). The department also supports The Center for Arts and Society (Judith Schachter, Director); and the Center for Historical Information Systems and Analysis (CHISA) (David Miller, Director).

The Department of History offers B. A. and B. S. degrees in Social and Cultural History, History and Policy, and Anthropology and History. Each of these majors is described below.

The Majors in History

The study of history involves not only the mastery of a body of subject matter, but also the development of a range of skills which are broadly applicable in modern society. Exploration of patterns in the past aids in understanding the workings of human society, while historical research and study promote abilities in handling and interpreting data that have a variety of uses. The Carnegie Mellon History programs are devoted to innovative approaches to history and to the development of key skills.

History provides a springboard to a number of career options. There is, of course, a profession of history, composed largely, but not exclusively, of historians who teach and conduct research in colleges and universities. The normal way to enter that profession is to complete a Ph.D. in the history department of a major university, and several undergraduate students with a major in the History Department go on to do just that. Most students who complete a major in the History Department, however, do not become professional historians in the sense that this term is normally used. History as a major is often chosen by students who plan to enter a profession which will require training in a post-baccalaureate professional school, such as law, business administration, public policy, urban planning, library science, journalism, the ministry, or social work. Most schools in these fields prefer students who have used their undergraduate years to acquire a strong liberal education and a broad perspective on human problems such as one gained by majoring in History, rather than students with narrowly specialized programs and skills.

History is also excellent preparation for certain specific careers which can be entered immediately upon graduation. The U. S. Foreign Service is one traditional avenue for History majors, especially those who have also acquired language skills, and there are a number of other government agencies that recruit History and other liberal arts graduates. Because History courses emphasize research and writing skills plus analysis of social and policy trends, journalism and editorial work are also natural careers for History majors.

The horizons for a student with a major in the History Department include business careers as well. Most majors in the History Department, at Carnegie Mellon and elsewhere, take jobs in business, and research shows that History majors have better than average career success in management. Because they have been trained to analyze subtle and complex issues, because they develop breadth of understanding, because they are accustomed to digging out information and making sense of it, and because they have learned to present their findings effectively, students with a major in the History department do extremely well in many different types of organizations, both public and private, throughout their careers. A major in History provides the general skills and sense of perspective that be of value as one advances to positions of greater responsibility in an organization. At the same time, Carnegie Mellon History majors are encouraged to take full advantage of complementary areas of study in the College and the University that offer other specific skills and perspectives that are an important professional addition to a major in History. Some students combine History with work in another specialty such as Business, Economics, Professional Writing, Statistics, Philosophy, Political Science, or Modern Languages.

The Department also offers a minor in History. Several other minors, described throughout this catalog, can be linked with any of the History majors to provide additional depth. These include H&SS minors in such fields as Gender Studies; Film and Media Studies; International Relations; Religious Studies; Minority Studies; Environment Studies; Policy and Management; and Russian Studies. Additional examples include minors offered in the arts, engineering, science, mathematics, business, and computer science.

History is also a central component of four interdisciplinary majors described elsewhere in this catalog: Ethics, History, and Public Policy; European Studies; Russian Studies; and International Relations.

The Major in Anthropology and History

Students who major in Anthropology and History learn to use both disciplines in analyzing pattern and change in human societies. The major examines the ways in which anthropological theories and methods can enrich an understanding of historical processes and events. The major also points to the ways historical method can strengthen the cross-cultural and ethnographic approaches central to anthropology. Throughout, the value of interdisciplinary work is emphasized.
In two preliminary courses, students are exposed to the basic concepts and perspectives of each discipline. At the intermediate level they select from two sets of courses combining historical and anthropological analysis: thematic courses that relate culture and symbols to institutions, daily life, and social change; and regional courses that allow students to study an evolving culture and society in its own terms as well as ours. In the senior year, students undertake original research which may combine field work and archival work.

Besides supplying a solid preparation for graduate work in history or anthropology, the major offers a gateway to careers in journalism, law, government, and business, especially as these address matters of multicultural or international concern. Its training in comparative and historical thinking will also be valuable in such professions as teaching, design, and medicine.

**Curriculum**

Students majoring in Anthropology and History normally are awarded a B.A. degree. Students should consult with departmental advisors about their course of study when declaring their major. The B.S. degree requires 36-201, Statistical Reasoning, and is awarded when it is deemed appropriate after a review of a student's overall undergraduate record including second majors, minors, and elective courses.

**Prerequisite Course**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-104 Introduction to World History</td>
<td>9 units</td>
</tr>
<tr>
<td>79-201 Introduction to Anthropology</td>
<td>9 units</td>
</tr>
</tbody>
</table>

**Historical Evidence and Interpretation (1) 12 units**

79-200 Historical Evidence and Interpretation

This course focuses on a single critical event in history (e.g., the French Revolution, the Cuban missile crisis). Materials in the course will include examples of various types of explanation as well as primary sources. The course is a common experience for students in this major and in the History and Policy and the Social and Cultural History majors.

**Theory and Practice in Anthropology (1) 9 units**

79-209 Theory and Practice in Anthropology

**Regional Courses (3) 27 units**

Choose three from among the following courses in African, Asian, European, and Latin American/Caribbean history. At least one of the courses must be a non-European course.

79-207 Development of European Culture
79-253 Development of Caribbean Culture
79-254 The Pacific Islands: History and Culture
79-255 Irish History
79-258 Introduction to African History: 18th Century to Neo-Colonialism
79-260 Mayan America
79-267 Pre Colonial West African History 1100 to 1800
79-268 From the Local to the Global: Africa in the World
79-270 Chinese Culture and Society
79-271 Modern China
79-288 Bananas, Baseball, and Borders: Latin America and the US from Alamo to Drug Wars
79-289 Development of South Asian Culture and Society
79-290 Between Revolutions: The Development of Modern Latin America
79-307 The Anthropology of Europe
79-310 Modern Spain: Culture, Politics and Society
79-319 The City and the Country in Modern Europe
79-356 Introduction to African History: Earliest Times to the Origins of the Slave Trade
79-374 Women in Modern India

**Thematic Courses (2) 18 units**

Choose two courses from among the following:

79-210 Picturing Others: A Course on Ethnographic Film
79-301 Ritual, Culture and Identity
79-303 Visual Anthropology

79-308 The Politics and Culture of Memory
79-312 Medical Anthropology
79-348 Objects of Value
79-364 Art, Anthropology, and Empire
79-392 Dilemmas and Controversies in Anthropology
79-404 Extreme Ethnography

**Advanced Studies in Anthropology and History (1) 12 units**

79-400 Advanced Studies in Anthropology and History*

*prerequisites: 79-200, 79-201 and 79-209

**Anthropology and History, B.A. and B.S.**

**Sample Curriculum**

<table>
<thead>
<tr>
<th>Junior Year</th>
<th>Fall</th>
<th>Spring</th>
<th>Senior Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory &amp; Practice in Anthropology</td>
<td>79-201</td>
<td>Theory &amp; Practice</td>
<td>79-209</td>
<td>Intermediate Regional Course</td>
<td>79-xxx</td>
</tr>
<tr>
<td>Historical Evidence &amp; Interpretation</td>
<td>79-200</td>
<td>Intermediate Regional Course</td>
<td>79-xxx</td>
<td>Advanced Studies in Anthropology and History</td>
<td>79-400</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
<td>Elective</td>
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<td>Elective</td>
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<td>Elective</td>
</tr>
</tbody>
</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed 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.

**Additional Major**

Anthropology and History may be scheduled as an additional major in consultation with the departments concerned.

**The Major in History and Policy**

The History and Policy major is designed to develop a special kind of policy analyst who applies the skills and interests of historians to current problems of policy in government and business. Besides providing a thorough grounding in historical analysis, the History and Policy major includes courses on theories of public policy and the role of the state. Other courses focus on specific policy areas such as urban planning, business development and regulation, the environment, public health, criminal justice, foreign policy, education, and social welfare. The major culminates with the History and Policy Project Course, in which students act as a team of consultants who apply historical understanding to bear on the making of decisions in the present and on projects for the future. History and Policy prepares students to use comparisons with past policy effectively so that experience can properly contribute to recommendations and
decision-making in the present. It develops an ability to assess social trends, in order to establish both continuities and discontinuities as the context for determining appropriate policy. Students also apply tools from other disciplines such as the social sciences to evaluate policy problems and to study how problems have been recognized, formulated, and assessed.

Carnegie Mellon has pioneered in the systematic application of historical perspective to policy issues. The History and Policy major prepares students for work in a number of policy areas while also serving as excellent preparation for graduate work in public policy, management, law, public health, journalism, social work, and business administration. At the same time, students are broadly prepared for intelligent participation in decision making in the leading problem areas of contemporary society.

**Curriculum**

Students majoring in History and Policy normally are awarded a B.A. degree. Students should consult with departmental advisors about their course of study when declaring their major. The B.S. degree requires 36-201, Statistical Reasoning, and is awarded when it is deemed appropriate after a review of a student's overall undergraduate record including second majors, minors, and elective courses.

**Prerequisite Course**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-104</td>
<td>Introduction to World History</td>
</tr>
</tbody>
</table>

**Survey Course**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose one survey course from among the following:</td>
<td></td>
</tr>
<tr>
<td>79-206</td>
<td>Development of American Culture</td>
</tr>
<tr>
<td>79-207</td>
<td>Development of European Culture</td>
</tr>
<tr>
<td>79-253</td>
<td>Development of Caribbean Culture</td>
</tr>
<tr>
<td>79-258</td>
<td>Introduction to African History: 18th Century to Neo-Colonialism</td>
</tr>
<tr>
<td>79-270</td>
<td>Chinese Culture and Society</td>
</tr>
<tr>
<td>79-280</td>
<td>Russian History: From the First to the Last Tsar</td>
</tr>
<tr>
<td>79-281</td>
<td>Russian History: From Communism to Capitalism</td>
</tr>
<tr>
<td>79-290</td>
<td>Between Revolutions: The Development of Modern Latin America</td>
</tr>
<tr>
<td>79-356</td>
<td>Introduction to African History: From the Earliest Times to the Origins of the Slave Trade</td>
</tr>
<tr>
<td>79-202</td>
<td>The History of Public Policy in the United States</td>
</tr>
<tr>
<td>79-208</td>
<td>Theory and Practice in History and Policy*</td>
</tr>
</tbody>
</table>

* Prerequisite: 79-202; Open only to declared majors in History and Policy

**Historical Evidence and Interpretation (1)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-200</td>
<td>Historical Evidence and Interpretation</td>
</tr>
</tbody>
</table>

This course focuses on a single critical event in history (e.g., the French Revolution, the Cuban missile crisis). Materials in the course will include examples of various types of explanation as well as primary sources. The course is a common experience for students in this major and in the Anthropology and History and the Social and Cultural History majors.

**History and Policy Introductory Courses (2)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-230</td>
<td>Technology in American Society</td>
</tr>
<tr>
<td>79-231</td>
<td>American Foreign Policy: 1945 to the Present</td>
</tr>
<tr>
<td>79-232</td>
<td>Vietnam: America's Lost War</td>
</tr>
<tr>
<td>79-233</td>
<td>The United States and the Middle East Since 1945</td>
</tr>
<tr>
<td>79-242</td>
<td>African-American History II</td>
</tr>
<tr>
<td>79-244</td>
<td>Pittsburgh and the Transformation of Modern Urban America</td>
</tr>
<tr>
<td>79-248</td>
<td>History and Theory of Property: Land, Bodies, Ideas and Information</td>
</tr>
</tbody>
</table>

**Public Agenda History Courses (4)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-256</td>
<td>Biology and Society: Evolution, Animal Experimentation and Eugenics</td>
</tr>
<tr>
<td>79-263</td>
<td>From Soil to Oil: Energy, Ecology and Globalization</td>
</tr>
<tr>
<td>79-282</td>
<td>The Soviet Union in World War II: Military, Political and Social History</td>
</tr>
<tr>
<td>79-288</td>
<td>Bananas, Baseball, and Borders: Latin America and the US from Alamo to Drug Wars</td>
</tr>
<tr>
<td>79-289</td>
<td>Development of South Asian Culture and Society</td>
</tr>
<tr>
<td>79-296</td>
<td>Genes, Clones and Stem Cells: Biology and Society in the 20th Century and Beyond</td>
</tr>
<tr>
<td>79-306</td>
<td>African American Urban History</td>
</tr>
<tr>
<td>79-309</td>
<td>The Politics of American Military Recruitment: Historical Perspective</td>
</tr>
<tr>
<td>79-330</td>
<td>The American Presidency</td>
</tr>
<tr>
<td>79-331</td>
<td>Crime and Punishment in American History</td>
</tr>
<tr>
<td>79-332</td>
<td>Juvenile Delinquency: Images, Realities and Shaping of Public Policy 1800-1960</td>
</tr>
<tr>
<td>79-335</td>
<td>Drug Use and Drug Policy</td>
</tr>
<tr>
<td>79-336</td>
<td>Epidemic Disease and Public Health</td>
</tr>
<tr>
<td>79-337</td>
<td>Educational Policy: Historical Perspectives</td>
</tr>
<tr>
<td>79-342</td>
<td>Science, Technology and Society</td>
</tr>
<tr>
<td>79-344</td>
<td>Science, Technology and the Cold War</td>
</tr>
<tr>
<td>79-345</td>
<td>American Environmental History: Critical Issues</td>
</tr>
<tr>
<td>79-354</td>
<td>Stalin and Stalinism</td>
</tr>
<tr>
<td>79-358</td>
<td>Complex Technological Systems: Past, Present, and Future</td>
</tr>
<tr>
<td>79-368</td>
<td>Poverty, Charity and Welfare in Historical Perspective</td>
</tr>
<tr>
<td>79-397</td>
<td>Religion and Politics in the Middle East</td>
</tr>
<tr>
<td>79-440</td>
<td>The Rise of Industrial Research and Development</td>
</tr>
</tbody>
</table>

* With advance approval by the Undergraduate Advisor, students may substitute one social science course from another department or school (e.g., SDS, EPP, Philosophy, Statistics, Heinz School) that adds depth to specific policy history interests.

**History and Policy Project Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-409</td>
<td>History and Policy Project Course Mini*</td>
</tr>
<tr>
<td>79-410</td>
<td>History and Policy Project Course**</td>
</tr>
</tbody>
</table>

* Prerequisites: 79-200, 79-202, 79-208
** Prerequisites: 79-200, 79-202, 79-208, 79-409

**Sample Curriculum**

<table>
<thead>
<tr>
<th>Junior Year Fall</th>
<th>Spring</th>
<th>Senior Year Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Course 79-xxx</td>
<td>Public Agenda Course 79-xxx</td>
<td>History and Policy Project Course 79-410</td>
<td>Public Agenda Course 79-xxx</td>
</tr>
<tr>
<td>Historical Evidence &amp; Interpretation 79-200</td>
<td>Theory and Practice in History and Policy 79-208</td>
<td>Public Agenda Course 79-xxx</td>
<td>Elective</td>
</tr>
<tr>
<td>The History of Public Policy in the U.S. 79-202</td>
<td>History and Policy Project Course Mini 79-409</td>
<td>Public Agenda Course 79-xxx</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
<td>Elective</td>
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<tr>
<td>Elective</td>
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</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

**Additional Major**

History and Policy may be scheduled as an additional major in consultation with the departments concerned.
The Major in Social and Cultural History

The Department has a national reputation in Social and Cultural History. Social and Cultural History can best be understood as the effort to understand the past as it was experienced and shaped by people at various social levels, from lower classes to elite. The Social and Cultural History major involves courses in labor, immigration, race, gender, politics and leisure, as well as in the history of culture. The Social and Cultural History major is also explicitly comparative in nature, reflecting a multi-cultural approach to the study of history. The major, finally, allows a wide range of choice in electives.

The Social and Cultural History major provides a good background for a wide variety of careers. It is excellent preparation for professional studies, such as law, but also for management programs and the ministry. Many Social and Cultural History majors also find employ-ment in government, business, and with public action groups, or in any field that prizes the ability to analyze materials and to write and think clearly.

Curriculum

Students majoring in Social and Cultural History normally are awarded a B.A. degree. Students should consult with departmental advisors about their course of study when declaring their major. The B.S. degree requires 36-201, Statistical Reasoning, and is awarded when it is deemed appropriate after a review of a student’s overall undergraduate record including second majors, minors, and elective courses.

Prerequisite Course

79-104 Introduction to World History 9 units

Survey Courses (2)

79-206 Development of American Culture 18 units
79-207 Development of European Culture

Historical Evidence and Interpretation (1)

Units 12 units

79-200 Historical Evidence and Interpretation

This course focuses on a single critical event in history (e.g., the French Revolution, the Cuban missile crisis). Materials in the course will include examples of various types of explanation as well as primary sources. The course is a common experience for students in this major and in the Anthropology and History and the History and Policy majors.

Social and Cultural History Distribution Requirements (5)

45 units

Five history courses at the 200/300 level. Of these five courses:

- one must be on African, Asian, Latin American/Caribbean, or Russian history;
- one must be substantially devoted to the period before 1900;
- two must deal with the same major geographic region (e.g. U.S., Europe, Russia, Latin America/Caribbean, East Asia);
- one additional course
- No Double-Counting

Advanced Studies in Social and Cultural History (1)

12 units

79-420 Advanced Studies in Social and Cultural History

*prerequisite: 79-200

***Majors in Social and Cultural History are also encouraged to consult with faculty about opportunities for undertaking their own research projects by enrolling in 79-421, Social and Cultural History Research Seminar and/or completing a Senior Thesis.

Social and Cultural History, B.A. and B.S.

Sample Curriculum

<table>
<thead>
<tr>
<th>Junior Year</th>
<th>Senior Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Spring</td>
</tr>
<tr>
<td>Historical Evidence &amp; Interpretation 79-200</td>
<td>Development of American Culture 79-206</td>
</tr>
<tr>
<td>Distribution Course Requirement 79-xxx</td>
<td>Distribution Course Requirement 79-xxx</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
</tr>
</tbody>
</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed 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.

Additional Major

Social and Cultural History may be scheduled as an additional major in consultation with the departments concerned.

Interdepartmental Majors Involving History

The History Department co-sponsors the Ethics, History, and Public Policy Major with the Philosophy Department, the European Studies Major with the Modern Languages Department, the International Relations Major with the Social and Decision Science Department and the Modern Languages Department, and the Russian Studies Major with the Modern Languages Department. For further information please see Interdepartmental Majors under the H&Ss section of this catalog.

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 units

79-104 Introduction to World History

(or equivalent as approved by the Department)

Introductory Courses (2)

18 units

Complete two courses.

79-206 Development of American Culture
79-207 Development of European Culture
79-253 Development of Caribbean Culture
79-258 Introduction to African History: 18th Century to Neo-Colonialism
79-270 Chinese Culture and Society
79-280 Russian History from First to Last Tsar
79-289 Development of South Asian Culture and Society
79-290 Between Revolutions: The Development of Modern Latin America
79-356 Introduction to African History: Earliest Times to the Origins of the Slave

Advanced Courses (4)

36 units

Complete four 200- or 300-level History courses

The Department of History 251
Internship Program

The History Department offers internships (or supervised off-campus work experiences) designed for qualified junior and senior majors in History, International Relations or Ethics, History, and Public Policy. In general, a QPA of 3.0 or better is required. Internships carry 3-9 units. Internships are available on a pass/fail basis only. Each internship is arranged, approved, and overseen by the Department’s Internship Director. Students have been placed at a wide variety of internship sites including: Carnegie Museums, WQED, The Juvenile Court Project, ACLU, Senator John Heinz Pittsburgh Regional History Center, and The Urban League.

Undergraduate Research Fellow

Highly qualified history majors with prior research experience may apply to serve in their senior year as research fellows in one of the department’s several research centers. 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.

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, Assistant 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. EIENBERG, Associate Teaching Professor of History - Ph.D., University of Michigan; Carnegie Mellon University, 1992–.
PAUL EISS, Associate Professor of Anthropology and History – Ph.D. University of Michigan; Carnegie Mellon, 2000–.
EDDA FIELDS-BLACK, Assistant Professor of History – Ph.D., University of Pennsylvania, Carnegie Mellon, 2001–.
WENDY Z. GOLDMAN, Professor of History – Ph.D., University of Pennsylvania; Carnegie Mellon, 1988–.
DONNA HARSCH, Associate Professor of History – Ph.D., Yale University; Carnegie Mellon, 1990–.
DAVID A. HOUNSHELL, Roderick Professor of Technology and Social Change – Ph.D., University of Delaware; Carnegie Mellon, 1991–.
TERA W. HUNTER, Associate Professor of History – Ph.D., Yale University; Carnegie Mellon, 1996–.
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–.
ROGER ROUSE, Associate Teaching Professor of History - Ph.D. Stanford University; Carnegie Mellon, 2006–.
SCOTT SANDAGE, Associate Professor of History – Ph.D. Rutgers University; Carnegie Mellon, 1995–.
JUDITH SCHACHTER, Professor of Anthropology and History; Director, Center for the Arts in Society – Ph.D., University of Minnesota; Carnegie Mellon, 1984–.
STEVEN SCHLOSSMAN, Professor of History – Ph.D. Columbia University; Carnegie Mellon 1988–.
JAYEEA SHARMA, Assistant Professor of History - Ph.D., St. Catharine’s College in the University of Cambridge; Carnegie Mellon, 2003–.

KIRON SKINNER, Associate Professor of History and Political Science – Ph.D. Harvard University; Carnegie Mellon, 1999–.
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, Assistant Professor of History - Ph.D., University of Wisconsin; Carnegie Mellon, 2005–.
JOE WILLIAM TROTTER, Mellon Professor of History; Head, Department of History – Ph.D., University of Minnesota; Carnegie Mellon, 1985–.

Adjunct Faculty

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–.
BENJAMIN REILLY, Visiting Assistant Professor of History - Ph.D., University of Pittsburgh; Carnegie Mellon, 2004–.
Department of Modern Languages

G. Richard Tucker, Department Head
Susan G. Polansky, Associate Head
Department Office: Baker Hall 160

The study of a foreign language is not only desirable but essential for successful integration into our current multinational, pluralistic world. If the United States is to achieve and maintain its respected leadership position in the world, it is incumbent upon us to educate 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, French & Francophone Studies, Hispanic Studies and Japanese

Modern Languages majors are available in Chinese, French & Francophone Studies, German, Hispanic Studies and Japanese as well as in English, European Studies and Russian Studies. These majors are designed to lead to acquisition of communicative language proficiency and substantive knowledge of other cultures.

Drawing on the unique interdisciplinary climate of the Carnegie Mellon campus, the undergraduate major in Modern Languages encourages 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, which is a state-of-the-art facility that provides students with access to authentic foreign language materials such as original television broadcasts, interactive video projects 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 China, France, Germany, Japan, Africa, Russia, Spain and Latin America. The Department also sponsors summer language courses in China, France, Germany, Japan, Russia and Spain (see http://ml.hss.cmu.edu/ml/). Foreign film series, informal conversation tables, native-speaker conversation partners, 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 their chosen languages.

The major in Modern Languages is designed to permit students to acquire communicative language proficiency in their language of specialization. Courses in literature, culture and civilization offer students a solid introduction to the main currents in national literatures as well as artistic and social movements. These courses also provide close studies of specific movements, genres, national or regional histories, literatures and cultures while continuing to promote 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 English which often include readings, discussions and papers in the foreign language. The rich technological environment of the campus (computers, videotdisks and satellite linkups) 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 professional or graduate studies. 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 complement to careers in fields such as the arts, government or public service, or volunteer work, technology, business and management, law and other areas in which proficiency in a second language is an asset.

Curriculum

Seven specializations are available to Modern Languages majors: Chinese, French and Francophone Studies, German, Hispanic Studies and Japanese as well as European Studies and Russian Studies.

Language-specific faculty advisors for these specializations are:

<table>
<thead>
<tr>
<th>Faculty Advisors</th>
<th>For Students in Majors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yueming Yu,</strong> Associate Teaching Professor of Chinese</td>
<td>Chinese</td>
</tr>
<tr>
<td><strong>Bonnie Youngs,</strong> Teaching Professor of French</td>
<td>French &amp; Francophone Studies</td>
</tr>
<tr>
<td><strong>Anne Green,</strong> Teaching Professor of German</td>
<td>German</td>
</tr>
<tr>
<td><strong>Kenya C. Dworkin y Mendez,</strong> Professor of Hispanic Studies</td>
<td>Hispanic Studies</td>
</tr>
<tr>
<td><strong>Kelko Koda,</strong> Associate Professor of Japanese</td>
<td>Japanese</td>
</tr>
<tr>
<td><strong>Beryl Schlossman,</strong> Professor of French</td>
<td>European Studies*</td>
</tr>
<tr>
<td><strong>Charlene Castellano,</strong> Teaching Professor of Russian</td>
<td>Russian Studies*</td>
</tr>
</tbody>
</table>

* The majors in European Studies and Russian Studies are interdepartmental majors offered jointly with the Department of History.

The Majors in Chinese 96-99 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam 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.

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 of these courses can be granted based on the result of the placement test administered by the program faculty.

1. Core Courses in Chinese 39 - 42 units*

Complete all four courses

<table>
<thead>
<tr>
<th>Prerequisites</th>
<th>0 - 36 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-232</td>
<td>Intermediate Chinese II**</td>
</tr>
<tr>
<td>82-331</td>
<td>Advanced Chinese I</td>
</tr>
<tr>
<td>82-332</td>
<td>Advanced Chinese II</td>
</tr>
<tr>
<td>82-333</td>
<td>Introduction to Chinese Language &amp; Culture</td>
</tr>
</tbody>
</table>

**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:

<table>
<thead>
<tr>
<th>Prerequisites</th>
<th>0 - 36 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-335</td>
<td>Selected Readings in Chinese</td>
</tr>
<tr>
<td>82-337</td>
<td>Mandarin Chinese for Oral Communication</td>
</tr>
</tbody>
</table>

** This course may be substituted by 82-235 (Intensive Intermediate Chinese).
2. Core Courses in Modern Languages 12 units

(Complete one 9 unit course plus the Senior Seminar)

82-280 Learning about Language Learning
82-281 Tutoring for Community Outreach
82-338 Literacies Across Language and Culture
82-337 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism
82-580 Senior Seminar

*In consultation with the Major Advisor, students may substitute a course related to language and culture from the listings in Chinese from another department.

Examples: 80-180 Nature of Language, 80-181 Language and Thought, 85-421 Language and Thought

3. Core course(s) in History & Society (minimum) 9 units

Complete one of the following History courses after consultation with the Major Advisor and the designated History or Modern Languages professor.

79-226 History and Cultures of East Asia
79-236 18th Century China through Literature
79-264 China's Neighbors
79-270 Chinese Culture & Society
79-271 Modern China

4. Chinese and Interdisciplinary Electives (minimum) 36 units

Complete two courses from List A and two course from List B, or two courses from List A, one course from List B and one course from List C. More courses from other departments will be added to List C as they are available.

List A: Core Chinese Electives (minimum) 18 units

82-337 Mandarin Chinese for Oral Communication (I)
82-433 Topics on Contemporary Culture of China
82-434 Studies in Chinese Traditions
82-436 Introduction to Classical Chinese
82-437 Advanced Business Chinese
82-438 Classical Chinese II
82-531/532 Special Topics: Chinese

List B: Chinese Electives (minimum) 9 units

82-334 Structure of Chinese
82-335 Selected Readings in Chinese
82-337 Mandarin Chinese for Oral Communication (I)
82-338 Mandarin Chinese for Oral Communication (II)
82-339 Media Literacy in Chinese
82-336 Chinese Americans in Literature
82-433 Topics on Contemporary Culture of China
82-434 Studies in Chinese Traditions*
82-436 Introduction to Classical Chinese
82-437 Introduction to Chinese Literature
82-438 Advanced Business Chinese
82-439 Classical Chinese II
82-531/532 Special Topics Chinese

* Students may repeat with new topics.

The x-numbered courses will be added over the next few years when more teaching staff is available.

List C: Interdisciplinary Electives 9 units

Students should consult OLA 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
48-351 Human Factors in Architecture
48-442 Asian Architecture
48-551 Ethics and Decision Making in Architecture

Art
60-373 Aesthetics from a Global Point of View
60-399 Art History/Theory Independent Study

Business
70-342 Managing across Cultures
70-365 International Trade and International Law
70-430 International Management

English
76-318 Communicating in the Global Marketplace
76-339 Advanced Studies in Film: Darkness, Despair, Desire
76-350 Asian American Literature
76-386 Language and Culture
76-387 Sociolinguistics
76-442 Communication across Cultures

History
79-225 Religions of China
79-226 History and Cultures of East Asia
79-236 18th Century China through Literature
79-247 East Asians in Film
79-270 Chinese Culture & Society
79-271 Modern China
79-283 East Asia and World War II
79-301 Ritual, Culture, and Identity
79-306 East Asians in Film
79-365 Climate Change, Energy Policy and Environmental Protection

Modern Languages
82-280 Learning about Language Learning
82-281 Tutoring for Community Outreach
82-358 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism
82-580 Senior Seminar

Philosophy
80-180 The Nature of Language
80-181 Language and Thought
80-280 Linguistic Analysis
80-276 Philosophy of Religion
80-380 Philosophy of Language

Psychology
85-375 Cross Cultural Psychology
85-421 Language and Thought

Social and Decision Science
88-357 Comparative Foreign Policy: China, Russia and the US

5. Additional Requirement

Oral Proficiency Interview

Complete an oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the test.

Study Abroad

A semester or year of study abroad or internship is strongly recommended.

Chinese (B.A.)

Sample Curriculum

This sample curriculum assumes that all prerequisites for 82-331 are fulfilled prior to the Junior year.

<table>
<thead>
<tr>
<th>Junior Year</th>
<th>Fall</th>
<th>Spring</th>
<th>Senior Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Chinese I 82-331</td>
<td>Advanced Chinese II 82-332</td>
<td>Core Chinese Elective List A</td>
<td>Core Chinese Elective List A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction to Chinese Language and Culture 82-333</td>
<td>Core History Course</td>
<td>Chinese Elective List B or C</td>
<td>Chinese Elective List B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core Modern Language Department Course</td>
<td>Elective</td>
<td>Elective</td>
<td>Senior Seminar 82-580</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business Elective</td>
<td>Elective</td>
<td>Elective</td>
<td>Elective</td>
<td>Elective</td>
<td></td>
</tr>
</tbody>
</table>
This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements as early as the start of the sophomore year; and in some instances, in the first year. Students should consult their advisor when planning their program.

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 level courses) during their freshman and sophomore years.

The Major in French and Francophone Studies 93 units

Students who arrive at Carnegie Mellon with previous language study and/or have high Advanced Placement, International Baccalaureate or internal placement exam 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.

Prerequisites 0 - 42 units

Intermediate level proficiency in the appropriate language. 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
82-304 The Francophone World
82-305 French in its Social Contexts*

* 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 Senior Seminar)
82-280 Learning about Language Learning
82-281 Tutoring for Community Outreach
82-358 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism
82-580 Senior Seminar (3 units)

*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 Nature of Language, 80-181 Language and Thought, 85-421 Language and Thought.

3. French and Francophone Interdisciplinary Electives

Complete 45 units from List A and 9 units from List B.

List A. French and Francophone Electives
82-401 Francophone Popular Song
82-404 Francophone Realities
82-405 Image of Modernity: Baudelaire and the Painting of Modern Life
82-407 French Modernism: The Arts in Society
82-408 Matisse, Chagall, Picasso and Their Contemporaries: Art and Museums on the Riviera

82-415/416 Topics in French and Francophone Studies
82-501/502 Special Topics: French

List B. Interdisciplinary Electives

English
76-239 Introduction to Film Studies
76-345 Contemporary Literary and Cultural Theory
76-386 Language and Culture
76-387 Introduction to Sociolinguistics
76-483 Cross Cultural Rhetoric

History
79-205 20th Century Europe: Collapse and Renewal
79-307 The Anthropology of Europe
79-321 Picasso and 20th Century Art
79-324 Modernism and Painting, 1880-1945
79-325 Art and Religion

Modern Languages
82-380 Learning About Language Learning
82-381 Tutoring for Community Outreach
82-385 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition
82-386 Undergraduate Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism

Music
57-203 Medieval, Renaissance, and Baroque Music History
57-204 Eighteenth and Nineteenth Century Music History
57-205 Twentieth Century Music History
57-306 World Music
57-321 Music and the Literary Imagination
57-323 Poetry and Music
57-324 Music and Dance
57-325 Music and Film
57-396 Introduction to Interdisciplinary Studies
57-397 European and American Cultural Studies
57-398 Global Heartbeat: A Cross Cultural Appreciation of Art, Song and Politics
58-399 Music, Cinema, Culture

Philosophy
80-280 Linguistic Analysis
80-180 The Nature of Language
80-180 Language and Thought
80-380 Philosophy of Language

Psychology
85-375 Cross Cultural Psychology
85-421 Language and Thought

New courses will be added as appropriate.

4. Additional Requirement

Oral Proficiency Interview

Complete an oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the test.

Study Abroad

A semester or year of study abroad or internship is strongly recommended.

French and Francophone (B.A.)

Sample Curriculum

<table>
<thead>
<tr>
<th>Junior Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>French Culture</td>
<td>82-303</td>
<td>French in its Social Contexts 82-305</td>
</tr>
<tr>
<td>The Francophone World</td>
<td>82-304</td>
<td>French Elective List A</td>
</tr>
<tr>
<td>Learning about Language Learning</td>
<td>82-280</td>
<td>Interdisciplinary Elective List B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Senior Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>French Elective List A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

The Major in German 93 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam 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.

Prerequisites 0 - 42 units

Intermediate level proficiency in the appropriate language. 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 27 units

Complete all three courses.
82-323 Germany, Austria, and Switzerland in the 20th Century
82-324 Contemporary Germany, Austria and Switzerland
82-325 Introduction to German Studies

* 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 Senior Seminar)
82-280 Learning about Language Learning
82-281 Tutoring for Community Outreach
82-358 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism
82-580 Senior Seminar (3 units)

*In consultation with the Major Advisor, students may substitute a course related to language analysis from the listings in German or from another department. Examples: 80-180 Nature of Language, 80-181 Language and Thought, 85-421 Language and Thought.

3. German 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
82-387 Film Festival (When offered by German Professor with German Topics) 82-420 German Classical Literature
82-421 German Literature of the Nineteenth Century
82-422 German Literature of the Early Twentieth Century
82-423 Postwar German Literature
82-424 The New Germany
82-425/426 Studies in German Literature and Culture
82-427 Nazi and Resistance Culture
82-428 History of German Film
82-521/522 Special Topics: German

List B: Interdisciplinary Electives

An additional elective(s), chosen in consultation with the Major Advisor, will be required of all students. 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
76-354 Contemporary Literary and Cultural Theory
76-386 Language and Culture
76-387 Introduction to Sociolinguistics
76-483 Cross Cultural Rhetoric

History
79-205 20th Century Europe: Collapse and Renewal 79-219 The Holocaust in Historical Perspective
79-221 Religion and Society: The European Experience
79-250 Two Revolutions: Dynamics of Change in Nineteenth Century Europe
79-251 European Cities
79-307 The Anthropology of Europe

Modern Languages
82-280 Learning about Language Learning
82-281 Tutoring for Community Outreach
82-358 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism
82-387 Film Festival (When offered by German Professor with German Topics)

Music
57-203 Medieval, Renaissance, and Baroque Music History
57-204 Eighteenth and Nineteenth Century Music History
57-205 Twentieth Century Music History
57-306 World Music
57-321 Music and the Literary Imagination
57-323 Poetry and Music
57-324 Music and Dance
57-325 Music and Film
57-396 Introduction to Interdisciplinary Studies
57-397 European and American Cultural Studies
57-398 Global Heartbeat: A Cross Cultural Appreciation of Art, Song and Politics
58-399 Music, Cinema, Culture

Philosophy
80-136 Social Structure, Public Policy and Ethical Dilemmas
80-151 God and the West
80-180 The Nature of Language
80-181 Language and Thought
80-251 Modern Philosophy
80-252 19th Century Philosophy
80-253 Continental Philosophy
80-256 Modern Moral Philosophy
80-260 Philosophy of Art
80-275 Metaphysics
80-279 Philosophy of Religion
80-280 Linguistic Analysis
80-380 Philosophy of Language

Psychology
85-375 Cross Cultural Psychology
85-421 Language and Thought

Additional courses from other departments may be added to list as information becomes available.

4. Additional Requirement: Oral Proficiency Interview

Complete an oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the test.

Study Abroad
A semester or year of study abroad or internship is strongly recommended.
German (B.A.)

Sample Curriculum

<table>
<thead>
<tr>
<th>Junior Year</th>
<th>Senior Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Fall</td>
</tr>
<tr>
<td>Germany, Austria, and Switzerland in the 20th Century 82-323</td>
<td>Contemporary German, Austria and Switzerland 82-324</td>
</tr>
<tr>
<td>Introduction to German Studies 82-325</td>
<td>German Elective List A</td>
</tr>
<tr>
<td>Learning about Language Learning 82-280</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
</tr>
</tbody>
</table>

This is presented as a two-year plan (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.

The Major in Hispanic Studies 93 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam 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.

Prerequisites 0 - 42 units

Intermediate level proficiency in the appropriate language. This is equivalent to the completion of four courses (two at the 100-level and two at the 200-level) or exemption based on Advanced Placement, International Baccalaureate or Carnegie Mellon internal placement test scores.

1. Core Courses in Hispanic Studies 27 units

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-342</td>
<td>Spain: Language and Culture</td>
</tr>
<tr>
<td>82-343</td>
<td>Latin America: Language and Culture</td>
</tr>
<tr>
<td>82-344</td>
<td>U.S. Latinos: Language and Culture</td>
</tr>
</tbody>
</table>

Complete required course.

2. Core Courses in Modern Languages 12 units

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-345</td>
<td>Introduction to Hispanic Literary and Cultural Studies</td>
</tr>
</tbody>
</table>

(Complete one 9 unit course* plus the Senior Seminar)

28-281 Tutoring for Community Outreach
82-280 Learning about Language Learning
82-358 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition

28-280 Introduction to Language Learning
82-383 Literacies Across Language and Culture
82-385 Understanding Second Language Fluency
82-387 Social and Cognitive Aspects of Bilingualism

*In consultation with the Major Advisor, students may substitute a course related to language analysis from the listings in German or from another department. Examples: 80-180 Nature of Language, 80-181 Language and Thought, 85-421 Language and Thought.

3. Hispanic Studies and Interdisciplinary Electives 54 units

Spanish (B.A.)

Complete 45 units from List A and 9 units from List B.

Sample Curriculum

List A: Hispanic Studies Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-441</td>
<td>Studies in Peninsular Literature and Culture*</td>
</tr>
<tr>
<td>82-442</td>
<td>Analysis of Spoken Spanish</td>
</tr>
<tr>
<td>82-443</td>
<td>Spanish Reading and Translation Workshop</td>
</tr>
<tr>
<td>82-444</td>
<td>The Structure of Spanish</td>
</tr>
<tr>
<td>82-445</td>
<td>U.S. Latino Literature: Necessity is the Mother of All &quot;Coyotes&quot;</td>
</tr>
<tr>
<td>82-446</td>
<td>Political Drama of Spain</td>
</tr>
<tr>
<td>82-451</td>
<td>Studies in Latin American Literature and Culture*</td>
</tr>
<tr>
<td>82-452</td>
<td>The Latin American Fin de Siglo: Modernity, Modernisms, and Underdevelopment</td>
</tr>
<tr>
<td>82-454</td>
<td>The Hispanic Caribbean: Rhyme, Reason and Song</td>
</tr>
<tr>
<td>82-455/456</td>
<td>Topics in Hispanic Studies*</td>
</tr>
<tr>
<td>82-457</td>
<td>Contemporary Latin American Texts: &quot;Back to the Future*</td>
</tr>
<tr>
<td>82-541/542</td>
<td>Special Topics: Spanish</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>76-239</td>
<td>Introduction to Film Studies</td>
</tr>
<tr>
<td>76-354</td>
<td>Contemporary Literary and Cultural Theory</td>
</tr>
<tr>
<td>76-386</td>
<td>Language and Culture</td>
</tr>
<tr>
<td>76-387</td>
<td>Introduction to Sociolinguistics</td>
</tr>
<tr>
<td>76-483</td>
<td>Cross Cultural Rhetoric</td>
</tr>
</tbody>
</table>

History

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>79-221</td>
<td>Religion in European Society</td>
</tr>
<tr>
<td>79-250</td>
<td>Two Revolutions: Dynamics of Change in Nineteenth-Century Europe</td>
</tr>
<tr>
<td>79-251</td>
<td>European Cities</td>
</tr>
<tr>
<td>79-263</td>
<td>Riots, Revolts and Revolutions</td>
</tr>
<tr>
<td>79-265</td>
<td>Ethnicity in Modern America</td>
</tr>
<tr>
<td>79-290</td>
<td>Modern Latin America, 1789 to the Present</td>
</tr>
<tr>
<td>79-292/452</td>
<td>The Latin America Fin de Siglo: Modernity, Modernisms, and Underdevelopment</td>
</tr>
<tr>
<td>79-294</td>
<td>Cultures of South America</td>
</tr>
<tr>
<td>79-307</td>
<td>The Anthropology of Europe</td>
</tr>
<tr>
<td>79-325</td>
<td>Art and Religion</td>
</tr>
</tbody>
</table>

Modern Languages

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-281</td>
<td>Tutoring for Community Outreach</td>
</tr>
<tr>
<td>82-280</td>
<td>Learning About Language Learning</td>
</tr>
<tr>
<td>82-358</td>
<td>Literacies Across Language and Culture</td>
</tr>
<tr>
<td>82-383</td>
<td>Introduction to Second Language Acquisition</td>
</tr>
<tr>
<td>82-480</td>
<td>Social and Cognitive Aspects of Bilingualism</td>
</tr>
</tbody>
</table>

Music

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>57-203</td>
<td>Medieval, Renaissance, and Baroque Music History</td>
</tr>
<tr>
<td>57-204</td>
<td>Eighteenth and Nineteenth Century Music History</td>
</tr>
<tr>
<td>57-205</td>
<td>Twentieth Century Music History</td>
</tr>
<tr>
<td>57-206</td>
<td>Music and the Literary Imagination</td>
</tr>
<tr>
<td>57-321</td>
<td>World Music</td>
</tr>
<tr>
<td>57-323</td>
<td>Poetry and Music</td>
</tr>
<tr>
<td>57-324</td>
<td>Music and Dance</td>
</tr>
</tbody>
</table>
371 are fulfilled prior to the Junior year.

This sample curriculum assumes that all prerequisites for 82-freshman and sophomore years.

Such students would need to satisfy the prerequisites (elementary and intermediate language study) during their freshman and sophomore years.

**Philosophy**

80-180 The Nature of Language  
80-181 Language and Thought  
80-280 Linguistic Analysis  
82-380 Philosophy of Language

**Psychology**

85-375 Cross Cultural Psychology  
85-421 Language and Thought

4. Additional Requirement

**Oral Proficiency Interview**

Complete the oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the test.

**Study Abroad**

A semester or year of study abroad or internship is strongly suggested.

**Hispanic Studies (B.A.)**

**Sample Curriculum**

This sample curriculum assumes that all prerequisites for 82-371 are fulfilled prior to the Junior year.

---

<table>
<thead>
<tr>
<th>Junior Year</th>
<th>Senior Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Spring</td>
</tr>
<tr>
<td>Spain</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>Introduction to Hispanic Literary and Cultural 82-345</td>
</tr>
<tr>
<td>38-342</td>
<td>Spanish Elective List A</td>
</tr>
<tr>
<td>Latin America Or U.S. Latinos Language and Culture 82-343/82-344</td>
<td>Spanish Elective List A</td>
</tr>
<tr>
<td>Learning about Language Learning 82-280</td>
<td>Spanish or Interdisciplinary Elective List A or List B</td>
</tr>
<tr>
<td>Elective</td>
<td></td>
</tr>
</tbody>
</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years, not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

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.

---

The **Major in Japanese** 93-105 units

Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate, or internal placement exam 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.

**Prerequisites 0 - 42 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 27 - 39 units**

   Complete all four courses.

   - 82-272 Intermediate Japanese II*
   - 82-273 Introduction to Japanese Language and Culture
   - 82-371 Advanced Japanese I
   - 82-372 Advanced Japanese II

   *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. **Core Courses in Modern Languages 12 units**

   Complete one 9 unit course* plus the Senior Seminar

   - 82-280 Learning about Language Learning
   - 82-281 Tutoring for Community Outreach
   - 82-358 Literacies Across America
   - 82-383 Introduction to Second Language Acquisition
   - 82-388 Understanding Second Language Fluency
   - 82-480 Social and Cognitive Aspects of Bilingualism
   - 82-580 Senior Seminar (3 units)

3. **Core Course(s) in History** *(minimum) 9 units*

   Complete one of the following History courses after consultation with the Major Advisor and the designated History or Modern Languages professor.

   - 79-263 Riots, Revolts, and Revolutions
   - 79-265 Ethnicity in Modern America
   - 79-269 Japan's Social History Since 1945
   - 79-272 Modern Japan, 1868 to the Present
   - 79-325 Art and Religion
   - 79-381 Male and Female in Japan

   *Majors are encouraged to complete at least one more History course from the list above in fulfillment of the major requirements, as well as additional courses from this list as electives. This list will evolve according to the current offerings of the Departments of History and Modern Languages.

4. **Japanese and Interdisciplinary Electives (minimum)**

   **45 units**

   **List A: Japanese Electives**

   - 82-473 Topics in Japanese Studies: Youth Culture
   - 82-474* *Topics in Japanese Studies: Samurai, Kamikaze, and Totoro
   - 82-475* *Topics in Japanese Studies: Aspects of Daily Life in a Buddhist Perspective
   - 82-476 Japanese Discourse Analysis
   - 82-571/572 Special Topics: Japanese

   *Students may repeat with new topics.

   **List B: Interdisciplinary Electives**

   An additional elective(s), chosen in consultation with the Major Advisor, will be required of all students. The student may be required to complete part of the course work in Japanese.

**English**

- 76-239 Introduction to Film Studies
- 76-354 Contemporary Literary and Cultural Theory
- 76-386 Language and Culture
- 76-387 Introduction to Sociolinguistics
- 76-483 Cross Cultural Rhetoric
History
79-265 Ethnicity in Modern America
79-269 Japan’s Social History Since 1945
79-272 Modern Japan, 1868 to the Present
79-381 Male and Female in Japan

Modern Languages
82-278 Japanese Literature in Translation
82-280 Learning About Language Learning
82-281 Tutoring for Community Outreach
82-358 Literacies Across Language and Culture
82-373 Structure of the Japanese Language
82-374 Technical Japanese
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism
82-487 On Writing in a Second Language

Music
57-203 Medieval, Renaissance, and Baroque Music History
57-204 Eighteenth and Nineteenth Century Music History
57-205 Twentieth Century Music History
57-306 WorldMusic
57-321 Music and Literary Imagination
57-323 Poetry and Music
57-324 Music and Dance
57-325 Music and Film
57-396 Introduction to Interdisciplinary Studies
57-397 European and American Cultural Studies
57-398 Global Heartbeat: A Cross-Cultural Appreciation of Art, Song and Politics
58-399 Music, Cinema, Culture

Philosophy
80-180 The Nature of Language
80-181 Language and Thought
80-280 Linguistic Analysis
80-380 Philosophy of Language

Psychology
85-375 Cross Cultural Psychology
85-421 Language and Thought

4. Additional Requirement
Oral Proficiency Interview
Complete an oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are strongly encouraged to take it by the end of the junior year. Students are permitted to retake the test.

Study Abroad
A semester or year of study abroad or internship is strongly recommended.

Japanese (B.A.)
Sample Curriculum
This sample curriculum assumes that all prerequisites for 82-371 are fulfilled prior to the Junior year.

<table>
<thead>
<tr>
<th>Junior Year</th>
<th>Senior Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>Introduction to Japanese Language and Culture 82-273</td>
<td>Core History Course</td>
</tr>
</tbody>
</table>

| **Advanced Japanese I 82-371** | **Advanced Japanese II 82-372** | **Required Elective List A** | **Required Elective List A** |
| Learning about Language Learning 82-280 | Elective | Elective/Required Elective List B | Elective |

| Elective | Elective | Elective | Elective |

| Elective | Elective | Elective | Elective |

Senior Seminar 82-580

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.

Additional Major
H&S students as well as students from other colleges may complete an additional major in Chinese, French, German, Hispanic Studies or Japanese by completing the major requirements as outlined above in addition to the requirements for their primary major. Non-H&S 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&S General Education program requirements.

Minors in the Department of Modern Languages
In addition to the majors in the Department of Modern Languages with specializations in English as a Second Language (ESL), European Studies, French, German, Hispanic Studies, Japanese, or Russian Studies, it is also possible to minor in Chinese, European Studies, French, German, Hispanic Studies, Japanese, 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:
For Students in Minors

Yueming Yu, Associate Teaching Professor of Chinese Chinese
Michael West, Teaching Professor of French French & Francophone Studies
Anne Green, Teaching Professor of German
Sono Takan Hayes, Associate Teaching Professor in Japanese
Therese Tardo, Lecturer in Hispanic Studies
Beryl Schlossman, Professor of French
Charlene Castellano, Professor of Russian Russian Studies
Yueming Yu, Anne Green, Sono Takan Hayes, Therese Tardo, Beryl Schlossman, Charlene Castellano

The minors in European Studies and Russian Studies are interdepartmental minors offered jointly with the Department of History. These minors are described in the H&SS Interdepartmental minors section of the catalog.

Curricula

The minimum requirement for the minor in French, 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 is 54-60 units, depending on the student's point of entry.

The Minor in Chinese 57-60 units

Prerequisites 0 - 36 units

Completion of Elementary Chinese I and II and Intermediate Chinese I at Carnegie Mellon University (with a minimum grade of "B") or equivalent (based on a placement test).

1. Core Courses in Chinese 39 units

Complete four courses.

82-232 *Intermediate Chinese II
82-331 Advanced Chinese I
82-332 Advanced Chinese II
82-333 Introduction to Chinese Language and Culture

* 82-235 Intensive Intermediate Chinese may be substituted for 82-232. Student may also place out of 82-232. 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 units for this category will be 39 units. Student must choose from the following two courses based on specific needs of each individual student:

82-335 Selected Readings in Chinese
82-337 Mandarin Chinese for Oral Communication

2. Chinese and Interdisciplinary Electives 9 units

List A. Chinese Electives

Complete one course after consultation with the Minor Advisor.

82-334 Structure of Chinese
82-335 Selected Readings in Chinese
82-336 Mandarin Chinese for Oral Communication I
82-338 Mandarin Chinese for Oral Communication II
82-433 Topics in Contemporary Culture of China
82-434 Studies in Chinese Traditions
82-4xx Advanced Readings in Chinese
82-4xx Business Chinese
82-5xx Classical Chinese Readings

List B. Interdisciplinary Elective (minimum) 9 units

Complete one course. Students may select another course in this category to substitute for the Core Elective.

79-225 Religions of Asia
79-270 Chinese Culture and Society
79-271 Modern China
79-275 The Chinese Cultural Revolution (mini course)
79-306 East Asians in Film
79-380 Women in Late Imperial and Modern China
82-280 Learning about Language Learning
82-387 The Film Festival*

New courses will be added as appropriate.

* This course is counted only when it has a China-related topic

The Minor in French and Francophone Studies 54 units

Prerequisites 0-42 units

Intermediate level proficiency in the French language. Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the minor earlier in their undergraduate. Study abroad is strongly recommended.

1. Core Courses in French and Francophone Studies 27 units

Complete three courses.

82-303 French Culture
82-304 The Francophone World
82-305 French in its Social Contexts*

* A 400 level course may be substituted with an advisor's approval.

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 Francophone Popular Song
82-404 Francophone Realities: Africa
82-405 Image of Modernity: Baudelaire and the Painting of Modern Life
82-407 French Modernism: The Arts in Society
82-408 Matisse, Chagall, Picasso and Their Contemporaries: Art and Museums on the Riviera
82-415/416 Topics in French and Francophone Studies
82-501/502 Special Topics: French

List B. Interdisciplinary Electives

English

76-239 Introduction to Film Studies
76-354 Contemporary Literary and Cultural Theory
76-386 Language and Culture
76-387 Introduction to Sociolinguistics
76-483 Cross Cultural Rhetoric

History

79-205 20th Century Europe: Collapse and Renewal
79-307 The Anthropology of Europe
79-321 Picasso and 20th Century Art
79-324 Modernism and Painting, 1880-1945
79-325 Art and Religion

Modern Languages

82-280 Learning About Language Learning
80-281 Tutoring for Community Outreach
80-358 Literacies Across America
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism

Music

57-203 Medieval, Renaissance, and Baroque Music History
57-204 Eighteenth and Nineteenth Century Music History
57-205 Twentieth Century Music History
57-306 World Music
57-321 Music and the Literary Imagination
57-323 Poetry and Music
57-324 Music and Dance
57-325 Music and Film
57-396 Introduction to Interdisciplinary Studies
57-397 European and American Cultural Studies
57-398 Global Heartbeat: A Cross Cultural Appreciation of Art, Song and Politics
58-399 Music, Cinema, Culture

Philosophy

80-180 The Nature of Language
80-181 Language and Thought
80-280 Linguistic Analysis
82-380 Philosophy of Language
Psychology
57-375 Cross Cultural Psychology
57-421 Language and Thought

New courses will be added as appropriate.

The Minor in German 54 units
Prerequisites 0 - 42 units
Intermediate level proficiency in the German language. Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the minor earlier in their undergraduate program. Study abroad is strongly recommended.

1. Core Courses in German 27 units
Complete three courses.
82-323 Germany, Austria and Switzerland in the 20th Century
82-324 Contemporary Germany and Switzerland
82-325 Introduction to German Studies
* A 400-level course may be substituted with an advisor’s approval.

2. German & 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 Electives
82-420 German Classical Literature
82-421 German Literature of the Nineteenth Century
82-422 German Literature of the Early Twentieth Century
82-423 Postwar German Literature
82-424 The New Germany
82-425/426 Studies in German Literature and Culture
82-427 Nazi and Resistance Culture
82-428 History of German Film
82-429 German Reading and Translation Workshop
82-520/522 Special Topics: German
82-387 Film Festival (When offered by German Professor with German Topics)

List B. Interdisciplinary Electives
An additional elective(s), chosen in consultation with the Major Advisor, will be required of all students. The student completes part of the course work in German. (Readings and or written papers in German with agreement of instructor.)

English
76-239 Introduction to Film Studies
76-354 Contemporary Literary and Cultural Studies
76-386 Language and Culture
76-387 Introduction to Sociolinguistics
76-483 Cross Cultural Rhetoric

History
79-205 20th Century Europe: Collapse and Renewal
79-219 The Holocaust in Historical Perspective
79-221 Religion and Society: The European Experience
79-250 Two Revolutions: Dynamics of Change in Nineteenth Century Europe
79-251 European Cities
79-307 The Anthropology of Europe

Modern Languages
82-280 Learning About Language Learning
82-281 Tutoring for Community Outreach
82-358 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism
82-387 Film Festival (When offered by German Professor with German Topics)

Music
57-203 Medieval, Renaissance, and Baroque Music History
57-204 Eighteenth and Nineteenth Century Music History
57-205 Twentieth Century Music History
57-306 World Music
57-321 Music and Literary Imagination

Physics
80-136 Social Structures, Public Policy and Ethical Dilemmas
80-151 God and the West
80-180 The Nature of Thought
80-181 Language and Thought
80-251 Modern Philosophy
80-252 19th Century Philosophy
80-253 Continental Philosophy
80-256 Modern Moral Philosophy
80-260 Philosophy of Art
80-275 Metaphysics
80-279 Philosophy of Religion
80-280 Linguistic Analysis
80-380 Philosophy of Language

Philosophy
85-375 Cross Cultural Psychology
85-421 Language and Thought

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 the appropriate language. Students who arrive at Carnegie Mellon with previous language study and/or who have high Advanced Placement, International Baccalaureate or internal placement exam scores will be able to begin taking courses toward the major earlier in their undergraduate program. Study abroad is strongly recommended.

1. Core Courses in Hispanic Studies
Complete required course.
82-342 Spain: Language and Culture
82-343 Latin America: Language and Culture
82-344 U.S. Latinos: Language and Culture

Complete required course.
82-345 Introduction to Hispanic Literary and Cultural Studies

2. Hispanic and Interdisciplinary 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 Electives
82-441 Studies in Peninsular Literature and Culture*
82-442 Analysis of Spoken Spanish
82-443 Spanish Reading and Translation Workshop
82-444 The Structure of Spanish
82-445 U.S. Latino Literature: Necessity is the Mother of All “Coyotes”
82-446 Political Drama of Spain
82-451 Studies in Latin American Literature and Culture
82-452 Modernisms and Underdevelopment
82-454 The Hispanic Caribbean: Ryhme, Reason and Song
82-455/456 Studies in Hispanic Studies*
82-457 Contemporary Latin American Texts: “Back to the Future”- Revision, Rewriting, and Representation
82-541/542 Special Topics: Spanish
* Students may repeat these course 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.

85-375 Cross Cultural Psychology
85-421 Language and Thought
Intermediate level proficiency in the Japanese language. Students who arrive at Carnegie Mellon with previous language study and/or who have high Advancement Placement will be able to begin taking courses toward the major earlier in their undergraduate program. Study abroad which is strongly recommended.

1. Core Courses in Japanese  
Complete four courses.

82-272 Intermediate Japanese II*
82-273 Introduction to Japanese Language and Culture
82-371 Advanced Japanese I
82-372 Advanced Japanese II

*Placement out of 82-272 is possible. For students who place out of 82-272 a minimum if 12 additional units may be taken from category 2 below.

2. Japanese and Interdisciplinary Electives

In consultation with the Minor Advisor, complete two courses from List A and one course from List B.

List A. Interdisciplinary Studies

Complete one course. Students may substitute a second Departmental Elective for the Core Elective with the permission of the Modern Languages advisor.

82-473 Topics in Japanese Studies: Youth Culture
82-474 Topics in Japanese Studies: Samurai, Kamikaze and Totoro*
82-476 Japanese Discourse Analysis
82-477 Japanese Conversation Analysis
82-571/572 Special Topics: Japanese

List B. Japanese Electives

79-265 Ethnicity in Modern America
79-269 Japan's Social History Since 1945
79-272 Modern Japan 1868 to the Present
79-381 Male and Female in Japan
82-280 Learning about Language Learning
82-281 Tutoring for Community Outreach
82-358 Literacies Across Language and Culture
82-383 Introduction to Second Language Acquisition
82-388 Understanding Second Language Fluency
82-480 Social and Cognitive Aspects of Bilingualism

Students may repeat with new topics

New courses will be added as appropriate.

Faculty

MARIANA ACHUGAR, Assistant Professor of Spanish & Second Language Acquisition — Ph.D., University of California at Davis; Carnegie Mellon University, 2003—.

STEPHEN BROCKMANN, Professor of German with a courtesy appointment in Modern Languages — Ph.D., University of Wisconsin-Madison; Carnegie Mellon University, 1993—.

CHARLENE CASTELLANO, Teaching Professor of Russian with a courtesy appointment in English — Ph.D., Cornell University; Carnegie Mellon University, 1996—.

KENYA C. DWORFIN Y MENDEZ, Associate Professor of Spanish with courtesy appointments in English and History — Ph.D., University of Michigan; Carnegie Mellon University, 1993—.

MICHEL FOUGERES, Associate Professor Emeritus of French — Ph.D., New York University; Carnegie Mellon University, 1969—.

BARBARA FREED, Professor of French and Second Language Acquisition — Ph.D., University of Pennsylvania; Carnegie Mellon University, 1990—.

FELIPE GOMEZ, Lecturer in Spanish — Ph.D., University of Michigan; Carnegie Mellon University, 2006—.

ANNE GREEN, Teaching Professor of German — Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon University, 1993—.

CHRISTIAN HALLSTEIN, Teaching Professor of German — Ph.D., University of Pittsburgh; Carnegie Mellon University, 1979—.

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BARBARA JOHNSTONE, Professor of Rhetoric and Linguistics with a courtesy appointment in Modern Languages — Ph.D., University of Michigan; Carnegie Mellon University, 1997—.

CHRISTOPHER M. JONES, Director of the Modern Language Resource Center and Teaching Professor of French — Ph.D., University of Massachusetts, Amherst; Carnegie Mellon University, 1993—.

XIAOFEI KANG, Assistant Professor of Chinese, —Ph.D. Columbia University; Carnegie Mellon University, 2006—.

KEIKO KODA, Professor of Japanese and Second Language Acquisition, — Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon University, 1995—.

BRIAN MACWHINNEY, Professor of Psychology with a courtesy appointment in Modern Languages — Ph.D., University of Pennsylvania; Carnegie Mellon University, 1990—.
appointment in Modern Languages — Ph.D., University of California, Berkeley; Carnegie Mellon University, 1981—.

SUSAN G. POLANSKY, Teaching Professor of Spanish, Associate Head of Modern Languages — Ph.D., Boston College; Carnegie Mellon University, 1986—.

GIOVANNI PUPO, Instructor of Italian — Ph.D., University of Rome; Carnegie Mellon University, 1975—.

SOPHIE QUEUNIET, Lecturer in French — Ph.D., Yale University; Carnegie Mellon University, 2003—.

BERYL SCHLOSSMAN, Professor of French and Francophone Studies and European Studies with a courtesy appointment in English — Ph.D., Université de Paris; Ph.D., Johns Hopkins University; Carnegie Mellon University, 1993—.

JURIS SILENIEKS, Professor Emeritus of French — Ph.D., University of Nebraska; Carnegie Mellon University, 1960—.

NAOKO TAGUCHI, —Professor of Japanese & Second Language Acquisition—Ph.D., Northern Arizona University; Carnegie Mellon University, 2005—.

THERESE TARDIO, Lecturer in Spanish — Ph.D. University of Pittsburgh; Carnegie Mellon University, 2001—.

G. RICHARD TUCKER, Paul Mellon University Professor of Applied Linguistics, Head of Modern Languages with a courtesy appointment in Psychology— Ph.D., McGill University; Carnegie Mellon University, 1992—.

JAN VAIRO, Instructor of Italian — M.A., University of Pittsburgh; Carnegie Mellon University, 1992—.

MICHAEL J. WEST, Teaching Professor of French — Ph.D., University of California, Santa Barbara; Carnegie Mellon University, 1989—.

DANIELLE WETZEL, —Lecturer and Director of First Year English with a courtesy appointment in Modern Languages, PhD, Carnegie Mellon University, 2006—.

SUE-MEI WU, Associate Teaching Professor in Chinese — Ph.D., Ohio State University; Carnegie Mellon University, 2000—.

BONNIE L. YOUNGS, Teaching Professor of French — Ph.D., University of Pennsylvania; Carnegie Mellon University, 1993—.

YUEMING YU, Associate Teaching Professor in Chinese — Ed.D., University of Pittsburgh; Carnegie Mellon University, 1992—.
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 an interdisciplinary major with the Department of History:

• the B.A. or B.S. in Ethics, History, and Public Policy
• the B.S. in Logic and Computation
• the B.A. in Philosophy

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

Preston Covey, Director

This is an interdepartmental major that is jointly sponsored by the Departments of History and of Philosophy. Preparing students for leadership positions is a vital goal of colleges and universities in every democratic and technologically advanced society. The intellectual challenges facing public and private sector leaders expand dramatically each year; and there is a compelling need in twenty-first-century America for broadly educated, ethically sensitive, and technically skilled public servants. They will have to demonstrate sophisticated interdisciplinary knowledge, deep understanding of how modern-day problems have evolved, and clear, rational criteria for ethical decision-making. The major in Ethics, History, and Public Policy seeks to provide students with a solid humanistic foundation for developing such high-level leadership capabilities. It also provides ample room for specialization, technical skill development, and internship experience in a wide range of policy areas. For a detailed discussion of the curriculum and the flexible tracks, consult the H&SS Interdepartmental Majors section of the catalogue.

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: Programming Fundamentals (15-111), Concepts of Mathematics (21-127), Statistical Reasoning (36-201), Arguments 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 15-211/212.

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*

15-111 or  
15-200 Intermediate/Advanced Programming (10 units)
21-127 Concepts of Mathematics  
36-201 Statistical Reasoning

Logic and Computation Core 69 units*  
80-211 Arguments and Mathematical Inquiry  
80-300 Minds, Machines, and Knowledge  
80-310 Logic and Computation  
80-311 Computability and Incompleteness  
80-511 Thesis seminar  
15-211 Fundamental Data Structures and Algorithms**  
15-212 Principles of Programming**

*Only 45 units are unique to the major; 15-211 and 15-212 count toward total units for the General Education Program, DCR6.

**It is recommended that students complete 15-211 and 15-212 in the sophomore year; H&SS students can use these courses to satisfy their General Education requirement in the category 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 (or: 80-413 Category Theory)  
80-316 Probability and Artificial Intelligence  
80-317 Constructive Logic  
15-312 Programming Languages: Design and Processing

Sample 2. A student interested in Language and Information Technology might take the following courses:

80-280 Linguistic Analysis 80-480 Linguistic Theory 80-481 Formal Semantics 80-682 Introduction to Language Technologies

Sample 3. A student interested in Artificial Intelligence and Cognitive Science might take the following courses:

80-314 Logic in Artificial Intelligence  
80-315 Modal Logic  
or:  
80-319 Computability and Learnability  
80-316 Probability and Artificial Intelligence  
85-411 Proof Theory

Sample 4. A student interested in Logic and the Foundations of Mathematics might consider the following courses:

80-312 Philosophy of Mathematics  
(or: 80-254 Analytic Philosophy)  
80-318 Proof Search  
or:  
80-411 Proof Theory  
or:  
80-413 Category Theory

Sample 5. A student interested in Methodology might consider the following courses:

80-220 Philosophy of Science  
or:  
80-221 Philosophy of Social Science  
80-319 Computability and Learnability  
80-321 Causation and Social Policy  
36-309 Experimental Design

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 of the student’s college, Philosophy majors and double majors must complete nine Philosophy courses in the Areas listed below. Only two of these nine courses may be at the 100-level, and (for H&S students) only one of them may be counted also as satisfying the College’s General Education requirements (DCR 1 through 4). 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. These nine courses can be taken during the junior and senior year.

Area 1: Values and Normative Theory 9 units
One of the following:
80-x30 through 80-x34 Ethics/Ethical Theory
80-x35 through 80-x39 Social/Political Philosophy
80-x40 through 80-x49 Applied/Professional Ethics

Area 2: Philosophy of Mind/Language/Metaphysics 9 units
One of the following:
80-x70 through 80-x79 Philosophy of Mind/Metaphysics
80-x80 through 80-x89 Philosophy of Language

Area 3: Logic/Philosophy of Mathematics 9 units
One course from (80-x10 through 80-x19)

Area 4: Epistemology/Methodology 9 units
One of the following:
80-x00 through 80-x09 Epistemology/Methodology
80-x20 through 80-x29 Philosophy of Science

Area 5: History of Philosophy 18 units
Two of the following:
80-250 through 80-259 History of Philosophy

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 80-236 Philosophy and Law
Area 2 80-180 Nature of Language
Area 3 80-212 Philosophical Analysis and Logic
Area 4 80-150 Nature of Reason
Area 5 80-250 Ancient Philosophy
Area 6 80-246 The Criminal Justice System in America: Ideals and Realities
s80-346 Values, Fact, and Policy

2. For an emphasis on Metaphysics and Epistemology a student might take:

Area 1 80-230 Ethical Theory
Area 2 80-275 Metaphysics
Area 3 80-211 Arguments and Mathematical Inquiry
Area 4 80-201 Epistemology
Area 5 80-250 Ancient Philosophy
Area 6 80-254 Analytic Philosophy
80-312 Philosophy of Mathematics

3. For an emphasis on Ethics and Social Philosophy a student might take:

Area 1 80-230 Ethical Theory
Area 2 80-276 Philosophy of Religion
Area 3 80-110 Nature of Mathematical Reasoning
Area 4 80-221 Philosophy of Social Science or
80-321 Causation and Social Policy
Area 5 80-250 Ancient Philosophy
Area 6 80-346 Value, Fact, and Policy

4. For an emphasis on Philosophy of Mind a student might take:

Area 1 80-130 Introduction to Ethics
Area 2 80-270 Philosophy of Mind
Area 3 80-211 Arguments and Mathematical Inquiry
Area 4 80-201 Epistemology
Area 5 80-251 Modern Philosophy
80-254 Analytic Philosophy
Area 6 80-271 Philosophy and Psychology
80-300 Minds, Machines, and Knowledge
80-316 Probability and Artificial Intelligence

Additional Major

Students who want an additional major in Philosophy must fulfill the same departmental requirements as primary majors in Philosophy.

The M.A. Program in Philosophy

The Department of Philosophy also offers a graduate M.A. degree in Philosophy, which culminates with the writing of a master’s thesis. It is ordinarily a two-year program, but students in the Philosophy major are able to complete the additional requirements in one year. Interested students are invited to visit the department’s homepage for further information: www.hss.cmu.edu/philosophy/.

Philosophy Department Minors

All majors in the Department allow for minors; in addition, there is a Minor in Ethics and an interdepartmental minor in Linguistics. The requirements are again designed to be flexible and to allow students to tailor courses to their special interests, while providing some breadth.

The Minor in Ethics

With the explosive growth of science and technology have come both new possibilities and new problems. Developments in medicine, in biology, in chemistry, in nuclear engineering or in computer science all have costs as well as benefits, and they present us with many hard choices. Some of the hardest of these new problems are moral problems.

The Philosophy Department’s Minor in Ethics introduces students to central ethical concepts and theories proposed and defended by the great philosophers of the past; it provides an understanding of how these theories and concepts can be applied to practical problems. This background in ethical theory and its applications should help students to respond more sensitively and appropriately to the new and unavoidable ethical problems that businesses, unions, and branches of government must face.

Ethics Core Courses 27 units

Complete three courses from any of the following areas with at least two courses at the 200-level or higher.
80-x30 through 80-x34 Ethics/Ethical Theory
80-x35 through 80-x39 Social/Ethical Theory
80-x40 through 80-x49 Applied/Professional Ethics

Ethics Electives 18 units

Complete two courses at the 200-level or higher.
The Minor in Linguistics

The Interdepartmental Minor in Linguistics is jointly sponsored with the departments of English, Modern Languages, and Psychology. It synthesizes the linguistics related offerings in these departments and provides students with an academic experience that reflects both the interdisciplinary character of the subject and its cross-departmental representation in H&SS. Students who wish to receive a minor in Linguistics must complete six courses. For a detailed discussion of the curriculum and the flexible electives, consult the H&SS College section “Other Major, Double Major, and Minor Options”.

The Minor In Logic and Computation

The Minor in Logic and Computation provides students with general course work in logic, the theory of computation, and philosophy. Students must complete six courses, among them the following three core courses.

Logic and Computation Core Courses 27 units

- 80-211 Arguments and Mathematical Inquiry
- 80-210 Logic and Proofs
- 80-300 Minds, Machines, and Knowledge
- 80-310 Logic and Computation
- 80-311 Computability and Incompleteness

Logic and Computation Electives 27 units

Students must take two courses in the Philosophy Department at the 300-level or higher, in subjects related to logic and computation, and an additional course at the 300-level or higher in an area that uses logical and computational tools, such as philosophy, computer science, linguistics, mathematics, psychology, or statistics. The choice of electives must be approved by the program director.

The Minor in Philosophy

The Minor in Philosophy allows students to complement their primary majors with a broad philosophical grounding.

Logic/Methodology Requirements 9 units

Complete one course:
- 80-x10 through 80-x19 Philosophy of Logic/Mathematics
- 80-x20 through 80-x29 Philosophy of Science

History of Philosophy Requirements 18 units

Complete two courses:
- 80-250 through 80-259 History of Philosophy

Philosophy Electives 18 units

Complete two courses in the Philosophy Department at the 200-level or higher.

The Honors Program

The H&SS Senior Honors Program provides recognition of outstanding performance by students majoring in Philosophy, Logic and Computation or Ethics, History, and Public Policy. Students have the opportunity to develop their skills and to apply their knowledge through completion of an honors thesis in their senior year. By completing the thesis, students earn 18 units of credit and qualify for graduation with College Honors. To qualify for the honors program, students must maintain a quality point average of at least 3.50 in the major and 3.25 overall, and be invited by the department to become a participant.

Undergraduate Research Fellows

Qualified upper level undergraduates, preferably majors in one of the Philosophy Department’s programs, may apply to serve in their junior or senior years as fellows in the Laboratory for Symbolic and Educational Computing. Applications are reviewed in the fall. Follow the link to LSEC from the Department’s home page: www.hss.cmu.edu/philosophy.

Faculty

HORACIO ARLO-COSTA, Associate Professor of Philosophy — Ph.D., Columbia University; Carnegie Mellon, 1998—.

JEREMY AVIGAD, Associate Professor of Philosophy — Ph.D., University of California, Berkeley; Carnegie Mellon, 1996—.

STEVEN AWODEY, Associate Professor of Philosophy — Ph.D., University of Chicago; Carnegie Mellon, 1997—.

ROBERT CAVALIER, Teaching Professor of Philosophy— Ph.D., Duquesne University; Carnegie Mellon, 1987—.

PRESTON K. COVEY JR., Associate Professor of Philosophy — Ph.D., Stanford University; Carnegie Mellon, 1974—.

DAVID DANKS, Assistant Professor of Philosophy — Ph.D., University of California, San Diego, Carnegie Mellon, 2003—.

CLARK GLYMOUR, Alumni University Professor of Philosophy—. Ph.D., Indiana University; Carnegie Mellon, 1984—.

MARALEE HARRELL, Associate Teaching Professor in Philosophy — Ph.D., University of California, San Diego, Carnegie Mellon, 2003—.

KEVIN T. KELLY, Professor of Philosophy — Ph.D., University of Pittsburgh; Carnegie Mellon, 1985—.

ALEX LONDON, Associate Professor of Philosophy — Ph.D., University of Virginia; Carnegie Mellon, 2000—.

LINDA PALMER, Research Scientist in Philosophy — Ph.D., University of California, Irvine, Carnegie Mellon, 2004—.

JOSEPH RAMSEY, Special Faculty and Director of Computing — Ph.D., University of California, San Diego; Carnegie Mellon, 2006—.

RICHARD SCHEINES, Professor of Philosophy, Human-Computer Interaction, and Machine Learning — Ph.D., University of Pittsburgh; Carnegie Mellon, 1987—.

DANA S. SCOTT, Hillman University Professor of Mathematical Logic, Computer Science and Philosophy (Emeritus) — Ph.D., Princeton University; Carnegie Mellon, 1981—.

TEDDY I. SEIDENFELD, Herbert A. Simon Professor of Philosophy and Statistics — Ph.D., Columbia University; Carnegie Mellon, 1985—.

WILFRIED SIEG, 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. SPIRTES, Professor of Philosophy — Ph.D., University of Pittsburgh; Carnegie Mellon, 1987—.
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 analyses, 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 in 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 the advanced course requirements: 21-111/112 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 science 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 Introductory 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 are required. 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 at advanced 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.
spring of the sophomore year. This also applies to the computer science sequence 15-211/212.

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*

15-111 or 15-200 Intermediate/Advanced Programming (10 units)
21-127 Concepts of Mathematics
36-201 Statistical Reasoning

Logic and Computation Core 69 units*

80-211 Arguments and Mathematical Inquiry
80-300 Minds, Machines, and Knowledge
80-310 Logic and Computation
80-311 Computability and Incompleteness
80-511 Thesis seminar
15-211 Fundamental Data Structures and Algorithms**
15-212 Principles of Programming**

*Only 45 units are unique to the major; 15-211 and 15-212 count toward total units for the General Education Program, DCR6.

**It is recommended that students complete 15-211 and 15-212 in the sophomore year; H&SS students can use these courses to satisfy their General Education requirement in the category 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 (or: 80-413 Category Theory)
80-316 Probability and Artificial Intelligence
80-317 Constructive Logic
15-312 Programming Languages: Design and Processing

Sample 2. A student interested in Language and Information Technology might take the following courses:

80-280 Linguistic Analysis 80-480 Linguistic Theory 80-481 Formal Semantics 80-682 Introduction to Language Technologies

Sample 3. A student interested in Artificial Intelligence and Cognitive Science might take the following courses:

80-314 Logic in Artificial Intelligence
80-315 Modal Logic or:
80-319 Computability and Learnability
80-316 Probability and Artificial Intelligence
80-411 Proof Theory

Sample 4. A student interested in Logic and the Foundations of Mathematics might consider the following courses:

80-312 Philosophy of Mathematics
80-318 Proof Search
80-411 Proof Theory
80-413 Category Theory

Sample 5. A student interested in Methodology might consider the following courses:

80-220 Philosophy of Science
80-221 Philosophy of Social Science
80-319 Computability and Learnability
80-321 Causation and Social Policy
36-309 Experimental Design

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 background, the requirements of the second major in Logic and Computation can be fulfilled with as few as five additional courses. However, the department limits the courses that may be 'double counted'; the core courses in the Philosophy department may not be double counted.

The M.S. Program in Logic and Computation

The Department of Philosophy also offers a graduate M.S. degree in Logic and Computation, which culminates with the writing of a master's thesis. It is ordinarily a two-year program, but students in the Logic and Computation major are able to complete the additional requirements in one year. Interested students are invited to contact the department for further information and apply to the program in their senior year. Details can be found on the department's homepage: http://hss.cmu.edu/philosophy/
Natural Sciences
09-105 Introduction to Modern Chemistry
09-106 Modern Chemistry II
33-xxx Physics I for Science Students
09-217 Organic Chemistry I
09-218 Organic Chemistry II

Computational Reasoning
99-xxx Computing Skills Workshop
15-100 Introductory/Intermediate Programming

Discipline Core Requirements

Biological Sciences
03-121 Modern Biology
03-231 Biochemistry
03-240 Cell Biology
03-330 Genetics

Psychology
85-102 Introduction to Psychology

Complete three of the following courses (85-219 should be included as one of the three):
85-211 Cognitive Psychology or
85-213 Human Information Processing and Artificial Intelligence
85-219 Biological Foundations of Behavior
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Personality

Laboratory/Research Methods Requirements
09-221 Chemistry Laboratory I
09-222 Chemistry Laboratory II
03-343 Experimental Genetics and Molecular Biology

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

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)

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 21-120/256 (or alternatively 21-120/122)* and a statistics sequence (36-201 or equivalent and if possible, 36-309). In addition, candidates complete 15-111 Intermediate/Advanced Programming, 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 15-111 and 21-127 early in their program of studies will allow students to move into the 15-211/212 sequence by the Junior year and prepare them for further work in artificial intelligence.

*The 3-Semester sequence 21-111/112/256 may be substituted by students who have already taken 21-111 before deciding on the major.

Computing Prerequisite 10 units
15-111 Intermediate/Advanced Programming*

* prerequisite for 15-211

Mathematics & Statistics Prerequisites 37-38 units
21-120 Differential and Integral Calculus (10 units)*
21-256 Multivariate Analysis and Approximation
21-120 Differential and Integral Calculus (10 units)
21-122 Integration, Differential Equations and Approximation (10 units)
21-127 Concepts of Mathematics
36-201 Statistical Reasoning, Statistical Practice or equivalent
36-309 Experimental Design for the Behavioral and Social Sciences

+Along with 15-111, prerequisite for 15-211.

Artificial Intelligence Core (minimum) 33 units
15-211 Fundamental Data Structures and Algorithms I
15-251 Great Theoretical Ideas in Computer Science
15-381 Artificial Intelligence: Representation and Problem Solving or
85-412 Cognitive Modeling
85-419 Introduction to Parallel Distributed Processing

Cognitive Psychology Core 27 units
85-211 Cognitive Psychology
85-212 Human Information Processing and Artificial Intelligence
85-310 Research Methods in Cognitive Psychology (Prerequisite for all research methods courses 36-309 and corresponding psychology survey course)
Plus complete one of the following:
85-412 Cognitive Modeling
85-419 Introduction to Parallel Distributed Processing
85-423 Cognitive Development
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 four of the following: 85-412, 85-419, 85-392, 85-417 (05-432 cross-listed course number in HCI) and 05-811 Cognitive Modeling for HCI. Another area might be cognitive neuroscience and could involve four of the following: 85-370 Perception, 03-360 The Biology of the Brain, 85-414 Cognitive Neuropsychology, 85-419 Introduction to Parallel Distributed Processing, 85-429 Cognitive Brain Imaging, and 85-465 Cognitive Neuroscience.

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
15-385 Artificial Intelligence: Computer Vision
15-453 Formal Language and Automata
15-681 Machine Learning
05-410 Introduction to Human Computer Interaction Methods

Psychology

85-219 Biological Foundations of Behavior
85-352 Evolutionary Psychology
85-355 Introduction to Cognitive Neuroscience
85-370 Perception
85-375 Cross-Cultural Psychology
85-382 Consciousness & Cognition
85-390 Human Learning and Memory
85-392 Human Expertise
85-406 Seminar on Autism
85-412 Cognitive Modeling
85-413 Human Factors
85-414 Cognitive Neuropsychology
85-417 Cognitive Modeling and Intelligent Tutoring Assessment
85-419 Introduction to Parallel Distributed Processing
85-421 Language and Thought
85-422 Infant Psychology
85-423 Cognitive Development
85-429 Cognitive Brain Imaging
85-601/602 Senior Thesis
66-501/502 Honors Thesis

Philosophy

80-210 Logic and Proofs
80-211 Logic and Mathematical Inquiry
80-220 Philosophy of Science
80-254 Analytic Philosophy
80-255 Pragmatism
80-270 Philosophy of Mind
80-271 Philosophy and Psychology
80-300 Minds, Machines and Knowledge
80-310 Logic and Computation
80-311 Computability and Incompleteness
80-314 Logic in Artificial Intelligence
80-316 Probability and Artificial Intelligence
80-319 Computability and Learnability
80-471 Cognitive Computation
80-518 Seminar in Epistemology

Linguistics

76-385 Introduction to Discourse Analysis
80-280 Introduction to Linguistic Analysis
80-306 Meaning in Language
80-481 Formal Semantics

Decision Sciences

88-302 Behavioral Decision Making
88-356 Rational Choice

Neurosciences

03-360 The Biology of the Brain
42-301 Physiology

Appropriate courses offered by the Department of Neurosciences 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 Neurosciences):

- NROSCI1000 Introduction to Neuroscience
- NROSCI1011 Functional Neuroanatomy
- NROSCI1012 Neurophysiology
- NROSCI1030 Psychiatric Disorders and Brain Function
- NROSCI1034 Neural Basis of Cognition
- NROSCI1040 Biological Basis of Learning and Memory
- NROSCI1000 Introduction to Neuroscience
- NROSCI1011 Functional Neuroanatomy
- NROSCI1012 Neurophysiology
- NROSCI1017 Synaptic Transmission
- NROSCI1030 Psychiatric Disorders and Brain Function
- NROSCI1032 Functional 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, 03-360, The Biology of the Brain.

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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 advisor when planning their program.

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 (15-111), the Mathematics and Statistics requirements, 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

I. Introductory courses 9 units
Complete only one of these courses.

85-100 Cognitive Processes: Theory & Practice
85-102 Introduction to Psychology

II. Area Survey courses 18 units
Complete two courses.

85-211 Cognitive Psychology
or
85-213 Human Information Processing and Artificial Intelligence

85-219 Biological Foundations of Behavior
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Personality

III. Statistics 19 units

36-201 Statistical Reasoning, Statistical Practice or equivalent
36-309 Experimental Design for the Behavioral and Social Sciences

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*
85-320 Research Methods in Child Development*
85-340 Research Methods in Social Psychology*

*Prerequisites (or corequisite) for all Research Methods courses: 36-309 and the appropriate survey course.

V. Advanced courses (minimum 9 units)

These courses exist within three areas (cognitive, cognitive-neuro-science, developmental and social psychology), and carry course numbers from 85-341 to 85-599. 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—.

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—.

BROOKE C. FEENEY, Assistant 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—.

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—.

DAVID KLAHR, Professor of Psychology — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1969—.

ROBERTA KLATZKY, Professor of Psychology, — Ph.D., Stanford University; Carnegie Mellon, 1993—.

KENNETH R. KOEDINGER, Associate Professor 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, Assistant Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000 —.

BRIAN MACWHINNEY, Professor of Psychology — Ph.D., University of California, Berkeley; Carnegie Mellon, 1981—.

DAVID RAKISON, Assistant Professor — D.Phil., University of Sussex; Carnegie Mellon, 2000 —.

LYNNE M. REDER, Professor of Psychology — Ph.D., University of Michigan; Carnegie Mellon, 1978—.

MICHAEL 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 —.

ERIK D. THIESEN, Assistant Professor — Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 2004 —.
Department of Social and Decision Sciences

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, Policy and Management, and Political Science. 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, Director
Office: Porter Hall 219E

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), 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. To the best of our knowledge, we offer the only program of its kind in the United States. Graduates of the Decision Science major are designed to be equipped to understand and improve the judgment and decision making of individuals, groups, and organizations. The program provides students with a strong foundation in the social sciences, decision analysis, empirical research, organizations, and policy analysis, and requires students to develop practical skills in areas such as research design and analysis. The program provides students with a strong foundation in the social sciences, decision analysis, empirical research, organizations, and policy analysis, and requires students to develop practical skills in areas such as research design and analysis.

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 perform surveys (e.g., uncovering consumer or managerial preferences), conduct experiments evaluating theories, and evaluate the effectiveness of prescriptive 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 additional research tools. 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 and Statistics Prerequisites 19 units

- 21-111 Calculus I or 21-120 Differential and Integral Calculus
- 36-201 Statistical Reasoning and Practice

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 45 units

- 88-120 Reason, Passion, and Social Cognition**
- 85-211 Cognitive Psychology
- 88-220 Policy Analysis I
- 88-223 Decision Analysis and Decision Support Systems
- 88-302 Behavioral Decision Making

** 88-120 should be taken in the freshman or sophomore year.

Research Methods 18 units

- 36-201 Statistical Methods
- 88-251 Empirical Research Methods

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 8 units

- 85-219 Biological Foundations of Behavior
- 85-241 Social Psychology
- 85-352 Evolution Psychology
Sample Curriculum*

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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 public policy. It is also an excellent major for those 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 public policy.

**Prerequisites**

All Policy and Management majors must complete mathematics and statistics prerequisites (see below), by the end of the sophomore year.

**Mathematics and Statistics Prerequisites 28-29 units**

- 21-111 Calculus I
- 21-112 Calculus II
- 21-120 Calculus I
- 21-256 Multivariate Analysis and Approximation
- 21-120 Differential and Integral Calculus (10 units)
- 21-22 Integration, Differential Equations and Approximation (10 units)

**Curriculum 111 units**

**Analytical Methods 39 units**

- 88-220 Policy Analysis I
- 88-221 Policy Analysis II
- 88-222 Policy Analysis III
- 88-223 Decision Analysis and Decision Support Systems

**Organizational Context 9 units**

- 88-260 Organizations

**Research Methods 18 units**

- 36-202 Statistical Methods
- 88-251 Empirical Research Methods

**Policy Making, Management, and Technology 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 three of these courses (27 units) must be Social and Decision Sciences courses (88-xxx).

**1. Policy Making**

- 73-248 Environmental Economics
- 73-340 Labor Economics
- 73-352 Public Economics
- 73-356 Political Economy of Public Institutions
- 73-357 Regulation: Theory and Policy
- 73-420 Monetary Theory and Policy
- 79-278 China’s Environment: Past and Present
- 79-329 Sex, Population, and Birth Control
- 79-331 Crime and Punishment in American History
- 79-335 Drug Use and Drug Policy
- 80-321 Causation and Social Policy
- 80-346 Value, Fact, & Policy
- 88-202 History of Public Policy in the United States
- 88-270 International Organizations
- 88-280 The New European Union: Old Europe, New Europe and the U.S.

**Sample Curriculum**

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<td>88-223</td>
<td>88-224</td>
</tr>
<tr>
<td>Elective</td>
<td>Statistical</td>
</tr>
<tr>
<td>Decision</td>
<td>Methods</td>
</tr>
<tr>
<td>36-202</td>
<td>36-203</td>
</tr>
</tbody>
</table>

*This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.
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, 88-251 toward the completion of both majors.

Students pursuing Political 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.

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 Director of the Policy and Management program.

The Major in Political Science

Silvia Borzutzky, Director
Office: Porter Hall 208B

The Political Science major at Carnegie Mellon is a uniquely rigorous, analytical, and interdisciplinary way to learn about politics and government. The major combines the study of classical issues in political behavior, institutions, and philosophy with the new tools and skills that are necessary in the job market and as a basis for graduate training.

The Political Science major builds on the H&SS General Education requirements through nine required courses that reflect the interdisciplinary nature of the Department of Social and Decision Sciences and its strengths in the areas of decision making, information, and organizations. Together these requirements provide an outstanding background in social science theory and methods, as well as solid grounding in the study of politics. A capstone course, in which theories and methods learned in the classroom are applied to a real-world problem for a real-world client, is one of the required courses.

Additionally, students in the Political Science major take four electives from the following four clusters: Law, American Politics, International Relations and Comparative Politics, and Political Theory and Methodology. A wide range of courses is offered within each cluster. The student’s course selection of the electives, decided in coordination with the director for the major, provides a depth and breadth of knowledge. This typically involves two elective courses in one cluster. At least two of the electives must be from the Department of Social and Decision Sciences (88-xxx).

The Department encourages students to complement their formal coursework with internship experiences. Whether the internship is in Pittsburgh or elsewhere, such as through the Washington Semester Program, students are able to experience directly the inner workings of government and government-related organizations, and to network with professionals in the field. Students can also spend a semester or year abroad at a wide range of overseas programs with which Carnegie Mellon is affiliated. The major is also compatible with pursuit of the H. John Heinz III School of Public Policy and Management accelerated masters program, where a student earns both a B.S. in Political Science and a M.S. in Public Policy and Management in five years.

The Political Science major prepares the student for a wide variety of careers in addition to being part of a liberal arts education. Political Science provides a valuable background for those pursuing careers in business or in public service through employment in government and the nonprofit sector. The major also provides a solid preparation for graduate study in law, public policy, business, and political science.

Prerequisites

All Political Science majors must complete mathematics and statistics prerequisites (see below), by the end of the sophomore year.

Mathematics and Statistics Prerequisites 18-19 units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-111 Calculus I</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>21-120 Calculus 1</td>
<td></td>
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<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus (10 units)</td>
<td></td>
</tr>
<tr>
<td>36-201 Statistical Reasoning and Practice</td>
<td></td>
</tr>
</tbody>
</table>

Curriculum 111 units

<table>
<thead>
<tr>
<th>Political Core</th>
<th>27 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-104 Decision Processes in American Political Institutions</td>
<td></td>
</tr>
<tr>
<td>Complete two courses:</td>
<td></td>
</tr>
<tr>
<td>88-205 Comparative Politics</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>88-326 Theories of International Relations</td>
<td></td>
</tr>
<tr>
<td>88-325 Electoral Politics</td>
<td></td>
</tr>
<tr>
<td>88-358 Policy Making Institutions</td>
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</tr>
</tbody>
</table>

Theoretical Perspectives 30 units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>88-220 Policy Analysis I</td>
<td></td>
</tr>
<tr>
<td>88-221 Policy Analysis II</td>
<td></td>
</tr>
<tr>
<td>88-222 Policy Analysis III</td>
<td></td>
</tr>
</tbody>
</table>

Research Methods 18 units

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-202 Statistical Methods</td>
<td></td>
</tr>
<tr>
<td>88-251 Empirical Research Methods</td>
<td></td>
</tr>
</tbody>
</table>

Theories and Applications 36 units

Select four 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 36 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. A student’s course selection among these menu electives is decided in close coordination with the faculty director to provide a depth and breadth of knowledge.

At least two of these courses (18 units) must be Social and Decision Sciences courses (88-xxx).

1. Law

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-364 Business Law</td>
<td></td>
</tr>
<tr>
<td>70-365 International Trade and International Law</td>
<td></td>
</tr>
<tr>
<td>73-354 Law and Economics</td>
<td></td>
</tr>
<tr>
<td>73-357 Regulation: Theory and Policy</td>
<td></td>
</tr>
<tr>
<td>79-331 Crime and Punishment In America</td>
<td></td>
</tr>
<tr>
<td>80-236 Philosophy and Law</td>
<td></td>
</tr>
<tr>
<td>80-340 Environmental Ethics &amp; Decision Processes</td>
<td></td>
</tr>
<tr>
<td>88-181 Topics in Law: 1st Amendment</td>
<td></td>
</tr>
<tr>
<td>88-184 Topics in Law: The Bill of Rights</td>
<td></td>
</tr>
<tr>
<td>88-352 International Environmental Law and Policy</td>
<td></td>
</tr>
<tr>
<td>88-382 Climate Change, Energy Policy, and Environmental Protection</td>
<td></td>
</tr>
</tbody>
</table>

2. American Politics

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-232 Business and Society</td>
<td></td>
</tr>
<tr>
<td>79-232 Vietnam: America’s Lost War</td>
<td></td>
</tr>
<tr>
<td>79-234 Body Politics: Women and Health in America</td>
<td></td>
</tr>
<tr>
<td>79-241 African-American History I</td>
<td></td>
</tr>
<tr>
<td>79-242 African-American History II</td>
<td></td>
</tr>
<tr>
<td>88-202 History of Public Policy in the United States</td>
<td></td>
</tr>
<tr>
<td>88-324 Electoral Systems and Processes</td>
<td></td>
</tr>
<tr>
<td>88-325 Electoral Politics**</td>
<td></td>
</tr>
<tr>
<td>88-329 American Foreign Policy: 1945-Present</td>
<td></td>
</tr>
<tr>
<td>88-358 Policy Making Institutions***</td>
<td></td>
</tr>
<tr>
<td>88-381 Business, Politics and Public Policy</td>
<td></td>
</tr>
</tbody>
</table>

3. International Relations and Comparative Politics

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-371 International Trade and Economic Development</td>
<td></td>
</tr>
<tr>
<td>73-372 International Money and Finance</td>
<td></td>
</tr>
<tr>
<td>79-232 Vietnam: America’s Lost War</td>
<td></td>
</tr>
<tr>
<td>79-233 The United States and the Middle East Since 1945</td>
<td></td>
</tr>
</tbody>
</table>
**Department of Social and Decision Sciences**

### 4. Political Theory and Methodology

36-303 Sampling, Survey and Society
73-356 Political Economy of Public Institutions
80-136 Social Structure, Public Policy, & Ethical Dilemmas
80-235 Political Philosophy
80-242 Conflict and Dispute Resolution
80-256 Modern Moral Philosophy
88-330 Political Economy of Inequality and Redistribution
88-332 Foreign Aid: The U.S., the E.U. and the Developing World
88-352 International Environmental Law and Policy
88-356 Comparative Foreign Policy: China, Russia, and the US
88-358 Policy Making Institutions***
88-359 Globalization
88-383 Latin America in the New International System

### Additional Major

Students who elect Political Science as part of an additional major must fulfill all of the requirements of the Political Science major.

Students pursuing Decision Science with an additional major in Political 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 Political Science may only count 36-202, 88-220, 88-221, 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 Director of the Political Science program.

### The Minor in Decision Science

Baruch Fischhoff, Program Director
Office: Porter Hall 219E

The minor in Decision Science provides students with a selective survey of disciplinary perspectives. The courses present descriptive and normative approaches to judgement and decision making, as well as some application of theories and results to real-world problems. Students who elect Decision Science as a minor must complete the four core courses (below) and two electives from the elective set (below).

### Curriculum

**Core Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>88-120</td>
<td>Reason, Passion, and Social Cognition</td>
</tr>
<tr>
<td>88-220</td>
<td>Policy Analysis I</td>
</tr>
<tr>
<td>88-223</td>
<td>Decision Analysis and Decision Support Systems</td>
</tr>
<tr>
<td>88-302</td>
<td>Behavioral Decision Making</td>
</tr>
</tbody>
</table>

**Elective Courses**

Complete any two courses from the following categories.

#### 1. Biological and Behavioral Aspects of Decision Making

- 85-219 Biological Foundations of Behavior
- 85-241 Social Psychology
- 85-352 Evolutionary Psychology
- 85-414 Cognitive Neuropsychology
- 85-442 Health Psychology
- 85-449 Emotion and Social Behavior
- 85-451 Psychology of Purpose
- 88-307 Irrationality
- 88-360 Behavioral Economics
- 88-377 Attitudes and Persuasion
- 88-379 Social Cognition
- 88-407 Health Risk Communication
- 88-421 Advanced Topics in Emotion and Decision Making

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

- 70-332 Business, Society and Ethics
- 70-381 Marketing
- 70-481 Marketing Research
- 88-221 Policy Analysis II
- 88-222 Policy Analysis III
- 88-341 Organizational Communication
- 88-354 Economics and Psychology of Organizational Communications
- 88-444 Public Policy & Regulation

#### 3. Philosophical and Ethical Perspectives on Decision Making

- 19-426 Environmental Decision Making
- 80-241 Ethical Judgments in Professional Life
- 80-242 Conflict, Dispute Resolution
- 80-271 Philosophy and Psychology
- 80-305 Rational Choice
The Minor in Policy and Management
Paul Fischbeck, Program Director
Office: Porter Hall 208B

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

Required Courses

- 88-220 Policy Analysis I
- 88-221 Policy Analysis II
- 88-223 Decision Analysis and Decision Support Systems
- 88-260 Organizations

Electives

Complete two courses from the following categories.

1. Policy Making
   - 73-248 Environmental Economics
   - 73-340 Labor Economics
   - 73-352 Public Economics
   - 73-356 Political Economy of Public Institutions
   - 73-357 Regulation: Theory and Policy
   - 73-420 Monetary Theory and Policy
   - 79-278 China’s Environment: Past and Present
   - 79-329 Sex, Population, and Birth Control
   - 79-331 Crime and Punishment in American History
   - 79-335 Drug Use and Drug Policy
   - 80-321 Causation and Social Policy
   - 80-346 Value, Fact, & Policy
   - 88-202 History of Public Policy in the United States
   - 88-270 International Organizations
   - 88-280 The New European Union: Old Europe, New Europe and the U.S.
   - 88-324 Electoral Systems and Processes
   - 88-325 Electoral Politics
   - 88-332 Foreign Aid: States, International Organizations, and Developing Countries
   - 88-352 International Environmental Law and Policy
   - 88-358 Policy Making Institutions
   - 88-378 International Economics
   - 88-381 Business, Politics, and Public Policy
   - 88-382 Climate Change, Energy Policy, Environment, and Sustainable Development
   - 88-444 Public Policy and Regulation

2. Management
   - 70-322 Business and Society
   - 70-342 Managing Across Cultures
   - 70-430 International Management
   - 80-241 Ethical Judgments in Professional Life
   - 80-242 Conflict and Dispute Resolution
   - 80-243 Business Ethics
   - 80-244 Environment, Management, and Ethics
   - 88-341 Organizational Communication
   - 88-343 Economics of Technological Change
   - 88-360 Organizational Communications

Elective Courses

Select three courses from the following categories. When courses offered for less than 9 units are chosen, students should note that a minimum of 27 units is required in this category, and should plan to take one or more additional courses as appropriate. A student's course selection among these menu electives is decided in close coordination with his or her academic advisor to provide a depth and breadth of knowledge. The selected courses may be from one category or from any combination of categories.

At least two of these courses (18 units) must be Social and Decision Sciences courses (88-xxx).

3. Technology and Information
   - 19-402 Telecommunications Policy
   - 19-448 Science, Technology and Ethics
   - 79-230 Technology in American Society
   - 79-340 Economics of Entrepreneurship in High Technology Industries
   - 88-340 Economics of Technological Change
   - 88-345 The Rise of Industrial Research and Development
   - 88-347 Complex Technological Systems: Past, Present and Future
   - 88-390 Technology Entrepreneurship: Principles for Practice and Policy

The Minor in Political Science

Silvia Borutzky, Director
Office: Porter Hall 208B

The minor in Political Science consists of 54 units of coursework. Half of these are in three required courses; the remainders are electives.

Curriculum

Required Courses

- 88-104 Decision Processes in American Political Institutions

Complete two courses:

- 88-205 Comparative Politics
- OR
- 88-326 Theories of International Relations
- 88-325 Electoral Politics
- 88-358 Policy Making Institutions

Elective Courses

Select three courses from the following categories. When courses offered for less than 9 units are chosen, students should note that a minimum of 27 units is required in this category, and should plan to take one or more additional courses as appropriate. A student's course selection among these menu electives is decided in close coordination with his or her academic advisor to provide a depth and breadth of knowledge. The selected courses may be from one category or from any combination of categories.

At least two of these courses (18 units) must be Social and Decision Sciences courses (88-xxx).

1. Law
   - 70-364 Business Law
   - 70-365 International Trade and International Law
   - 73-354 Law and Economics
   - 73-357 Regulation: Theory and Policy
   - 79-331 Crime and Punishment in America
   - 80-236 Philosophy and Law
   - 80-340 Environmental Ethics & Decision Processes
   - 88-181 Topics in Law: 1st Amendment
   - 88-184 Topics in Law: The Bill of Rights
   - 88-352 International Environmental Law and Policy
   - 88-382 Climate Change, Energy Policy, and Environmental Protection

2. American Politics
   - 70-332 Business and Society
   - 79-232 Vietnam: America’s Lost War
   - 79-234 Body Politics: Women and Health in America
   - 79-241 African-American History I
   - 79-242 African-American History II
   - 88-302 History of Public Policy in the United States
   - 88-324 Electoral Systems and Processes
   - 88-325 Electoral Politics
   - 88-329 American Foreign Policy: 1945-Present
   - 88-358 Policy Making Institutions
   - 88-361 Business, Politics and Public Policy
3. International Relations and Comparative Politics

73-371 International Trade and Economic Development
73-372 International Money and Finance
79-232 Vietnam: America's Lost War
79-233 The United States and the Middle East Since 1945
79-260 Mayan America
79-263 From Soil to Oil: Energy, Ecology and Globalization
79-268 From the Local to the Global: Africa in the World
79-271 Modern China
79-281 Modern Soviet History: From Communism to Capitalism
79-299 US-Arab Encounters
79-310 Modern Spain: Culture, Politics and Society
79-351 The Cold War in Documents and Film
79-352 Arab-Israeli Condition: War and Peace
79-357 Religion and Politics in the Middle East
88-205 Comparative Politics
88-270 International Organizations
88-280 The New European Union: Old Europe, New Europe and the US
88-314 Politics through Film: Tyranny and Resistance
88-324 Electoral Systems and Processes
88-326 Theories of International Relations
88-330 Political Economy of Inequality and Redistribution
88-332 Foreign Aid: The U.S., the E.U. and the Developing World
88-352 International Environmental Law and Policy
88-357 Comparative Foreign Policy: China, Russia, and the US
88-358 Policy Making Institutions
88-359 Globalization
88-383 Latin America in the New International System

4. Political Theory and Methodology

36-303 Sampling, Survey and Society
73-356 Political Economy of Public Institutions
80-136 Social Structure, Public Policy, & Ethical Dilemmas
80-235 Political Philosophy
80-242 Conflict and Dispute Resolution
80-256 Modern Moral Philosophy
88-330 Political Economy of Inequality and Redistribution
88-356 Rational Choice
88-358 Policy Making Institutions
88-437 Strategic Analysis: Game Theory for Social Scientists

***Course counts as a Theories and Applications elective only if not taken in fulfillment of Political Core requirement.

NOTE: Some courses have additional prerequisites.

Faculty

SILVIA BORZUTZKY, Associate Teaching Professor — Ph.D., University of Pittsburgh; Carnegie Mellon, 2001–.

LEE BRANSTETTER, Assistant Professor — Ph.D., Harvard University; Carnegie Mellon, 2006–.

ROBYN M. DAWES, Charles J. Queenan, Jr. University Professor of Psychology— Ph.D., The University of Michigan; Carnegie Mellon, 1985–.

JULIE DOWNS, Researcher — 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, Research Scientist — Ph.D., University of Massachusetts, Amherst; Carnegie Mellon, 2001–.

CLEOTILDE GONZALEZ, Assistant Professor of Information and Decision Sciences — Ph.D., Texas Tech University; Carnegie Mellon, 2000–.

DAVID A. HOUNSHELL, David M. Roderick Professor of Technology and Social Change — Ph.D., University of Delaware; Carnegie Mellon, 1991–.

WILLIAM R. KEECH, Professor of Political Economy, Emeritus — Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 1997–.

STEVEN KLEPPER, Arthur Arton Hamerschlag Professor of Economics and Social Science — Ph.D., Cornell University; Carnegie Mellon, 1980–.

JENNIFER S. LERNER, Estella Loomis McCandless Associate Professor of Social and Decision Sciences and Psychology — Ph.D., The University of California, Berkeley; Carnegie Mellon, 1998–.

GEORGE F. LOEWENSTEIN, Professor of Economics — Ph.D., Yale University; Carnegie Mellon, 1990–.

ROBERT A. LOWE, Assistant Professor of Entrepreneurship — Ph.D., University of California, Berkeley; Carnegie Mellon, 2005–.


ANGELA NO, Assistant Professor; Carnegie Mellon, 2003.

EDWARD O’DONOGHUE, Assistant Professor — Ph.D., The University of California, Berkeley; Carnegie Mellon, 2006–.

KIRON K. SKINNER, Associate Professor of History and of Political Science — Ph.D., Harvard University; Carnegie Mellon, 1999–.

ROBERTO A. WEBER, Associate Professor of Social and Decision Sciences — Ph.D., California Institute of Technology; Carnegie Mellon, 1999–.

JONATHAN WOON, Assistant Professor — Ph.D., Stanford University; Carnegie Mellon, 2005–.

Faculty by Courtesy Appointment

LINDA ARGOTE, David and Barbara Kirr Professor of Organizational Behavior — Ph.D., University of Michigan; Carnegie Mellon, 1979–.

LINDA BABCOCK, James Mellon Walton Professor of Economics — Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 1988–.

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, Herbert A. Simon Professor of Human Computer Interaction — Ph.D., Yale University; Carnegie Mellon, 1993–.

PATRICK D. LARKEY, Professor of Political Economy and Decision Sciences — Ph.D., The University of Michigan; Carnegie Mellon, 1977–.

DON MOORE, Assistant Professor of Organizational Behavior and Theory — Ph.D., Northwestern University; Carnegie Mellon, 2000–.

PETER P. VANDERSCHRAAF, Assistant Professor of Philosophy and Social and Decision Sciences — Ph.D., University of California, Irvine; Carnegie Mellon, 1997–.
Department of Statistics

Mark J. Schervish, Department Head
Department Office: Baker Hall 132

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 other fields. The faculty are accessible and committed to involving undergraduates in research. Both majors and 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.

Basic 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. We first describe the different categories within our basic curriculum and the courses offered within each category. We then give details about the requirements for the Major and Minor in Statistics.

Mathematical Foundations (Prerequisites)

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*:

There are three sequences of mathematics courses at Carnegie Mellon that provide sufficient preparation in calculus:

**Sequence 1**

- 21-111 Calculus I
- 21-112 Calculus II

**Sequence 2**

- 21-120 Differential and Integral Calculus
- 21-122 Integration, Differential Equations and Approximation
Sequence 3
21-120 Differential and Integral Calculus
21-256 Multivariate Analysis and Approximations

Other sequences are possible, and require approval from the undergraduate advisor.

Linear Algebra**: There are two mathematics courses at Carnegie Mellon that provide sufficient preparation in linear algebra:
21-241 Matrix Algebra
21-341 Linear Algebra I

* It is recommended that students complete this requirement during their freshman year.
** This requirement needs to be completed before taking 36-401

Data Analysis
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. This course is the recommended course for students in the College. A score of 5 on the Advanced Placement (AP) Exam in Statistics may be used to waive this requirement but does not confer course credit. 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.

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 and a substantial component of independent research.

Beginning
36-201 Statistical Reasoning and Practice
36-207 Probability and Statistics for Business Applications
36-220 Engineering Statistics and Quality Control
36-247 Statistics for the Laboratory Sciences

Intermediate
36-202 Statistical Methods
36-208 Regression Analysis (cross listed as 70-208)
36-309 Experimental Design for Behavioral and Social Sciences

Advanced
36-303 Sampling, Surveys, and Society
36-315 Statistical Graphics and Visualization
36-350 Data Mining
36-401 Modern Regression
36-402 Advanced Data Analysis

Probability Theory
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 advanced statistical theory. Students who are taking Statistical Theory Sequence 1 (see below) will learn probability theory in the first part of the course 36-310. For students taking Statistical Theory Sequences 2 or 3 (see below), a full course in probability theory is necessary as a prerequisite:

Typically, students take corresponding pairs 36-225/36-226 or 36-625/36-626, but it is possible to substitute 36-217 for 36-225. 36-225 is the standard introduction to probability, 36-217 is tailored for engineers and Computer Scientists but should be of interest for students in the sciences as well. 36-410 is an upper level probability course, which exposes students to more sophisticated probability models. All of the probability courses listed below qualify as Statistical Electives, and thus taking any of them as prerequisites can satisfy additional Major and Minor requirements.

36-217 Probability Theory and Random Processes
36-225 Introduction to Probability and Statistics I
36-625 Probability and Mathematical Statistics I
36-410 Introduction to Probability Models

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.

The Statistics Department offers three parallel sequences that cover statistical theory. Sequence 1 is intended for students with less experience in mathematics and probability and provides a conceptual bridge between data analysis methods and the theory underlying them. Sequences 2 and 3 cover the theory in greater depth and with more mathematical content for students who are concentrating in technical fields. The latter is more mathematically rigorous and is good preparation for later graduate work in Statistics or other disciplines. Sequences 2 and 3 both require a prerequisite in Probability Theory (see previous category).

Sequence 1
36-310 Fundamentals of Statistical Modeling

Sequence 2
36-226 Introduction to Probability and Statistics II

Sequence 3
36-626 Probability and Mathematical Statistics II

Special Topics
The Statistics Department offers seminar courses that focus on specific statistical applications or advanced statistical methods. At least one of these Special Topics seminars (36-461) will be offered every year; others are offered intermittently according to interest and demand. Past topics included statistics and the law, Bayesian statistics, non-parametric statistics, applied multivariate methods, 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.

36-461 Topics in Statistics
36-462 Topics in Statistics

Statistical Electives
Statistical electives courses can be either within or outside the statistics department (some restrictions apply – see requirements).

Courses within Statistics
Any course in Probability Theory, Advanced Data Analysis, or Special Topics categories that does not satisfy any other requirement for a Statistics Major and Minor (detailed below) may be counted as a Statistical Elective.

Courses outside Statistics
The following is a partial list of courses 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 Department of Statistics.
Undergraduate Advisor.

15-100 Introductory/Intermediate Programming
15-111 Intermediate/Advanced Programming
15-200 Advanced Programming/Practicum
21-127 Concepts of Mathematics
21-259 Calculus in Three Dimensions
21-260 Differential Equations
21-292 Operations Research I
21-301 Combinatorial Analysis
80-220 Philosophy of Science
80-221 Philosophy of Social Science
80-222 Philosophy of Economics
80-310 Logic and Computability I
85-310 Research Methods in Cognitive Psychology
85-340 Research Methods in Social Psychology
88-223 Decision Analysis and Decision Support Systems
88-302 Behavioral Decision Making

Note: Additional prerequisites are required for some of these courses. Students should carefully check the course descriptions to determine if additional prerequisites are necessary.

Concentration Area

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. Double majors usually satisfy this requirement by default (see "Additional Majors" section below).

Research

One goal of the Statistics program is to give students experience with statistical research. A wide variety of exciting research projects are ongoing in the department, and students have many opportunities to get involved in a project that interests them. Before graduation, students will be expected to participate in an independent research project under faculty supervision. Students may satisfy this requirement through projects in specific courses such as 36-303 and 36-402, through an independent study, 36-310 or 36-226, through a summer research position. Qualifying seniors are also encouraged to participate in an advanced research project or independent study under the supervision of a Statistics faculty advisor. Students earn credit for this work by enrolling in 36-495. 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).

The Major 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 applying statistical tools to real problems in other fields and learn the nuances of interdisciplinary collaboration.

Requirements

<table>
<thead>
<tr>
<th>Basic Curriculum Category</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical Foundation (prereq)</td>
<td>Calculus: 19-20 units via Sequence 1, 2 or 3</td>
</tr>
<tr>
<td></td>
<td>Algebra: 9 units via one of 21-241 or 21-341</td>
</tr>
<tr>
<td></td>
<td>Statistics Elective</td>
</tr>
<tr>
<td></td>
<td>Probability Theory prerequisite for Statistical Theory sequences 2 or 3 (counts as a Statistical Elective)</td>
</tr>
<tr>
<td></td>
<td>Statistical Theory 1, 2 or 3**</td>
</tr>
<tr>
<td></td>
<td>Special Topics 9 units (one course)</td>
</tr>
<tr>
<td></td>
<td>Statistical Elective 18 units (two courses, only one of which can be outside Statistics)</td>
</tr>
<tr>
<td></td>
<td>Concentration Area 36 units</td>
</tr>
<tr>
<td>Total</td>
<td>145 Units</td>
</tr>
</tbody>
</table>

** For students who enter the program with 36-225/226 or 36-625/626, in which case either 36-225 or 36-625 can serve as the elective.

Recommendations

Students in the College of Humanities and Social Sciences who wish to major 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 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!

Statistics Majors with concentrations in Computer Science, Operations Research, or Mathematics or who are considering graduate study in Statistics should carefully consider (in consultation with their advisor) taking 36-625/626 (sequence 3) in order to satisfy their Statistical Theory requirement.

Sample Programs

The following sample programs illustrate two (of many) ways to satisfy the requirements of the Statistics Major. It is possible to complete the requirements of the Major in as few as two years, but many students prefer to spread them out over more than two years. The program is flexible enough to support many other possible schedules and to emphasize a wide variety of interests. The first schedule below has a heavier emphasis on data analysis; it includes Mathematical Foundations Sequence 1 and 15-127 as a Statistical Elective outside of Statistics.

The second schedule below has a heavier emphasis on statistical theory and probability; it substitutes an extra Statistical Elective (36-225) for Beginning Data Analysis, and includes Mathematical Foundations Sequence 2.

In both schedules, C.A. refers to Concentration Area courses.
Schedule 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>36-201, 21-111</td>
<td>36-202, 21-112</td>
</tr>
<tr>
<td>Sophomore</td>
<td>15-127 (elective)</td>
<td>36-303, 36-315</td>
</tr>
<tr>
<td>Junior</td>
<td>21-241 C.A.</td>
<td>36-310 C.A.</td>
</tr>
<tr>
<td>Senior</td>
<td>36-401, 36-461 C.A.</td>
<td>36-402 C.A.</td>
</tr>
</tbody>
</table>

Schedule 2

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>21-120, 21-241</td>
<td>21-256</td>
</tr>
<tr>
<td>Sophomore</td>
<td>36-225</td>
<td>36-226</td>
</tr>
<tr>
<td>Junior</td>
<td>36-350, 36-309 C.A.</td>
<td>36-315 C.A.</td>
</tr>
<tr>
<td>Senior</td>
<td>36-401, 36-461 C.A.</td>
<td>36-410 C.A.</td>
</tr>
</tbody>
</table>

Additional Majors

Students who elect Statistics as a second or third major must fulfill all Statistics degree requirements. However, the Concentration Area requirement is usually waived in consultation with the student’s advisor. Majors in many other programs would naturally complement a Statistics Major, including GSIA’s undergraduate business program, Economics, Social and Decision Sciences, Policy and Management, History and Policy, 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 prerequisites.

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.

Requirements

<table>
<thead>
<tr>
<th>Basic Curriculum Category</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical Foundation (prereq)</td>
<td>Calculus: 19-20 units via Sequence 1, 2, or 3</td>
</tr>
<tr>
<td></td>
<td>Algebra: 9 units via 21- or 21-341</td>
</tr>
<tr>
<td>21-241</td>
<td>9 units (one course) or Statistical Elective*</td>
</tr>
<tr>
<td>Beginning Data Analysis</td>
<td>9 units (one course)</td>
</tr>
<tr>
<td>Intermediate Data Analysis</td>
<td>27 units: one of 36-303, 36-315, or 36-350 + both 36-401 and 36-402</td>
</tr>
<tr>
<td>Advanced Data Analysis</td>
<td>prereq for Statistical sequences 2 or</td>
</tr>
<tr>
<td>Probability Theory Theory</td>
<td>3 (counts as Statistical Elective)</td>
</tr>
<tr>
<td>Statistical Theory</td>
<td>9 units via sequences 1, 2 or 3**</td>
</tr>
<tr>
<td>Total</td>
<td><strong>82 Units</strong></td>
</tr>
</tbody>
</table>

* For students who enter the program with 36-225/226 or 36-625/626, in which case either 36-225 or 36-625 can serve as the elective.

** In order to be a Major or a Minor in good standing, a grade of at least a C is required in 36-310 or in 36-226. (In particular, this is required in order or be able to continue to senior level courses.)

Sample Programs

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 has a heavier emphasis on data analysis, and is one that would be typically taken by students in the College of Humanities and Social Sciences (such as psychology majors). The second schedule (or similar) is more mathematical, and is suggested, for example, for students who major in Computer Science.

Schedule 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>21-120, 21-241</td>
<td>21-111, 36-201</td>
</tr>
<tr>
<td>Sophomore</td>
<td>36-309</td>
<td>36-303</td>
</tr>
<tr>
<td>Junior</td>
<td>21-241</td>
<td>36-310</td>
</tr>
<tr>
<td>Senior</td>
<td>36-401</td>
<td>36-402</td>
</tr>
</tbody>
</table>

Schedule 2

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>21-120, 21-241</td>
<td>21-111, 36-201</td>
</tr>
<tr>
<td>Sophomore</td>
<td>36-225</td>
<td>36-226</td>
</tr>
<tr>
<td>Junior</td>
<td>36-309</td>
<td>36-315</td>
</tr>
<tr>
<td>Senior</td>
<td>36-401</td>
<td>36-402</td>
</tr>
</tbody>
</table>

Substitutions and Waivers

Many departments require Statistics courses as part of their Major or Minor programs. Students seeking transfer credit for those require-ments 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

ANTHONY BROCKWELL, Assistant Professor - Ph.D., The University of Melbourne, Australia; Carnegie Mellon, 1999-.

JAMES DELANEY, Visiting Assistant Professor – Ph.D., Georgia Institute of Technology; Carnegie Mellon, 2006-.

BERNIE DEVLIN, Adjunct Associate Professor - Ph.D., Pennsylvania State University; Carnegie Mellon, 1994-.

MICHELE DIPIETRO, Instructor and Associate Director, Eberly Center - Ph.D., Carnegie Mellon, 2001-.

GEORGE T. DUNCAN, Professor of Statistics and Public Policy - Ph.D., University of Minnesota; Carnegie Mellon, 1974-.

WILLIAM F. EDDY, 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, 1980-1991; 1993-.

CHRISTOPHER GENOVESE, Associate 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-.

MATTHEW HARRISON, Visiting Assistant Professor - Ph.D., Brown University; Carnegie Mellon, 2006-.

BRIAN JUNKER, Professor of Statistics - Ph.D., University of Illinois; Carnegie Mellon, 1990-.

JOSEPH B. KADANE, Leonard J. Savage Professor of Statistics and Social Sciences - Ph.D., Stanford University; Carnegie Mellon, 1969-.

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-.

JONG SOO LEE, Visiting Assistant Professor - Ph.D., Rice University; Carnegie Mellon, 2006-.

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-.

TANZY LOVE, Visiting Assistant Professor – Ph.D., Iowa State University; Carnegie Mellon, 2005-.

ODED MEYER, Lecturer - Ph.D., University of Pittsburgh; Carnegie Mellon, 1999-.

REBECCA NUGENT, Visiting Assistant Professor – Ph.D., University of Washington; Carnegie Mellon, 2006-.

KATHRYN ROEDER, Professor of Statistics - Ph.D., Pennsylvania State University; Carnegie Mellon, 1994-.

CHAD M. SCHAFER, Visiting 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, Research Scientist - Ph.D., Carnegie Mellon University; Medical College of Pennsylvania - M.D. Carnegie Mellon, 1999-.

COSMA SHALIZI, Visiting Assistant Professor – PhD. University of Wisconsin, Madison, Carnegie Mellon, 2005-.

SURYA TOKDAR, Visiting Assistant Professor – Ph.D. Purdue University; Carnegie Mellon, 2006-.

VALERIE VENTURA, Research Scientist - Ph.D., University of Oxford; Carnegie Mellon, 1997-.

ISABELLA VERDINELLI, Professor in Residence - Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991-.

PANTELOS K. VLACHOS, Research Scientist - Ph.D., University of Connecticut; Carnegie Mellon, 1996-.

LARRY WASSERMAN, Professor of Statistics - Ph.D., University of Toronto; Carnegie Mellon, 1988-.

LAN ZHANG, Assistant Professor of Statistics - Ph.D., University of Chicago; Carnegie Mellon, 2001-.
H. John Heinz III School of Public Policy and Management

Mark Wessel, Dean
Office: 1509 Hamburg Hall
http://www.heinz.cmu.edu/

What draws students to the graduate programs of the H. John Heinz III School of Public Policy and Management? Students entering the Heinz School 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 School 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 School are:

- Master of Science in Public Policy and Management (options include joint and dual degree programs with the Tepper School of Business, and a dual degree program with the University of Pittsburgh School of Law)
- 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 Information Security Policy and Management
- Doctor of Philosophy in Public Policy and Management

Distinctive features of the Heinz School include the quality of its research and teaching, and the attention it gives to the needs of its students. The Heinz School 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 School 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.

Options for Carnegie Mellon undergraduates

The Heinz School 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.

Accelerated Master’s Program

Through the Heinz School Accelerated Master’s Program (AMP), exceptional Carnegie Mellon undergraduate students can earn their master’s degree, along with their undergraduate degree, in less time than it would take to earn each degree separately. For example, a Carnegie Mellon student could earn an undergraduate degree and a Master of Science or Master of Arts Management degree in five years of study. In the AMP program, students take their undergraduate course load during their first three years, a combination of Heinz School courses and undergraduate courses in their fourth year, and finish their master’s degree in their fifth year of study.

Students admitted to the AMP program register for their final undergraduate year at Carnegie Mellon as undergraduates, pay undergraduate tuition, and receive undergraduate financial aid. They enroll in courses required for their B.A./B.S. degree and also take courses toward their Heinz School degree. They receive their B.A./B.S. degree at the end of the fourth year. For the fifth year, they register as Heinz School graduate students, pay graduate tuition, and receive graduate financial aid, if eligible.

Undergraduate Minor in Health Care Policy and Management

The minor in health care policy and management is offered jointly by the Heinz School, the College of Humanities and Social Sciences, and the Mellon College of Science. The minor is designed to provide students considering a career in the health professions with an understanding of the ways in which social, political, managerial and economic changes are transforming the face of health care, and the roles of organizations and individuals that provide it. 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) Prerequisites:

- 73-250, 88-220, or equivalent.

Required Courses: 33 units

- 90-761 Introduction to Health Care Policy and Management
- 90-735 Health Economics
- 79-384 Medicine and Society

Elective Courses: 27 units

See page 287 for additional information and lists of elective courses.

How is the Heinz School different?

Diversity

The Heinz School 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 School 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 School, 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 School students can work on projects initiated in these centers or as research assistants for center faculty.
What kinds of careers do Heinz School graduates pursue?

A Heinz School 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 School graduates can get the kind of interesting, exciting jobs they want, because they have the expertise in finance, accounting, information systems, and decision-making that employers need.

The Heinz School 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 School 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 School 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 School. For a more complete, current list, visit www.heinz.cmu.edu/researchers/faculty/.

ACQUISTI, ALESSANDRO, Assistant Professor of Information Systems and Public Policy — Ph.D., UC Berkeley; Carnegie Mellon, 2003—.

ARORA, ASHISH, Professor of Economics and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1991—.

BABCOCK, LINDA, James M. Walton Professor of Economics — Ph.D., University of Wisconsin at Madison; Carnegie Mellon, 1988—.

BARR, EDWARD, Associate Teaching Professor — M.S., Indiana University of Pennsylvania; Carnegie Mellon, 2000—.

BLUMSTEIN, ALFRED, J. Erik Jonsson University Professor of Urban Systems and Operations Research; Director, National Consortium on Violence Research — Ph.D., Cornell University; Carnegie Mellon, 1969—.

BORZUTSKY, SYLVIA, Associate Teaching Professor — Ph.D., University of Pittsburgh; Carnegie Mellon, 2001—.

CALLAN, JAMES, Associate Professor of Computer Science — Ph.D., University of Massachusetts at Amherst; Carnegie Mellon, 1999—.

CARLEY, KATHLEEN, Professor of Organizational Sociology (Joint with Department of Social and Decision Sciences) — Ph.D., Harvard University; Carnegie Mellon, 1984—.

CAULKINS, JONATHAN, Professor of Operations Research and Public Policy; Faculty Chair, Master of Public Policy and Management Program — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1990—.

CLAY, KAREN, Assistant Professor of Economics and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1997—.

COHEN, JACQUELINE, Principal Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1982—.

COHEN, WESLEY, (Affiliated) Professor of Economics and Social Sciences — Ph.D., Yale University; Carnegie Mellon, 1982—.

DAVIS, DEVRA, Visiting Professor — Ph.D., University of Chicago; Carnegie Mellon, 2000—.

DAVIS, OTTO, W.W. Cooper University Professor of Economics and Public Policy — Ph.D., University of Virginia; Carnegie Mellon, 1960—.

DEKAY, MICHAEL, Assistant Professor of Engineering, Public Policy, and Decision Sciences (Joint with Department of Engineering and Public Policy) — Ph.D., University of Colorado; Carnegie Mellon, 1996—.

DOMINITZ, JEFFREY, Assistant Professor of Economics and Public Policy — Ph.D., University of Wisconsin at Madison; Carnegie Mellon, 2000—.

DUNCAN, GEORGE, Professor of Statistics — Ph.D., University of Minnesota; Carnegie Mellon, 1974—.

EPPLER, DENNIS, (Affiliated) Thomas Lord Professor of Economics — Ph.D., Princeton University; Carnegie Mellon, 1974—.

FARROW, SCOTT, Principal Research Engineer and Director, Center for the Study and Improvement of Regulation — Ph.D., Washington State University; Carnegie Mellon, 1982—.

FERREIRA, PENELIPE, Distinguished Service Professor of Environmental Policy and Law — J.D., Duquesne University; Carnegie Mellon, 1998—.


GAYNOR, MARTIN, E.J. Barone Professor of Economics and Health Policy; Faculty Chair, Ph.D. Program — Ph.D., Northwestern University; Carnegie Mellon, 1995—.

GORR, WILPEN, Professor of Public Policy and Management Information Systems — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1985—.

HUNG, ANGELA, Assistant Professor of Economics and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon, 2000—.

HUNKER, JEFFREY, Professor of Technology and Public Policy — Ph.D., Harvard University; Carnegie Mellon, 2001—.

JOHNSON, MICHAEL, Associate Professor of Management Science and Urban Affairs — Ph.D., Northwestern University; Carnegie Mellon, 1997—.


KLEPPER, STEVEN, (Affiliated) Professor of Economics and Social Science — Ph.D., Cornell University; Carnegie Mellon, 1980—.

KRACKHARDT, DAVID, Professor of Organizations and Public Policy — Ph.D., University of California at Irvine; Carnegie Mellon, 1991—.

KRISHNAN, RAMAYYA, William W. and Ruth F. Cooper Professor of Management Science and Information Systems; Faculty Chair, Master of Information Systems Management Program — Ph.D., University of Texas at Austin; Carnegie Mellon, 1987—.

KURLAND, KRISTIN, Associate Teaching Professor (joint with School of Architecture) — B.A., University of Pittsburgh; Carnegie Mellon, 1999—.

LARKER, PATRICK, Professor of Public Policy and Decision Making — Ph.D., University of Michigan; Carnegie Mellon, 1977—.

LAVE, LESTER, James Higgins Professor of Economics and Finance, Professor of Urban and Public Affairs, Professor of Engineering and Public Policy — Ph.D., Harvard University; Carnegie Mellon, 1963—.

LEWIS, GORDON, Associate Professor of Sociology; Faculty Chair, Master of Public Management Program — Ph.D., Stanford University; Carnegie Mellon, 1969—.

LEWIS, PAMELA, Teaching Professor of Professional Speaking — D.A., Carnegie Mellon University; Carnegie Mellon, 1980—.

MADSEN, PETER, Senior Lecturer in Ethics and Public Policy — Ph.D., Duquesne University; Carnegie Mellon, 1988—.
MARINELLI, DONALD, (Affiliated) Professor of Drama and Arts Management (College of Fine Arts) — Ph.D., University of Pittsburgh; Carnegie Mellon, 1984—.

MARTIN, DAN, Director, Master of Arts Management Program, and Associate Professor (College of Fine Arts) — M.F.A., Brooklyn College/City University of New York; Carnegie Mellon, 1993—.

MCCARTHY, MICHAEL, Associate Teaching Professor of Information Systems Management — M.S., University of Pittsburgh; Carnegie Mellon, 1999—.

MERTZ, JOE, Associate Teaching Professor — Ph.D., Carnegie Mellon; Carnegie Mellon, 1994—.

MORGAN, M. GRANGER, Lord Chair Professor of Engineering and Public Policy, and Head, Department of Engineering and Public Policy — Ph.D., University of California at San Diego; Carnegie Mellon, 1974—.

NAGIN, DANIEL, Theresa and H. John Heinz III Professor of Public Policy, and Research Director, National Consortium on Violence Research — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1979—.

NYBERG, ERIC, Assistant Professor of Computer Science and Public Policy (joint with School of Computer Science) — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1986—.

PADMAN, REMA, Professor of Operations Research and Information Management; Faculty Chair, Master of Science in Health Care Policy and Management Program — Ph.D., University of Texas at Austin; Carnegie Mellon, 1989—.

ROEHIG, STEPHEN, Associate Professor of Information Systems and Public Policy — Ph.D., University of Pennsylvania Wharton School; Carnegie Mellon, 1991—.

ROUSSEAU, DENISE, H. J. Heinz II Professor of Organizational Behavior (joint with Graduate School of Industrial Administration) — Ph.D., University of California at Berkeley; Carnegie Mellon, 1994—.

SKINNER, KIRON, (Courtesy) Assistant Professor of History and Political Science — Ph.D., Harvard University; Carnegie Mellon, 1999—.

SMITH, DONALD, Professor of Practice; University Director for Economic Development — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995—.

SMITH, KATHLEEN, Associate Teaching Professor — Ph.D. candidate, University of Pittsburgh; Carnegie Mellon, 1991—.

SMITH, MICHAEL, Assistant Professor of Information Technology — Ph.D., Alfred P. Sloan School of the Massachusetts Institute of Technology; Carnegie Mellon, 2000—.

STEPHENS, MELVIN, Assistant Professor of Economics — Ph.D., University of Michigan; Carnegie Mellon, 2000—.

STEWMAN, SHELBY, Professor of Sociology and Demography — Ph.D., Michigan State University; Carnegie Mellon, 1973—.

STRAUSS, ROBERT, Professor of Economics and Public Policy; Faculty Chair, Master of Science in Educational Technology Management Program — Ph.D., University of Wisconsin; Carnegie Mellon, 1979—.

SZCZYPULA, JANUSZ, Associate Teaching Professor in Information Systems — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000—.

TARR, JOEL, Richard S. Caliguire Professor of Urban and Environmental History and Policy — Ph.D., Northwestern University; Carnegie Mellon, 1967—.

TAYLOR, LOWELL, Professor of Economics and Public Policy; Associate Dean of Faculty — Ph.D., University of Michigan; Carnegie Mellon, 1990—.


THOMAS, HELEN, Assistant Professor of Information Systems — Ph.D., Georgia Institute of Technology; Carnegie Mellon, 2002—.

VOGT, WILLIAM, Assistant Professor of Economics — Ph.D., Stanford University; Carnegie Mellon, 1996—.

WESSEL, MARK, Dean, University of Wisconsin; Carnegie Mellon, 1992—.

For further information about the Heinz School, contact: Director of Admissions
H. John Heinz III School of Public Policy and Management Carnegie Mellon University Pittsburgh, PA 15213
Telephone: (412) 268-2164 Toll-free (U.S.): 1-800-877-3498
Fax: (412) 268-7036
Email: hnzadmit@andrew.cmu.edu
Website: http://www.heinz.cmu.edu
Mellon College of Science

Richard D. McCullough, Dean
Eric W. Grotzinger, Associate Dean for Undergraduate Affairs
Undergraduate Office: Doherty Hall 1324
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, 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 or preparation for graduate or professional schools.

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
- Biophysics
- Molecular Biology

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 on page 54 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
- Robotics Minor
- Scientific Computing Minor
- Technology and Policy Minor

For a complete list of the minors offered at Carnegie Mellon, please see the catalog section on Undergraduate Options on page 76.

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. See page 89 for details.

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. See page 89 for details.

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 Chemical Biology
• Honors B.S./M.S. Program in Mathematical Sciences
• Accelerated Master's Program in the Heinz School of Public Policy and Management
• 3-1-1 Master's Program in Biotechnology Management (joint program between the Heinz School, 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: Amy Burkert

Please see page 76 for details on the Health Professions Program.

Pre-Law Advising Program

Faculty Contact: Joseph Devine

Please see page 77 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 on page 76 for more details about this opportunity.

Study Abroad

There are many programs for studying abroad, usually during your junior year. Please see the catalog section on Undergraduate Options on page 78 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. Please see www.cmu.edu/mcs/research/uq-res.html for details.

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 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 for Molecular Analysis features modern high-performance analytical instruments for use by researchers. In addition to the analytical instrumentation, the CMA provides collaborations, analytical assistance, and training. The CMA houses two NMRs, four photon spectrometers, and two mass spectrometers.
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 mathematicians and all scientists.

The Green Design Initiative involves forming partnerships with industrial corporations, foundations, and government agencies to develop joint research and education programs which improve environmental quality while encouraging sustainable economic development.

Hunt Institute for Botanical Documentation, founded in 1961, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation.

The Institute for Green Oxidation Chemistry 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 Steinbrenner Institute for Environmental Education and Research's mission is to help change the way the world thinks about the environment, through our education and research methods and results, through the issues we raise, and through the outcomes we produce.

The W.M. Keck Center for Advanced Training in Computational Biology is a collaboration among Carnegie Mellon University, the University of Pittsburgh, and the Pittsburgh Supercomputing Center.

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.

Science Core Courses

| 21-120 | Differential and Integral Calculus |
| 21-122 | Integration, Differential Equations, and Approximation |
| 33-111 | Physics for Science Students I |
| 33-112 | Physics for Science Students II |
| 03-121 | Modern Biology |
| 09-105 | Introduction to Modern Chemistry |
| 15-100 | Introductory/Intermediate Programming |

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; an optional first-year seminar, and Computing Skills Workshop, 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**

| 21-120 | Differential and Integral Calculus | 10 |
| 21-122 | Integration, Differential Equations, and Approximation | 10 |
| 33-111 | Physics for Science Students I | 9-12 |
| 33-112 | Physics for Science Students II | 9-12 |
| 03-121 | Modern Biology | 9-12 |
| 09-105 | Introduction to Modern Chemistry | 9-12 |
| 15-100 | Introductory/Intermediate Programming | 9-12 |

**Spring Semester**

| 21-122 | Integration, Differential Equations, and Approximation | 10 |
| 33-111 | Physics for Science Students I | 9-12 |
| 33-112 | Physics for Science Students II | 9-12 |
| 03-121 | Modern Biology | 9-12 |
| 09-105 | Introduction to Modern Chemistry | 9-12 |

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 Seminars**

First-year students in the Mellon College of Science have the opportunity to explore a special area of modern science in optional 3 unit mini-seminars. The seminars focus on a variety of topics in each department, from astrophysics and math software to polymers and proteins. Enrollment in the seminars is deliberately limited to encourage student participation and increase interaction with the professor. These seminars are an excellent opportunity for students to gain specific insight into a scientific discipline early in their undergraduate training. Although the topics offered vary each semester, here is a sample of recent seminar titles:

EUREKA: An Interdisciplinary Laboratory Experience

Proteins in Disease

Curing Cancer

Pills and Poisons: How Scientists View Molecules

Fractals

For more information on these unique seminars, please see the MCS departmental sections of this catalog.

**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 |

Notes
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

- Introduction to Ethics
- Nature of Reason
- Language and Thought
- Philosophy of Science
- Philosophy of Social Science
- Ethical Theory
- Ethical Judgments in Professional Life
- Conflict, Dispute Resolution
- Philosophy of Mind
- Philosophy and Psychology
- Introduction to Intelligence in Humans, Animals and Machines
- Introduction to Psychology
- Principles of Child Development
- Social Psychology
- Personality
- Abnormal Psychology
- Reason, Passion, and Cognition

Category 2: Economic, Political and Social Institutions

- Sampling, Surveys, and Society
- Business, Society, and Ethics
- Entrepreneurship for Scientists
- Principles of Economics
- Protest and Dissent in American History
- Crime and Punishment
- Drug Use and Drug Policy
- History of Modern Warfare
- American Environmental History: Critical Issues
- Medicine and Society
- Theories of International Relations
- Introduction to Political Philosophy
- Social Structure, Public Policy, and Ethical Dilemmas
- Political Philosophy
- Philosophy and the Law
- Environment Management and Ethics
- Medical Ethics
- Computers, Society, and Ethics
- Decision Processes in American Political Institutions
- Experiments with Economic Principles
- Comparative Politics
- Rachel Carson: Her Work and Legacy
- The Year is 1905: E=mc², Photons and Relativity

Category 3: Cultural Analysis

- Survey of Western Music History
- Introduction to Religion
- Managing Across Cultures
- Comedy
- African-American Studies
- Introduction to Gender Studies
- Introduction to World History
- Culture and Identity in American Society
- Introduction to Anthropology
- Development of American Culture
- Development of European Culture
- Theory and Practice in Anthropology
- The Roots of Rock & Roll
- African-American History I
- African-American History II
- Chinese Culture and Society
- Poverty, Charity, and Welfare
- Medicine and Society
- What Philosophy Is
- God in the West
- Ancient Philosophy
- Modern Philosophy
- Continental Philosophy
- Analytical Philosophy
- Pragmatism
- Aesthetics of Mass Art
- Introduction to Japanese Language & Culture
- Topics in Russian Language and Culture
- French Culture
- Francophone World
- Introduction to German Studies

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 School) that do satisfy these requirements. The direct URL is www.cmu.edu/mcs/education/edu.HSSFA.html.

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 relation indicated below between probation, suspension, and drop is normal, not binding. In unusual circumstances, MCS College Council may 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 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 on p. 48)

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 “Applying your Education through Research” on page 283 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 School of Public Policy and Management
College of Humanities and Social Sciences
Mellon College of Science

Faculty Advisors:
Caroline Acker, College of Humanities and Social Sciences
Laura Synnott, H. John Heinz III School
Amy Burkert, 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 been 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 deeper understanding of the changing structure of health care organizations and policy.

Curriculum (minimum) 60 units
Six courses (a minimum of 60 units) are required to complete this minor. Entry into the minor requires completion of 73-250, Intermediate Microeconomics or 88-220, Policy Analysis I or the equivalent by approval.

Required Courses 33 units
Students are required to take the following courses.
- 79-384 Medicine and Society
- 90-761 Principles of Healthcare
- 90-735 Health Economics

Elective Courses 27 units
Complete three courses totaling a minimum of 27 units.

Heinz School Courses (12 units each)
- 90-721 Non-Profit and Health Marketing
- 91-830 Financial Management of Health Systems
- 91-836 Legal Issues in Health Systems Management
- 91-844 Managing Quality Improvement
- 91-853 Health Care Information Systems
- 91-861 Health Policy
- 91-862 Managed Care

Humanities and Social Sciences Courses (9 units each)
- 76-494 Medical Communications
- 79-335 Drug Use and Drug Policy
- 79-336 Epidemic Disease and Public Health
- 80-245 Medical Ethics
- 85-241 Social Psychology
- 85-442 The Social Psychology of Health
- 85-446 The Psychology of Gender
- 85-451 The Psychology of Purpose
- 88-373 Mental Health Ideologies

Please note that some of these courses have prerequisites that will not count toward the completion of the requirements for this minor.

Minor in Environmental Science
Faculty Contact:
Neil Donahue, Chemistry and Chemical Engineering Departments

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.
Minor in Scientific Computing

Faculty Contact:
Richard Holman, Physics Department

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.
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, 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 science, medicine, public health, law or business.

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, and mathematics. In addition to the core courses, the program includes six biology electives, five free electives and 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. A bachelor of arts (B.A.) degree is available when coupled with an additional major from any department in the College of Humanities and Social Sciences. In addition, the department offers a B.S. in Computational Biology for students with interests in computational modeling and analysis of biological systems as well as a unified B.S. in Biological Sciences and Psychology.

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.

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 page 76 for more information.)

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. Many students broaden their education by pursuing minors and additional majors in disciplines throughout the university, not just within the Mellon College of Science. 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.

One of the most important features of the Department of Biological Sciences is the opportunity for undergraduate students to interact with faculty. The faculty members are prominent research scientists who also teach beginning and advanced courses. The 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 in the junior, or, in unusual cases, the sophomore year. The department has an Honors Program in Research Biology that is intended 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 B.S. in Biological Sciences is built around a core program and elective units as detailed in the following section.

<table>
<thead>
<tr>
<th>Course Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biological Sciences</strong></td>
<td></td>
</tr>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>02-231/232 Biochemistry</td>
<td>9</td>
</tr>
<tr>
<td>03-240 Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-330 Genetics</td>
<td>3</td>
</tr>
<tr>
<td>03-343 Experimental Genetics and Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-344 Experimental Biochemistry or</td>
<td>12</td>
</tr>
<tr>
<td>03-345 Experimental Cell and Developmental Biology</td>
<td></td>
</tr>
<tr>
<td>03-202 Colloquium</td>
<td>2</td>
</tr>
<tr>
<td>03-203 Colloquium</td>
<td></td>
</tr>
<tr>
<td>03-411 Topics in Research</td>
<td></td>
</tr>
<tr>
<td>03-412 Topics in Research</td>
<td>2</td>
</tr>
<tr>
<td>03-XXX Biological Sciences Electives*</td>
<td>54</td>
</tr>
<tr>
<td><strong>Mathematics, Physics and Computer Science</strong></td>
<td></td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations, and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>33-111 Physics for Science Students I</td>
<td>12</td>
</tr>
<tr>
<td>33-112 Physics for Science Students II</td>
<td>12</td>
</tr>
<tr>
<td>15-100 Introductory/Intermediate Programming</td>
<td>10</td>
</tr>
<tr>
<td>10-101/111 Introduction to Computing</td>
<td></td>
</tr>
<tr>
<td>103 Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
</tr>
<tr>
<td>09-105 Introduction to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-106 Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-217 Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>09-218 Organic Chemistry II</td>
<td>9</td>
</tr>
<tr>
<td>09-221 Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-222 Laboratory II: Organic Synthesis and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-214 Physical Chemistry</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>246</td>
</tr>
<tr>
<td><strong>Elective Units</strong></td>
<td></td>
</tr>
<tr>
<td>Free Electives</td>
<td>42</td>
</tr>
<tr>
<td>H&amp;SS and Fine Arts Electives</td>
<td>72</td>
</tr>
<tr>
<td>(see Note 2 on p. 269 of the Mellon College of Science section)</td>
<td></td>
</tr>
<tr>
<td><strong>Minimum number of units required for degree:</strong></td>
<td>360</td>
</tr>
</tbody>
</table>

* Biological Sciences Electives

The following specifications apply to Biological Sciences electives:

- At least 18 units must be at the 03-3xx 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 Research Biology may count as biology electives; a maximum of 36 units can count toward graduation.
Courses in biology taken through cross-registration at another university may count as electives if prior permission has been obtained from the Carnegie Mellon Department of Biological Sciences advisor.

**Departmental Electives Group**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-122</td>
<td>Organismic Botany</td>
</tr>
<tr>
<td>03-124</td>
<td>Modern Biology Laboratory</td>
</tr>
<tr>
<td>03-125</td>
<td>Evolution and the History of Life</td>
</tr>
<tr>
<td>03-130</td>
<td>Biology of Organisms</td>
</tr>
<tr>
<td>03-310</td>
<td>Introduction to Computational Biology</td>
</tr>
<tr>
<td>03-311</td>
<td>Introduction to Computational Molecular Biology</td>
</tr>
<tr>
<td>03-315</td>
<td>Magnetic Resonance Imaging in Neuroscience</td>
</tr>
<tr>
<td>03-350</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>03-360</td>
<td>Biology of the Brain</td>
</tr>
<tr>
<td>03-380</td>
<td>Virology</td>
</tr>
<tr>
<td>03-390</td>
<td>Molecular and Cellular Immunology</td>
</tr>
<tr>
<td>03-439</td>
<td>Introduction to Biophysics</td>
</tr>
<tr>
<td>03-442</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>03-445</td>
<td>Undergraduate Research</td>
</tr>
<tr>
<td>03-450</td>
<td>Cellular and Genetic Mechanisms of Development</td>
</tr>
<tr>
<td>03-510</td>
<td>Computational Biology</td>
</tr>
<tr>
<td>03-511</td>
<td>Computational Molecular Biology and Genomics</td>
</tr>
<tr>
<td>03-512</td>
<td>Computational Methods for Biological Modeling and Simulation</td>
</tr>
<tr>
<td>03-513</td>
<td>Bioinformatics Data Integration Practicum</td>
</tr>
<tr>
<td>03-534</td>
<td>Biological Imaging and Fluorescence Spectroscopy</td>
</tr>
<tr>
<td>03-545</td>
<td>Honors Research</td>
</tr>
<tr>
<td>03-620</td>
<td>Techniques in Electron Microscopy</td>
</tr>
<tr>
<td>03-710</td>
<td>Computational Biology</td>
</tr>
<tr>
<td>03-711</td>
<td>Computational Genomics and Molecular Biology</td>
</tr>
<tr>
<td>03-712</td>
<td>Computational Methods for Biological Modeling and Simulation</td>
</tr>
<tr>
<td>03-713</td>
<td>Bioinformatics Data Integration Practicum</td>
</tr>
<tr>
<td>03-730</td>
<td>Advanced Genetics</td>
</tr>
<tr>
<td>03-740</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>03-741</td>
<td>Advanced Cell Biology</td>
</tr>
<tr>
<td>03-742</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>03-744</td>
<td>Membrane Trafficking</td>
</tr>
<tr>
<td>03-751</td>
<td>Advanced Developmental Biology</td>
</tr>
<tr>
<td>03-761</td>
<td>Neural Plasticity in Sensory and Motor Systems</td>
</tr>
<tr>
<td>03-871</td>
<td>Structural Biophysics</td>
</tr>
</tbody>
</table>

**Interdisciplinary Electives Group**

Up to three of the following courses may count as biology electives

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-518</td>
<td>Bioorganic Chemistry: Nucleic Acids and Carbohydrates</td>
</tr>
<tr>
<td>09-519</td>
<td>Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry</td>
</tr>
<tr>
<td>09-521</td>
<td>Bioinorganic Chemistry</td>
</tr>
<tr>
<td>15-211</td>
<td>Fundamental Structures of Computer Science I</td>
</tr>
<tr>
<td>21-127</td>
<td>Concepts of Mathematics</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
</tr>
<tr>
<td>21-260</td>
<td>Differential Equations</td>
</tr>
<tr>
<td>36-247</td>
<td>Statistics for Lab Sciences</td>
</tr>
<tr>
<td>42-202</td>
<td>Physiology</td>
</tr>
<tr>
<td>42-621</td>
<td>Biotechnology and Environmental Processes</td>
</tr>
<tr>
<td>85-219</td>
<td>Biological Foundations of Behavior</td>
</tr>
</tbody>
</table>

**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. Students 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:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-740</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
</tr>
<tr>
<td>or</td>
<td>21-260</td>
</tr>
</tbody>
</table>

**Any one of the following courses:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-518</td>
<td>Bioorganic Chemistry: Nucleic Acids and Carbohydrates</td>
</tr>
<tr>
<td>09-519</td>
<td>Bioorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry</td>
</tr>
<tr>
<td>09-521</td>
<td>Bioinorganic Chemistry</td>
</tr>
</tbody>
</table>

**Recommended Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-442</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>03-534</td>
<td>Biological Imaging and Fluorescence Spectroscopy</td>
</tr>
<tr>
<td>03-439</td>
<td>Introduction to Biophysics</td>
</tr>
<tr>
<td>03-871</td>
<td>Structural Biophysics</td>
</tr>
</tbody>
</table>

**Biophysics Option**

**Required Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-740</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>03-439</td>
<td>Introduction to Biophysics</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
</tr>
<tr>
<td>or</td>
<td>21-260</td>
</tr>
</tbody>
</table>

**Recommended Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-315</td>
<td>Magnetic Resonance Imaging in Neuroscience</td>
</tr>
<tr>
<td>03-34</td>
<td>Biological Imaging and Fluorescence Spectroscopy</td>
</tr>
<tr>
<td>03-871</td>
<td>Structural Biophysics</td>
</tr>
</tbody>
</table>

**Cell Biology Option**

**Required Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-350</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>03-450</td>
<td>Cellular and Genetic Mechanisms of Development</td>
</tr>
<tr>
<td>03-741</td>
<td>Advanced Cell Biology</td>
</tr>
</tbody>
</table>

**Recommended Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-360</td>
<td>Biology of the Brain</td>
</tr>
<tr>
<td>03-442</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>03-751</td>
<td>Advanced Developmental Biology</td>
</tr>
</tbody>
</table>

**Computational Biology Option**

**Required Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-510</td>
<td>Computational Biology</td>
</tr>
<tr>
<td>15-211</td>
<td>Fundamental Structures and Algorithms I</td>
</tr>
</tbody>
</table>

**Any one of the following courses:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-247</td>
<td>Statistics for Laboratory Sciences</td>
</tr>
<tr>
<td>21-260</td>
<td>Differential Equations</td>
</tr>
<tr>
<td>21-241</td>
<td>Matrix Algebra</td>
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**Recommended Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-511</td>
<td>Computational Molecular Biology and Genomics</td>
</tr>
<tr>
<td>03-12</td>
<td>Computational Methods for Biological Modeling and Simulation</td>
</tr>
<tr>
<td>15-212</td>
<td>Fundamental Structures of Computer Science II</td>
</tr>
<tr>
<td>15-451</td>
<td>Algorithm Design and Analysis</td>
</tr>
<tr>
<td>09-560</td>
<td>Computational Chemistry</td>
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**Developmental Biology Option**

**Required Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-350</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>03-442</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>03-751</td>
<td>Advanced Developmental Biology</td>
</tr>
</tbody>
</table>

**Recommended Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-360</td>
<td>Biology of the Brain</td>
</tr>
<tr>
<td>03-450</td>
<td>Cellular and Genetic Mechanisms of Development</td>
</tr>
<tr>
<td>03-730</td>
<td>Advanced Genetics (minimum grade of B in 03-330 required)</td>
</tr>
</tbody>
</table>

**Genetics Option**

**Required Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-450</td>
<td>Cellular and Genetic Mechanisms of Development</td>
</tr>
<tr>
<td>03-730</td>
<td>Advanced Genetics</td>
</tr>
</tbody>
</table>

**Molecular Biology Option**

**Required Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-442</td>
<td>Molecular Biology</td>
</tr>
<tr>
<td>09-518</td>
<td>Bioorganic Chemistry: Nucleic Acids and Carbohydrates</td>
</tr>
<tr>
<td>03-450</td>
<td>Cellular and Genetic Mechanisms of Development</td>
</tr>
</tbody>
</table>

**Recommended Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-350</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>03-360</td>
<td>Biology of the Brain</td>
</tr>
<tr>
<td>03-380</td>
<td>Virology</td>
</tr>
<tr>
<td>03-730</td>
<td>Advanced Genetics</td>
</tr>
<tr>
<td>03-751</td>
<td>Advanced Developmental Biology</td>
</tr>
</tbody>
</table>

**Neuroscience Option**

**Required Biology Electives:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-360</td>
<td>Biology of the Brain</td>
</tr>
</tbody>
</table>

**Any two of the following courses:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-315</td>
<td>Magnetic Resonance Imaging in Neuroscience</td>
</tr>
<tr>
<td>03-761</td>
<td>Neural Plasticity in Sensory and Motor Systems</td>
</tr>
<tr>
<td>85-219</td>
<td>Biological Foundations of Behavior</td>
</tr>
</tbody>
</table>
**Recommended Biology Electives:**
- 42-202 Physiology
- 03-534 Biological Imaging and Fluorescence Spectroscopy
- 03-350 Developmental Biology

**B.S. Computational Biology**
The B.S. in Computational Biology is now listed in the Intercollege section of this catalog. It is a joint degree program offered with the School of Computer Science.

**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 on this program, contact the Department of Biological Sciences.

**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 B.S. in Biological Sciences and Psychology. Students in the joint SHS program can complete the SHS educational core and choose either departmental order for their diploma.

<table>
<thead>
<tr>
<th>Course Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biological Sciences</strong></td>
<td></td>
</tr>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-231/232 Biochemistry</td>
<td>9</td>
</tr>
<tr>
<td>03-240 Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-330 Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-343 Experimental Genetics and Molecular Biology</td>
<td>12</td>
</tr>
<tr>
<td>03-201 Colloquium</td>
<td>2</td>
</tr>
<tr>
<td>03-202 Colloquium</td>
<td>2</td>
</tr>
<tr>
<td>03-411 Topics in Research</td>
<td>2</td>
</tr>
<tr>
<td>03-412 Topics in Research</td>
<td>2</td>
</tr>
<tr>
<td>03-3XX Advanced Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td>03-3XX Advanced Biology Elective (03-360 recommended)</td>
<td></td>
</tr>
<tr>
<td><strong>Mathematics, Statistics, Physics and Computer Science</strong></td>
<td></td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations, and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>36-247 Statistics for Lab Sciences</td>
<td>9</td>
</tr>
<tr>
<td>36-309 Experimental Design for Behavioral and Social Sciences</td>
<td>9</td>
</tr>
<tr>
<td>33-111 Physics for Science Students I</td>
<td>12</td>
</tr>
<tr>
<td>33-112 Physics for Science Students II</td>
<td>12</td>
</tr>
<tr>
<td>15-100 Introductory/Intermediate Programming</td>
<td>10</td>
</tr>
<tr>
<td>99-101/102/103</td>
<td></td>
</tr>
<tr>
<td>103 Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
</tr>
<tr>
<td>09-105 Introduction to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-106 Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-217 Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>09-218 Organic Chemistry II</td>
<td>9</td>
</tr>
<tr>
<td>09-221 Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-222 Laboratory II: Organic Synthesis and Analysis</td>
<td>12</td>
</tr>
<tr>
<td><strong>Psychology Courses</strong></td>
<td></td>
</tr>
<tr>
<td>85-102 Introductory to Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-219 Biological Foundations of Behavior</td>
<td>9</td>
</tr>
<tr>
<td>85-2XX * Survey Psychology Courses</td>
<td>18</td>
</tr>
<tr>
<td>85-310 or 85-320</td>
<td></td>
</tr>
<tr>
<td>85-340 Research Methods in Psychology</td>
<td>9</td>
</tr>
<tr>
<td>85-3XX Advanced Psychology Electives</td>
<td>18</td>
</tr>
<tr>
<td><strong>Advanced Biological Sciences or Psychology Elective</strong></td>
<td></td>
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<tr>
<td>85-3XX Advanced Psychology Elective</td>
<td>9</td>
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</tbody>
</table>

**Additional Laboratory or Research Methods**
(Choose one of the following courses) 9-12
- 03-344 Experimental Biochemistry
- 03-345 Experimental Cell and Developmental Biology
- 85-310 Research Methods in Cognitive Psychology
- 85-320 Research Methods in Developmental Psychology

**Elective Units**
- Free Electives 33-36
- H&SS and Fine Arts Electives 27

**Minimum number of units required for degree:** 360
* Excluding 85-261, Abnormal Psychology

**B.A. Biological Sciences with an Additional Major**
The Department of Biological Sciences offers a B.A. when combined with an additional major that is intended for students who wish to combine their interest in science with one of the majors in the College of Humanities and Social Sciences. The requirements for the B.A. degree are distributed as follows:

<table>
<thead>
<tr>
<th>Course Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B.A. Biological Sciences</strong></td>
<td></td>
</tr>
<tr>
<td>03-121 Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-231/232 Biochemistry</td>
<td>9</td>
</tr>
<tr>
<td>03-240 Cell Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-330 Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-343 Modern Biological Laboratory: Experimental Genetics and Molecular Biology</td>
<td>9-12</td>
</tr>
<tr>
<td>03-201 Colloquium</td>
<td>2</td>
</tr>
<tr>
<td>03-202 Colloquium</td>
<td>2</td>
</tr>
<tr>
<td>03-411 Topics in Research</td>
<td>2</td>
</tr>
<tr>
<td>03-412 Topics in Research</td>
<td>2</td>
</tr>
<tr>
<td>03-XXX General Biology Electives</td>
<td>18</td>
</tr>
<tr>
<td>03-3XX Advanced Biology Elective</td>
<td>9</td>
</tr>
<tr>
<td><strong>Mathematics, Physics and Computer Science</strong></td>
<td></td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>21-122 Integration, Differential Equations, and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>33-111 Physics for Science Students I</td>
<td>12</td>
</tr>
<tr>
<td>33-112 Physics for Science Students II</td>
<td>12</td>
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<tr>
<td>99-101/102/103</td>
<td></td>
</tr>
<tr>
<td>103 Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
</tr>
<tr>
<td>09-105 Introduction to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>09-106 Modern Chemistry II</td>
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</tr>
<tr>
<td>09-217 Organic Chemistry I</td>
<td>9</td>
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<tr>
<td>09-218 Organic Chemistry II</td>
<td>9</td>
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<tr>
<td>09-221 Laboratory I: Introduction to Chemical Analysis</td>
<td>12</td>
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<td>09-222 Laboratory II: Organic Synthesis and Analysis</td>
<td>12</td>
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<td><strong>Total</strong></td>
<td>195-198</td>
</tr>
<tr>
<td><strong>Elective Units</strong></td>
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</tr>
<tr>
<td>MCS required distribution courses in H&amp;SS and Fine Arts</td>
<td>36</td>
</tr>
<tr>
<td>Courses as specified for the additional major and Free Electives</td>
<td>126-129</td>
</tr>
<tr>
<td><strong>Minimum number of units required for degree:</strong> 360</td>
<td></td>
</tr>
</tbody>
</table>
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.

Prerequisite and Required Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite and Required Courses for the Minor</td>
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<td></td>
</tr>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-231/232</td>
<td>Biochemistry</td>
<td>9</td>
</tr>
<tr>
<td>03-240</td>
<td>Cell Biology</td>
<td>9</td>
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<tr>
<td>03-330</td>
<td>Genetics</td>
<td>9</td>
</tr>
<tr>
<td>03-XXX</td>
<td>General Biology Elective</td>
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<tr>
<td>03-3XX</td>
<td>Advanced Biology Elective</td>
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<td>Total</td>
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<td>19 + 54</td>
</tr>
</tbody>
</table>

Faculty

ERIC T. AHRENS, Associate Professor of Biological Sciences—Ph.D., University of California, Los Angeles; Carnegie Mellon, 2000—.
ALISON L. BARTH, Assistant Professor of Biological Sciences—Ph.D., University of California, Berkeley; Carnegie Mellon, 2002—.
PETER B. BERGET, Associate Professor of Biological Sciences—Ph.D., University of Minnesota; Carnegie Mellon, 1986—.
WILLIAM E. BROWN, Professor of Biological Sciences—Ph.D., University of Minnesota; Carnegie Mellon, 1973—.
AMY L. BURKERT, Teaching Professor of Biological Sciences; Associate Department Head for Undergraduate Affairs; Director, University Health Professions Program—Ph.D., Carnegie Mellon University; Carnegie Mellon, 1997—.
JAMES M. BURNETTE III, Lecturer, Biological Sciences;—Ph.D., Carnegie Mellon University; Carnegie Mellon, 2004—.
JUSTIN C. CROWLEY, Assistant Professor of Biological Sciences,—Ph.D., Duke University; Carnegie Mellon, 2003—.
CARRIE B. DOONAN, Associate Teaching Professor of Biological Sciences—Ph.D., University of Connecticut; Carnegie Mellon, 1993—.
M. DANNIE DURAND, Associate Professor of Biological Sciences—Ph.D., Columbia University; Carnegie Mellon, 2000—.
CHARLES A. ETTENSOHN, Professor of Biological Sciences—Ph.D., Yale University; Carnegie Mellon, 1987—.
ERIC W. GROTZINGER, Teaching Professor of Biological Sciences; Associate Dean, Mellon College of Science—Ph.D., University of Pittsburgh; Carnegie Mellon, 1979—.
DAVID D. HACKNEY, Professor of Biological Sciences—Ph.D., University of California, Berkeley; Carnegie Mellon, 1978—.
VERONICA F. HINMAN, Assistant Professor of Biological Sciences—Ph.D., University of Queensland; Carnegie Mellon, 2006—.
CHIEN HO, Alumni Professor of Biological Sciences; Director, NMR Center for Biomedical Research—Ph.D., Yale University; Carnegie Mellon, 1979—.

JEFFREY O. HOLLINGER, Professor of Biological Sciences and Biomedical Engineering; Director, Bone Tissue Engineering Center—Ph.D., D.D.S., University of Maryland; Carnegie Mellon, 2000—.
JONATHAN W. JARVIK, Associate Professor of Biological Sciences—Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1978—.
ELIZABETH W. JONES, Dr. Frederick A. Schwartz Distinguished Professor of Life Sciences; Head, Department of Biological Sciences—Ph.D., University of Washington; Carnegie Mellon, 1974—.
LINDA R. KAUFFMAN, Teaching Professor of Biological Sciences—Ph.D., University of Pittsburgh; Carnegie Mellon, 1977—.
FREDERICK LANNI, Associate Professor of Biological Sciences—Ph.D., Harvard University; Carnegie Mellon, 1982—.
CHRISTINA H. LEE, Assistant Professor of Biological Sciences—Ph.D., University of California, San Francisco; Carnegie Mellon, 2000—.
ADAM D. LINDESTEDT, Associate Professor of Biological Sciences—Ph.D., University of California, San Francisco; Carnegie Mellon, 1995—.
ANTONIO-JAVIER LÓPEZ, Associate Professor of Biological Sciences—Ph.D., Duke University; Carnegie Mellon, 1989—.
BROOKE M. McCARTNEY, Assistant Professor of Biological Sciences—Ph.D., Duke University; Carnegie Mellon, 2003—.
JONATHAN S. MINDEN, Associate Professor of Biological Sciences—Ph.D., Albert Einstein College of Medicine; Carnegie Mellon, 1990—.
ROBERT F. MURPHY, Professor of Biological Sciences and Biomedical Engineering—Ph.D., California Institute of Technology; Carnegie Mellon, 1983—.
JOHN F. NAGLE, Professor of Physics and Biological Sciences—Ph.D., Yale University; Carnegie Mellon, 1967—.
GORDON S. RULE, Robert Eberly Professor of Biological Sciences—Ph.D., Carnegie Mellon University; Carnegie Mellon, 1996—.
RUSSELL S. SCHWARTZ, Assistant Professor of Biological Sciences—Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2002—.
V. EMILY STARK, Associate Teaching Professor, Biological Sciences, Coordinator of Graduate Programs—M.S., Carnegie Mellon University; Carnegie Mellon, 2003—.
JOSEPH P. SUHAN, Special Principal Lecturer, Electron Microscopy in Biological Sciences—MA, Hofstra University; Carnegie Mellon, 1989—.
NATHAN N. URBAN, Assistant Professor of Biological Sciences—Ph.D., University of Pittsburgh; Carnegie Mellon, 2002—
LINDA M. VISOMIRSKI-ROBIC, Special Lecturer, Biological Sciences—Ph.D., Case Western Reserve; Carnegie Mellon, 2003—.
ALAN S. WAGGONER, Professor of Biological Sciences; Director, Molecular Biosensor and Imaging Center—Ph.D., University of Oregon; Carnegie Mellon, 1999—.
HEATHER E. WEITZEL, Assistant Professor of Biological Sciences—Ph.D., Carnegie Mellon University, 2003—
JAMES F. WILLIAMS, Professor of Biological Sciences—Ph.D., University of Toronto; Carnegie Mellon, 1976—.
JOHN L. WOOLFORD JR., Professor of Biological Sciences—Ph.D., Duke University; Carnegie Mellon, 1979—.

Adjunct Faculty

CYNTHIA M. MORTON, Associate Curator of the Carnegie Museum of Natural History—Ph.D., New York Botanical Garden/CUNY; Carnegie Mellon, 2002—.
PETER L. STRICK, Professor, Co-Director of the Center for the Neural Basis of Cognition, Neurobiology, and Psychiatry, University of Pittsburgh—Ph.D., University of Pennsylvania; Carnegie Mellon, 2000—.
D. LANSING TAYLOR, President and Chief Executive Officer of Cellumen, Inc.—Ph.D., State University of New York at Albany; Carnegie Mellon, 1982—.
GEORGE S. ZUBENKO, Professor of Psychiatry, University of Pittsburgh School of Medicine — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1984—.

Affiliated Faculty

BRUCE A. ARMITAGE, Associate Professor of Chemistry — Ph.D., University of Arizona; Carnegie Mellon, 1997—.

ZIV BAR-JOSEPH, Assistant Professor, Center for Automated Learning and Discovery, School of Computer Science — Ph.D. Massachusetts Institute of Technology; Carnegie Mellon, 2003—.

PHIL G. CAMPBELL, Associate Research Professor, Institute for Complex Engineered Systems, Carnegie Institute of Technology—Ph.D. Pennsylvania State University; Carnegie Mellon, 1999—.

WILLIAM F. EDDY, Professor of Statistics—Ph.D., Yale University; Carnegie Mellon, 1976—.

T.D. JACOBSEN, Assistant Director and Principal Research Scientist, Hunt Institute for Botanical Documentation — Ph.D., Washington State University; Carnegie Mellon, 1979—.

ROBERT W. KIGER, Distinguished Service Professor of Botany; Professor of History of Science; Director and Principle Research Scientist, Hunt Institute for Botanical Documentation — Ph.D., University of Maryland; Carnegie Mellon, 1974—.

CHRISTOPHER J. LANGMEAD, Assistant Professor of Computer Science — Ph.D., Dartmouth College; Carnegie Mellon 2004—.

PHILIP R. LEDUC, Assistant Professor of Mechanical Engineering — Ph.D., The Johns Hopkins University; Carnegie Mellon, 2002—.

JAMES L. MCCLELLAND, Professor of Psychology; Co-director, Center for the Neural Basis of Cognition — Ph.D., University of Pennsylvania; Carnegie Mellon, 1984—.

CARL OLSON, Professor of the Center for the Neural Basis of Cognition — Ph.D., University of California, Berkeley; Carnegie Mellon, 1996—.

JOEL R. STILES, Associate Professor of Mellon College of Science and Senior Scientific Specialist, Pittsburgh Super Computing Center—Ph.D., M.D., University of Kansas School of Medicine; Carnegie Mellon, 1999—.

FREDERICK UTECH, Principal Research Scientist, Hunt Institute for Botanical Documentation — Ph.D., Washington University; Carnegie Mellon, 1977—.

ERIC P. XING, Assistant Professor of Computer Science — Ph.D., University of California, Berkeley; Carnegie Mellon, 2004—.

Emeritus Faculty

WILLIAM R. McCLURE, Professor of Biological Sciences — Ph.D., University of Wisconsin; Carnegie Mellon, 1981—.

C. ROY WORTHINGTON, Professor of Biological Sciences — Ph.D., University of California, Berkeley; Carnegie Mellon 1969.
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.

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. 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 Master’s/M.S. degree programs 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 either Chemistry, Polymer Science, or Public Policy and 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 80 to 90% of the graduating chemistry majors have taken part in research either for pay or for credit as part of their undergraduate training. Departmental majors and programs are described by individual departments in this catalog. Students should take the last Science Core Course as early as
possible and by the end of their sixth semester. Course 09-106 (Modern Chemistry II) is defined as a Technical MCS Elective.

*NOTE: Students who plan to continue in any computer science program as part of their chemistry degree (e.g. Computational Chemistry Option or Track) or take any upper level computer science courses and have any previous programming experience should take 15-111 (Intermediate/Advanced Programming) in lieu of 15-100. If you have no prior programming experience you should take 15-100 followed by 15-200 (Advanced Programming/Practicum) in order to take upper level computer science courses.

**First Year**

<table>
<thead>
<tr>
<th>Fall (Four Course Schedule)</th>
<th>Units</th>
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<tbody>
<tr>
<td>09-105 Introduction to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>33-111 Physics I for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>76-101 Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td>99-101 Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>44</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>09-106 Modern Chemistry II</td>
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<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
</tr>
<tr>
<td>33-112 Physics II for Science Students</td>
</tr>
<tr>
<td>15-100 Introductory/Intermediate Programming (or core elective)</td>
</tr>
<tr>
<td>09-xxx H&amp;SS Distribution Course 1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

An optional 3-unit Freshman Chemistry Seminar, 09-102, is offered to MCS students in the spring semester. These are low enrollment, discussion oriented classes on special topics in modern chemistry.

**Sophomore Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
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<tbody>
<tr>
<td>09-201 Undergraduate Seminar I</td>
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<tr>
<td>09-217 Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>09-221 Laboratory I: Introduction to Chemical Analysis</td>
<td>9</td>
</tr>
<tr>
<td>09-231 Mathematical Methods for Chemists</td>
<td>9</td>
</tr>
<tr>
<td>03-121 Modern Biology (or core elective)</td>
<td>9</td>
</tr>
<tr>
<td>09-xxx H&amp;SS Distribution Course 2</td>
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<tr>
<td><strong>Total</strong></td>
<td>49</td>
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</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>09-202 Undergraduate Seminar II</td>
<td>1</td>
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<tr>
<td>09-204 Issues in Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>09-218 Organic Chemistry II*</td>
<td>9</td>
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<tr>
<td>09-222 Lab II: Organic Synthesis and Analysis</td>
<td>12</td>
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<tr>
<td>09-348 Inorganic Chemistry</td>
<td>10</td>
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<tr>
<td>09-xxx H&amp;SS Distribution Course 3</td>
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<td><strong>Total</strong></td>
<td>44</td>
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</tbody>
</table>

**A 3-unit mini course 09-220 Supramolecular Chemistry is offered as an elective to compliment 09-218. (Enrollment Limited)**

**Junior Year**

<table>
<thead>
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<th>Fall</th>
<th>Units</th>
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<tbody>
<tr>
<td>09-301 Undergraduate Seminar III</td>
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<tr>
<td>09-321 Laboratory III: Molecular Design and Synthesis</td>
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</tr>
<tr>
<td>09-344 Physical Chemistry (Quantum)</td>
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<tr>
<td>09-xxx Modern Analytical Instrumentation</td>
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</tr>
<tr>
<td>09-xxx H&amp;SS/CFA Elective 1 (of 4)*</td>
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<tr>
<td><strong>Total</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>09-302 Undergraduate Seminar IV</td>
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<tr>
<td>09-322 Laboratory IV: Molecular Spectroscopy and Dynamics</td>
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</tr>
<tr>
<td>09-345 Physical Chemistry (Thermo)</td>
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<tr>
<td>09-xxx Chemical Elective (see Notes on Electives)</td>
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</tr>
<tr>
<td>09-xxx H&amp;SS/CFA Elective 2 (of 4)*</td>
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<tr>
<td><strong>Total</strong></td>
<td>40</td>
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**Senior Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
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<tbody>
<tr>
<td>09-401 Undergraduate Seminar V</td>
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<tr>
<td>09-xxx Chemical Elective (see notes on electives)</td>
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<tr>
<td>09-xxx Free Electives</td>
<td>27</td>
</tr>
<tr>
<td>09-xxx H&amp;SS/CFA Elective 3 (of 4)*</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-402 Undergraduate Seminar VI</td>
<td>3</td>
</tr>
<tr>
<td>09-xxx Electives</td>
<td>36</td>
</tr>
<tr>
<td>09-xxx H&amp;SS/CFA Elective 4 (of 4)*</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>48</td>
</tr>
</tbody>
</table>

* Certain non-technical courses from Business Administration, Heinz School, 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. Accounting, finance, management, marketing, production, and statistics courses may NOT be used. Also, 70-100 (Introduction to Business) and 85-219 (Biological Foundations of Behavior) may NOT be used as electives 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 (161; See Distribution Below)**

**Required Chemistry Courses***

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105 Introduction to Modern Chemistry**</td>
</tr>
<tr>
<td>09-106 Modern Chemistry II</td>
</tr>
<tr>
<td>09-204 Issues in Chemistry</td>
</tr>
<tr>
<td>09-217 Organic Chemistry I</td>
</tr>
<tr>
<td>09-218 Organic Chemistry II</td>
</tr>
<tr>
<td>09-231 Mathematical Methods for Chemists***</td>
</tr>
<tr>
<td>09-331 Modern Analytical Instrumentation</td>
</tr>
<tr>
<td>09-344 Physical Chemistry (Quantum)</td>
</tr>
<tr>
<td>09-345 Physical Chemistry (Thermo)</td>
</tr>
<tr>
<td>09-348 Inorganic Chemistry</td>
</tr>
<tr>
<td>09-222 Lab I: Introduction to Chemical Analysis</td>
</tr>
<tr>
<td>09-321 Lab II: Molecular Design and Synthesis</td>
</tr>
<tr>
<td>09-322 Lab IV: Molecular Spectroscopy and Dynamics</td>
</tr>
<tr>
<td>09-xxx Chemistry Seminars</td>
</tr>
<tr>
<td>09-xxx Chemistry Electives (includes 9 units of lab electives)</td>
</tr>
</tbody>
</table>

* These, plus 33-111 Physics I for Science Students and 33-112 Physics for Science Students II, are the required courses for students earning an additional major in chemistry.

** 09-107, Honors Chemistry, 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.

**Other Requirements**

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
</tr>
<tr>
<td>Computer Science</td>
</tr>
<tr>
<td>Mathematics</td>
</tr>
<tr>
<td>Physics</td>
</tr>
<tr>
<td>Humanities and Social Sciences or Fine Arts courses</td>
</tr>
<tr>
<td>Free Electives</td>
</tr>
<tr>
<td>Computing Skills Workshop</td>
</tr>
</tbody>
</table>

**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 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 Laboratory Sciences). Less mathematically rigorous courses in statistics such as 36-201 (Statistical Reasoning and Practice) and 36-202 (Introduction to Statistical Methods) can NOT be used towards fulfillment of this requirement.

Chemistry Electives

A minimum of 18 units of chemical electives is required. At least nine must be in a chemistry laboratory course, defined as one of the following. Note that some of these have prerequisites not normally taken by chemistry majors.

- 09-445 Undergraduate Research* 9 units
- 03-344 Experimental Techniques in Biochemistry 12 units
- 06-xxx Approved Chemical Engineering Laboratory 9-12 units
- 09-560 Computational Chemistry 12 units
- 39-802 Colloids, Polymers and Surfaces Laboratory II 9-12 units

*This must be an experimental project involving research work.

Other chemical electives can also be satisfied by 09-445, Undergraduate Research, or by any other chemistry course 09-3xx or higher, undergraduate or graduate, for which the student has the necessary prerequisites, or by 03-231/232 Biochemistry I. Certain interdisciplinary courses (e.g. 39-xxx) relating to chemistry also can 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.

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 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.

Biochemistry Option

- 03-231/232 Biochemistry I 9 units
- 03-330 Genetics 9 units
- 03-344 Experimental Techniques in Biochemistry 12 units

*Elective may be 03-439, Introduction to Biophysics, 03-740, Advanced Biochemistry, 09-518, Biorganic Chemistry: Nucleic Acids and Carbohydrates or 09-519, Biorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry

Polymer Science Option

- 09-502 Organic Polymer Chemistry 9 units
- 09-509 Physical Chemistry of Macromolecules 9 units
- 39-802 Colloids, Polymers and Surfaces Laboratory II 9-12 units

*Elective may be 09-445, Undergraduate Research (polymer project), or an upper level course in polymer science such as 09-545, Polymer Rheology

Colloids, Polymers, and Surfaces Option

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

Materials Chemistry Option

- 27-100 Materials in Engineering 12 units
- 27-201 The Structure of Materials 9 units

Environmental Chemistry Option

- 09-510 Introduction to Green Chemistry 9 units

Computational Chemistry Option

- 09-520 Global Atmospheric Chemistry 9 units
- 09-502 Organic Polymer Chemistry 9 units
- 09-545 Polymer Rheology 9 units
- 09-445 Undergraduate Research 9 units
- 39-802 Colloids, Polymers, and Surfaces Laboratory 9 units
- 09-511 Solid State Materials 9 units
- 27-xxx Approved MSE Course 9 units

Mathematics Option

- 03-510 Computational Biology 12 units
- 03-511 Computational Molecular Biology and Genomics 12 units
- 03-512 Computational Methods for Biological Modeling and Simulation 9 units

Environmental Chemistry Option

- 15-200 Data Structures 9 units
- 21-369 Numerical Methods 9 units
- 09-560 Computational Chemistry 12 units
- xx-xxx One Upper Level Computational Elective Course* 9 units

*Elective may be 03-439, Introduction to Biophysics, 03-740, Advanced Biochemistry, 09-518, Biorganic Chemistry: Nucleic Acids and Carbohydrates or 09-519, Biorganic Chemistry: Peptides, Proteins and Combinatorial Chemistry

Note: The Chemistry/Computational Chemistry Track (described later) requires the completion of the two upper level Computer Science courses 15-211 and 15-212, while in the Computational Chemistry Option, 15-200 and 21-369 are taken in place of these two courses. Since both 15-211 and 15-212 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 15-212 may count 15-211 towards the Computational Chemistry Option as the required elective. Students pursuing the Computational Chemistry Option must complete course 15-100 as part of their MCS computing requirement.

A student who completes the recommended courses for any of these options will receive a certificate from the Department of...
Chemistry as formal evidence of the accomplishment and a notation of this will be made on the student's transcript.

**B.S. in Chemistry with Departmental Honors**

Outstanding students with an interest in research are encouraged to consider the Honors program by the beginning of the junior year. The program combines a modified B.S. curriculum with close faculty-student contact in an individual research project, culminating with the student presentation and defence of a bachelor's honors thesis to an Honors 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-credit 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 are sometimes available for summer B.S. honors research.

At any time before the fall 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. To be accepted, students will be expected to have shown excellent performance in class work — normally at least a 3.2 average. An Honors Committee, comprised of the department's undergraduate advisors, will monitor and evaluate the progress of the student's research project. A written and oral progress report to the Honors Committee is required in the fall of the junior and senior year. 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 of the senior year, the Honors Committee will evaluate all theses 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 be eligible for 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. They 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 ahead by one year. 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.

The student is expected to keep the research advisor selected by May of the sophomore year for the duration of the thesis project. Summer independent study for 8 to 12 weeks after the freshman year is recommended and thesis research for 12 weeks after the sophomore and junior years is required. 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. In addition students must meet with the Honors 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.

A Thesis Committee will be formed to monitor the progress of each 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, lecturer track or research track faculty. At the start of the spring semester 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 department undergraduate program coordinator. This will be distributed by the program coordinator 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 Honors Committee will evaluate the written thesis and oral defense of the project before 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. 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 GPA is a strong secondary criterion. While we expect that most students will maintain a GPA 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 GPA 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 level 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 Chemistry Department.

**Curriculum — B.S. with Departmental Honors / M.S. in Chemistry**

**Freshman Year**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-121</td>
<td>Introduction to Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>33-111</td>
<td>Physics for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>76-101</td>
<td>Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td>99-101</td>
<td>Computing Skills Workshop</td>
<td>3</td>
</tr>
</tbody>
</table>

Students interested in majoring in chemistry should consider enrolling in the 3-unit lab course 09-101, Introduction to Experimental Chemistry, in the fall semester of the freshman year. Although not required, the laboratory course is recommended for chemistry majors.

**Spring**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>33-112</td>
<td>Physics for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>15-100</td>
<td>Introductory/Intermediate Programming</td>
<td>10</td>
</tr>
<tr>
<td>xxx-xxx</td>
<td>HASS Distribution Course 1</td>
<td>9</td>
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</tbody>
</table>

An optional 3-unit Freshman Chemistry Seminar, 09-102, is offered to MCS students in the spring semester. Chemistry faculty discuss special topics in modern chemistry.
**Summer Independent Study**

**Sophomore Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-217 Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>09-231 Mathematical Methods for Chemists</td>
<td>9</td>
</tr>
<tr>
<td>09-221 Lab I: Introduction to Chemical Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-201 Undergraduate Seminar I</td>
<td>1</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Distribution Course 2</td>
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</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>09-202 Undergraduate Seminar II</td>
<td>1</td>
</tr>
<tr>
<td>09-204 Issues in Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>09-222 Lab II: Organic Design and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-218 Organic Chemistry II***</td>
<td>9</td>
</tr>
<tr>
<td>09-348 Inorganic Chemistry</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS Distribution Course 3</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>12 weeks Honors Research required</td>
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</table>

**Junior Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-301 Undergraduate Seminar III</td>
<td>1</td>
</tr>
<tr>
<td>09-321 Lab III: Organic Synthesis and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>09-344 Physical Chemistry (Quantum)</td>
<td>9</td>
</tr>
<tr>
<td>09-331 Modern Analytical Instrumentation</td>
<td>9</td>
</tr>
<tr>
<td>09-445 Undergraduate Research</td>
<td>10</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS/CFA Elective 1 (of 4)*</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-302 Undergraduate Seminar IV</td>
<td>1</td>
</tr>
<tr>
<td>09-322 Lab IV: Molecular Spectroscopy and Dynamics</td>
<td>12</td>
</tr>
<tr>
<td>09-345 Physical Chemistry (Thermo)</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS/CFA Elective 2 (of 4)*</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 weeks Honors Research required</td>
<td></td>
</tr>
</tbody>
</table>

**Senior Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-402 Undergraduate Seminar VI</td>
<td>3</td>
</tr>
<tr>
<td>09-445 Undergraduate Research</td>
<td>10</td>
</tr>
<tr>
<td>09-xxx Graduate Chemistry Course</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS/CFA Elective 3 (of 4)*</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-401 Undergraduate Seminar V</td>
<td>1</td>
</tr>
<tr>
<td>09-455 Honors Thesis</td>
<td>15</td>
</tr>
<tr>
<td>09-xxx Graduate Chemistry Course</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx H&amp;SS/CFA Elective 4 (of 4)*</td>
<td>9</td>
</tr>
</tbody>
</table>

* Certain non-technical courses from Business Administration, Heinz School, 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. Accounting, finance, management, marketing, production, and statistics courses may NOT be used. Also, 70-100 (Introduction to Business) and 85-219 (Biological Foundations of Behavior) may NOT be used as electives in the H&SS/CFA category. If in doubt, check with your advisor.

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**Distribution of Units for the B.S. with Honors/M.S. Degrees**

**Minimum Total Chemistry Units (248, See distribution below)**

**Required Chemistry Courses**

<table>
<thead>
<tr>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105 Introduction to Modern Chemistry**</td>
</tr>
<tr>
<td>09-106 Modern Chemistry II</td>
</tr>
<tr>
<td>09-204 Issues in Chemistry</td>
</tr>
<tr>
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<td>09-348 Inorganic Chemistry</td>
</tr>
<tr>
<td>09-221 Lab I: Introduction to Chemical Analysis</td>
</tr>
<tr>
<td>09-222 Lab II: Organic Synthesis and Analysis</td>
</tr>
<tr>
<td>09-321 Lab III: Molecular Design and Synthesis</td>
</tr>
<tr>
<td>09-322 Lab IV: Molecular Spectroscopy and Dynamics</td>
</tr>
<tr>
<td>09-xxx Chemistry Seminars</td>
</tr>
</tbody>
</table>

Undergraduate Research (2 summers also required) | 30 |
Graduate chemistry courses (see notes on B.S./M.S. electives) | 60 |
Honors Thesis | 15 |

**Minimum number of units required for degrees:** 386

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**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 molecular properties. Experimental physical chemists use computers to fit data to their models. 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 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, 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

Freshman Year

**Fall (Four Course Schedule) Units**
- 09-105 Introduction to Modern Chemistry 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 Skills Workshop 3

**Spring**
- 09-106 Modern Chemistry II 10
- 15-100+ Introductory/Intermediate Programming 10
- 21-122 Integration, Differential Equations and Approximation 10
- 33-112 Physics II for Science Students 12
- xx-xxx H&S/CFA Elective Course 1 9

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Sophomore Year

**Fall**
- 09-201 Undergraduate Seminar I 1
- 09-217 Organic Chemistry I 9
- 09-221 Lab I: Introduction to Chemical Analysis 12
- 21-127 Concepts of Mathematics 9
- 15-200 Data Structures 9
- xx-xxx H&S/CFA Elective Course 2 9

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**Spring**
- 09-202 Undergraduate Seminar II 1
- 09-204 Issues in Chemistry 3
- 09-222 Lab II: Organic Synthesis and Analysis 12
- 09-218 Organic Chemistry II*** 9
- 21-259 Calculus in Three Dimensions++ 9
- 15-211 Fundamental Data Structures and Algorithms 12
- xx-xxx H&S/CFA Elective Course 3 9

55

*Students with prior programming experience should take 15-111 Intermediate/Advanced Programming. Students can then take 15-211 in the sophomore year. Those who take 15-100 will need to take 15-200 in the fall of the sophomore year to prepare for 15-211.

An optional 3-unit Freshman Chemistry Seminar, 09-102, is offered to MCS students in the spring semester. Chemistry faculty discuss special topics in modern chemistry.

Junior Year

**Fall**
- 09-301 Undergraduate Seminar III* 1
- 09-321 Lab III: Molecular Design and Synthesis 12
- 09-344 Physical Chemistry (Quantum) 9
- 09-331 Modern Analytical Instrumentation 9
- 15-212 Principles of Programming 12
- xx-xxx H&S/CFA Elective 1 (of 4)* 9

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**Spring**
- 09-302 Undergraduate Seminar IV* 1
- 09-322 Lab IV: Molecular Spectroscopy and Dynamics 12
- 09-345 Physical Chemistry II (Thermo) 9
- xx-xxx Computing Elective 9
- 03-121 Modern Biology 9
- xx-xxx H&S/CFA Elective 2 (of 4)* 9

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* Note that for this track 09-301 and 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**
- 09-401 Undergraduate Seminar V 1
- 09-560 Computational Chemistry** 12
- xx-xxx Chemistry Elective 9
- xx-xxx Free Elective 9
- xx-xxx H&S/CFA Elective 3 (of 4)* 9

40

**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&S/CFA Elective 4 (of 4)* 9

40

* Certain non-technical courses from Business Administration, Heinz School, and EPP also may be used. A listing of approved and non-approved courses for the H&S/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. Accounting, finance, management, marketing, production, and statistics courses may NOT be used. Also, 70-100 (Introduction to Business) and 85-219 (Biological Foundations of Behavior) may NOT be used as electives in the H&S/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

<table>
<thead>
<tr>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-312 Comparative Languages</td>
</tr>
<tr>
<td>15-411 Compiler Design</td>
</tr>
<tr>
<td>15-412 Operating Systems</td>
</tr>
<tr>
<td>15-413 Software Engineering</td>
</tr>
<tr>
<td>15-381 Artificial Intelligence: Representation and Problem Solving</td>
</tr>
<tr>
<td>15-384 Artificial Intelligence: Robotic Manipulation</td>
</tr>
<tr>
<td>15-385 Artificial Intelligence: Computer Vision</td>
</tr>
<tr>
<td>15-462 Computer Graphics (or equivalent)</td>
</tr>
<tr>
<td>15-xxx Approved Elective</td>
</tr>
</tbody>
</table>

### Upper Level Mathematics Courses

<table>
<thead>
<tr>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-369 Numerical Methods</td>
</tr>
<tr>
<td>21-228 Discrete Mathematics</td>
</tr>
<tr>
<td>21-301 Combinatorial Analysis (note 21-228 prerequisite)</td>
</tr>
<tr>
<td>21-xxx Approved Elective</td>
</tr>
</tbody>
</table>

### Distribution of Units for the B.S. in Chemistry/Computational Chemistry Track

Minimum Total Chemistry Units (153; See distribution below)

### Required Chemistry Courses

<table>
<thead>
<tr>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-105 Introduction to Modern Chemistry**</td>
</tr>
<tr>
<td>09-106 Modern Chemistry II</td>
</tr>
<tr>
<td>09-204 Issues in Chemistry</td>
</tr>
<tr>
<td>09-217 Organic Chemistry I</td>
</tr>
<tr>
<td>09-218 Organic Chemistry II</td>
</tr>
<tr>
<td>09-331 Modern Analytical Instrumentation</td>
</tr>
<tr>
<td>09-344 Physical Chemistry (Quantum)</td>
</tr>
<tr>
<td>09-345 Physical Chemistry (Thermo)</td>
</tr>
<tr>
<td>09-348 Inorganic Chemistry</td>
</tr>
<tr>
<td>09-221 Lab I: Introduction to Chemical Analysis</td>
</tr>
<tr>
<td>09-222 Lab II: Organic Synthesis and Analysis</td>
</tr>
<tr>
<td>09-321 Lab III: Molecular Design and Synthesis</td>
</tr>
<tr>
<td>09-322 Lab IV: Molecular Spectroscopy and Dynamics</td>
</tr>
<tr>
<td>09-560 Computational Chemistry</td>
</tr>
<tr>
<td>xx-xxx Chemistry Seminars</td>
</tr>
<tr>
<td>xx-xxx Chemistry Elective</td>
</tr>
</tbody>
</table>

** 09-107, Honors Chemistry, may be taken instead of 09-105.
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. 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: 09-217 (Organic Chemistry I) and 09-321 (Laboratory III: Molecular Design and Synthesis); and the spring-only courses: 09-214 (Physical Chemistry), 09-218 (Organic Chemistry II), 09-248 (Inorganic Chemistry), 09-249 (Issues in Chemistry) and 09-222 (Laboratory II: Organic Synthesis and Analysis). Also, in some cases, a course that is normally scheduled for the fall may be changed to a spring course (or vice versa) due to a departmental curriculum change.

Curriculum — B.A. in Chemistry

Freshman Year

Fall (Four Course Schedule) | Units
--- | ---
09-105 Introduction to Modern Chemistry | 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 Skills Workshop | 3

Total Chemistry Units: 44

Spring

09-106 Modern Chemistry II | 10
15-100 Introductory/Intermediate Programming | 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

Total Chemistry Units: 51

An optional 3 unit Freshman Chemistry Seminar, 09-102, is offered to MCS students in the spring semester. Chemistry faculty discuss special topics in modern chemistry.

Sophomore Year

Fall | Units
--- | ---
09-201 Undergraduate Seminar I | 1
09-217 Organic Chemistry I | 9
09-221 Lab I: Introduction to Chemical Analysis | 12
xx-xxx Free Elective | 9
xx-xxx H&SS Distribution Course 2 | 9

Total Chemistry Units: 40

Spring

09-202 Undergraduate Seminar II | 1
09-204 Issues in Chemistry | 3
09-218 Organic Chemistry II*** | 9
09-222 Lab II: Organic Synthesis and Analysis | 12
09-214 Physical Chemistry | 9
xx-xxx H&SS Distribution Course 3 | 9

Total Chemistry Units: 43

A 3-unit course 09-220 Supramolecular Organic Chemistry is offered as an elective to compliment 09-218. (Enrollment Limited)

Junior Year

Fall | Units
--- | ---
09-301 Undergraduate Seminar III | 1
09-321 Lab III: Molecular Design and Synthesis | 12
03-121 Modern Biology | 9
xx-xxx Chemistry Elective | 9
xx-xxx Free Elective | 9
xx-xxx H&SS/CFA Elective 1 (of 4)* | 9

Total Chemistry Units: 49

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

Total Chemistry Units: 47

Senior Year

Fall | Units
--- | ---
09-401 Undergraduate Seminar V | 1
xx-xxx Free Electives | 36
xx-xxx H&SS/CFA Elective 3 (of 4)* | 9

Total Chemistry Units: 46

Spring

09-402 Undergraduate Seminar VI | 3
xx-xxx Free Electives | 28
xx-xxx H&SS/CFA Elective 4 (of 4)* | 9

Total Chemistry Units: 40

* Certain non-technical courses from Business Administration, Heinz School, 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. Accounting, finance, management, marketing, production, and statistics courses may NOT be used. Also, 70-100 (Introduction to Business) and 85-219 (Biological Foundations of Behavior) may NOT be used as electives 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 (122; See distribution below)

Required Chemistry Courses | Units
--- | ---
09-105 Introduction to Modern Chemistry** | 10
09-106 Modern Chemistry II | 10
09-204 Issues in Chemistry | 3
09-217 Organic Chemistry I | 9
09-218 Organic Chemistry II | 9
09-214 Physical Chemistry (or 09-344 or 09-345) | 9
09-348 Inorganic Chemistry | 10
09-221 Lab I: Introduction to Chemical Analysis | 12
09-222 Lab II: Organic Synthesis and Analysis | 12

**A 3-unit course 09-220 Supramolecular Organic Chemistry is offered as an elective to compliment 09-218. (Enrollment Limited)
** 09-107, Honors Chemistry, may be taken instead of 09-105

** Other Requirements

Biology (03-121) 9
Computer Science 15-100 10
Mathematics (21-120 and 21-122) 10
Physics (33-111(I) and 33-112(II)) 24
Humanities and Social Sciences or Fine Arts courses 72
Free Electives 100

Computing Skills Workshop 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.

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.A. 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.

A. Four Required Core Courses
1. 09-106 Modern Chemistry II
2. 09-221 Laboratory I: Introduction to Chemical Analysis
3. 09-217 Organic Chemistry I
4. Choice of one of the following courses*
   09-348 Inorganic Chemistry
   09-344 Physical Chemistry (Quantum)
   09-345 Physical Chemistry (Thermo)
   09-347 Advanced Physical Chemistry**
   09-214 Physical Chemistry

*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 this course is only open to students majoring in chemical engineering.

B. Two Elective Courses from the following list.
09-344 Physical Chemistry (Quantum) or
09-214 Physical Chemistry
09-345 Physical Chemistry (Thermo)
09-348 Inorganic Chemistry
09-222 Laboratory II: Organic Synthesis and Analysis
09-218 Organic Chemistry II
09-231/232 Biochemistry I
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 -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, can not 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 H. John Heinz School of Public Policy and Management; Interdisciplinary Majors and Minors including Health Care Policy and Management, and Secondary Education and Teacher Certification. For more details, see the Tailoring Your Education portion of the Mellon College of Science section in this catalog.

Faculty

CATALINA ACHIM, Assistant Professor of Chemistry – Ph.D., Carnegie Mellon; Carnegie Mellon, 2001 -.
BRUCE A. ARMITAGE, Associate Professor of Chemistry – Ph.D., University of Arizona; Carnegie Mellon, 1997 -.
MARK E. BIER, Associate 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 -.
THERESE J. COLLINS, Thomas Lord Professor of Chemistry and Director, Institute for Green Oxidation Chemistry – Ph.D., University of Würzburg, Germany; Carnegie Mellon, 1987 -.
SUBHA R. DAS, Assistant Professor of Chemistry – Ph. D., Auburn University; Carnegie Mellon, 2006 -.
NEIL M. DONAHUE, Associate Professor of Chemistry and Chemical Engineering – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000 -.
REBECCA FREELAND, Associate Dean, Mellon College of Science and Associate Head, Department of Chemistry – Ph.D., Carnegie Mellon; Carnegie Mellon, 1993 -.
ROBERTO GIL, Research Scientist and Director, NMR - Ph.D., Córdoba National University Córdoba, Argentina; Carnegie Mellon, 2002 -.
SUSAN T. GRAUL, Lecturer – Ph.D., Purdue University; Carnegie Mellon, 1992 -.
MICHAEL P. HENDRICH, Associate Professor of Chemistry – Ph.D., University of Illinois; Carnegie Mellon, 1994 -.
COLIN HORWITZ, Research Professor – Ph.D., Northwestern University; Carnegie Mellon, 1993 -.
RONGCHAO JIN, Assistant Professor of Chemistry – Ph.D., Northwestern University; Carnegie Mellon, 2006 -.
MORTON KAPLAN, Professor of Chemistry – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1970 -.
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 -.
TOMASZ KOWALEWSKI, Associate Professor of Chemistry – Ph.D., Polish Academy of Sciences; Carnegie Mellon, 2000 -.
MARIA KURNIKOVA, Assistant Professor of Chemistry – Ph.D., University of Pittsburgh; Carnegie Mellon, 2003 -.
MIGUEL LLINAS, Professor of Chemistry – Ph.D., University of California at Berkeley; Carnegie Mellon, 1976 -.
DANITH LY, Assistant Professor of Chemistry – Ph.D., Georgia Tech; Carnegie Mellon, 2001 -.
KRZYSZTOF MATYJASZEWSKI, University Professor and J.C. Warner Professor of Natural Sciences and Director, Center for Macromolecular Engineering – Ph.D., Polish Academy of Sciences; Carnegie Mellon, 1985 -.
RICHARD D. MCCULLOUGH, Professor of Chemistry and Dean, Mellon College of Science – Ph.D., Johns Hopkins University; Carnegie Mellon, 1990 -.
ECKARD MÜNCK, Professor of Chemistry – Ph.D., Technical University of Darmstadt, (Germany); Carnegie Mellon, 1990 -.
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 -.
STUART W. STALEY, Professor of Chemistry – Ph.D., Yale University; Carnegie Mellon, 1986 -.
KAREN H. STUMP, Teaching Professor and Director of Undergraduate Studies and Director of Laboratories – M.S., Carnegie Mellon University; Carnegie Mellon, 1983 -.
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 -.
DAVID YARON, Associate Professor of Chemistry – Ph.D., Harvard University; Carnegie Mellon, 1992 -.

Emeriti

GUY C. BERRY, University Professor of Chemistry and Polymer Science, Emeritus – Ph.D., University of Michigan; Carnegie Mellon, 1960 -.
AKSEL A. BOTHNER-BY, University 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 -.
EDWARD F. CASASSA, Professor of Chemistry, Emeritus – Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1956 -.
JOSEF DADOK, Professor of Chemical Instrumentation, Emeritus – Ph.D., Czechoslovak Academy of Sciences; Carnegie Mellon, 1967 -.
ROBERT L. KAY, Professor of Chemistry, Emeritus – Ph.D., University of Toronto; Carnegie Mellon, 1963 -.
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

WILLIAM E. BROWN, Professor of Biological Sciences and Chemistry – Ph.D., University of Minnesota; Carnegie Mellon, 1973 -.
ANDREW GELLMAN, Thomas Lord Professor and Head, Chemical Engineering and Professor of Chemistry – Ph.D., University of California, Berkeley; Carnegie Mellon, 1992 -.
GORDON RULE, Faculty of Biomedical Engineering and Chemistry; Associate Professor of Biology – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995 -.
JAMES SCHNEIDER, Faculty of Biomedical Engineering and Chemistry; Assistant Professor of Chemical Engineering – Ph.D., University of Minnesota; Carnegie Mellon, 1999 -.
ALAN S. WAGGONER, Faculty of Biomedical Engineering and Chemistry; Director, Molecular Biosensor and Imaging Center and NSF Science and Technology Center - Ph.D. University of Oregon; Carnegie Mellon University, 1982 -.
LYNN WALKER, Associate Professor of Chemical Engineering and Chemistry, Ph.D. – University of Delaware; Carnegie Mellon, 1997 -.
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 6 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 Mathematics degree and the 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 modelling and forecasting in business and government, to actuarial applications in the life, health, 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 21-131/132 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 21-235/236 Mathematical Studies I/II. This pair of intensive courses is team taught with a typical enrollment of about 20 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.

Finally, a joint program with the Heinz School of Public Policy and Management 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 and a statistics course must have at least 36-225 as a prerequisite.

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 15-100 or 15-111. Students who plan to take further computer science courses must complete 15-111.

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 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 Undergraduate Colloquium each semester of the Sophomore year. This course plays an important role in introducing students to career opportunities, graduate school preparation, and student and faculty research in the Department.
Mathematics Degree

This program is the most flexible available to our majors. The flexibility to choose eight electives within the major plus seven humanities courses and seven free electives allows the student to design a program to suit his or her individual needs and interests. The requirements for the Mathematics Degree are:

Mathematical Sciences

21-120 Differential and Integral Calculus
21-122 Integration, Differential Equations and Approximation
21-127 Concepts of Mathematics
21-201 Undergraduate Colloquium
21-228 Discrete Mathematics (or 21-301 or 21-484)
21-341 Linear Algebra I
21-259 Calculus in Three Dimensions
21-260 Differential Equations
21-265 Principles of Real Analysis I
21-356 Principles of Real Analysis II
21-373 Algebraic Structures

five Mathematical Sciences electives

Other courses

15-100 Introductory/Intermediate Programming
36-225 Introduction to Probability and Statistics I (or 21-325)

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 for Science Students I 12
15-100 Introductory/Intermediate Programming 10
03-121 Modern Biology 9
76-101 Interpretation and Argument 9
99-101 Computer Skills Workshop 3

Spring

21-122 Integration, Differential Equations and Approximation 10
21-127 Concepts of Mathematics 9
33-112 Physics for Science Students II 12
09-105 Intro to Modern Chemistry 10
xx-xxx H&SS Elective 9

Sophomore Year

Fall Units
21-228 Discrete Mathematics (or 21-301 or 21-484) 9
21-341 Linear Algebra I 9
21-259 Calculus in Three Dimensions 9
21-201 Undergraduate Colloquium 1
xx-xxx Mathematical Sciences Elective 9
xx-xxx H&SS Elective 9
xx-xxx Elective 9

Spring

21-260 Differential Equations 9
21-201 Undergraduate Colloquium 1
xx-xxx Mathematical Sci, Statistics, or Computer Sci Elective 9
xx-xxx H&SS Elective 9
xx-xxx Elective 9

Junior Year

Fall Units
21-356 Principles of Real Analysis I 9
36-325 Introduction to Probability and Statistics I (or 21-325) 9
xx-xxx Mathematical Sciences Elective 9
xx-xxx H&SS Elective 9
xx-xxx Elective 9

Spring

21-373 Algebraic Structures 9
21-xxx Mathematical Sciences Elective 9
xx-xxx H&SS Elective 9
xx-xxx Elective 9

Senior Year

Fall
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

Spring

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

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
21-342 Linear Algebra II
21-371 Functions of a Complex Variable
21-372 Partial Differential Equations
21-374 Field Theory
21-465 Topology and Geometry
21-470 Selected Topics in Analysis
21-476 Ordinary Differential Equations
21-484 Graph Theory
21-600 Mathematical Logic I
21-602 Introduction to Set Theory
21-620 Real Analysis
21-621 Introduction to Lebesgue Integration
21-651 General Topology
21-660 Numerical Analysis I

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 modelling 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

21-120 Differential and Integral Calculus
21-122 Integration, Differential Equations and Approximation
21-127 Concepts of Mathematics
21-201 Undergraduate Colloquium
21-228 Discrete Mathematics (or 21-484)
21-241 Matrix Algebra
21-259 Calculus in Three Dimensions
21-260 Differential Equations
21-292 Operations Research I
21-369 Numerical Methods
21-393 Operations Research II
**Statistics**

36-225 Introduction to Probability and Statistics I (or 21-325)  
36-226 Introduction to Probability and Statistics II  
36-401 Modern Regression  
36-402 Topic in Data Analysis  
36-410 Introduction to Probability Models  

**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  
15-212 Principles of Programming  
21-270 Introduction to Mathematical Finance  
21-355 Principles of Real Analysis I  
21-365 Projects in Applied Mathematics  
21-366 Topics in Applied Mathematics  
21-370 Discrete-Time Finance  
21-373 Algebraic Structures  
21-420 Continuous-Time Finance  
21-484 Graph Theory  
36-461 Statistics Topic  
36-462 Topic in Statistics  
36-495 Independent Study  
70-371 Production and Operations Management  
70-460 Mathematical Methods for Consulting  
70-471 Logistics and Supply Chain Management  
70-473 Modeling for Operations Management Applications  

**Other Courses**

15-100 Introductory/Intermediate Programming  
70-122 Introduction to Accounting  
73-100 Principles of Economics  
73-251 Economic Theory  

MCS humanities, social science, and science core (114 units, including 73-100 and 73-250)

Five free electives

**Suggested Schedule**

**Freshman Year**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fall</strong></td>
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**Sophomore Year**

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<td>21-259 Calculus in Three Dimensions</td>
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<td>73-100 Principles of Economics</td>
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**Junior Year**

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<td>73-251 Economic Theory</td>
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**Senior Year**

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**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 36-225/226 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:
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
15-212 Principles of Programming
21-270 Introduction to Mathematical Finance
21-355 Principles of Real Analysis I
21-365 Projects in Applied Mathematics
21-366 Topics in Applied Mathematics
21-370 Discrete-Time Finance
21-373 Algebraic Structures
21-420 Continuous-Time Finance
21-484 Graph Theory
36-461 Statistics Topic
36-462 Topic in Statistics
36-495 Independent Study

Other Courses

15-100 Introductory/Intermediate Programming
15-200 Advanced Programming/Practicum
73-100 Principles of Economics

MCS humanities, social science, and science core (114 units, including 73-100) four free electives

Suggested Schedule

Freshman Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
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<tr>
<td>21-120 Differential and Integral Calculus</td>
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<td>76-101 Interpretation and Argument</td>
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<td>99-101 Computing Skills Workshop</td>
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<tr>
<td>21-122 Integration, Differential Equations and Approximation</td>
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<td>33-112 Physics for Science Students II</td>
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<td>09-105 Intro to Modern Chemistry</td>
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<td>21-127 Concepts of Mathematics</td>
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<td>xx-xx H&amp;SS Elective</td>
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Junior Year

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<td>21-369 Numerical Methods</td>
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<td>36-225 Introduction to Probability and Statistics I (or 21-325)</td>
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<tr>
<td>xx-xx Depth Elective</td>
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<tr>
<td>36-226 Introduction to Probability and Statistics II</td>
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Senior Year

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<th>Fall</th>
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<tbody>
<tr>
<td>21-393 Operations Research II</td>
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<tr>
<td>36-402 Topic in Data Analysis</td>
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<td>xx-xx Elective</td>
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</table>

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)**

- 15-111 Intermediate/Advanced Programming
- 15-211 Fundamental Data Structures and Algorithms
- 15-212 Principles of Programming
- 21-120 Differential and Integral Calculus (or 21-132 Analysis I)
- 21-122 Integration, Differential Equations and Approximation (or 21-132 Analysis II)
- 21-127 Concepts of Mathematics
- 21-201 Undergraduate Colloquium
- 21-300 Basic Logic
- 21-301 Combinatorics
- 21-341 Linear Algebra I
- 21-355 Principles of Real Analysis I
- 21-374 Algebraic Structures
- 21-484 Graph Theory

Discrete Mathematics and Logic

Three of the following: (27 to 36 units)
21-229 Set Theory  
21-373 Field Theory  
21-441 Number Theory  
80-410 Recursion and Hierarchies  
21-602 Introduction to Set Theory  
21-603 Introduction to Model Theory  
21-610 Algebra I  
21-700 Mathematical Logic II

**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
- 15-451 Algorithms, Design and Analysis
- 15-453 Formal Languages and Automata
- 17-651 Models of Software Systems

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
- 21-260 Differential Equations
- 21-292 Discrete Mathematics (or 21-301 or 21-484)
- 21-201 Undergraduate Colloquium
- 21-212 Integration, Differential Equations and Approximation
- 76-101 Interpretation and Argument
- 99-101 Computing Skills Workshop
- 80-405 Game Theory
- 80-411 Proof Theory
- 80-481 Formal Semantics

**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**

- 21-120 Differential and Integral Calculus  10 units
- 33-112 Physics for Science Students I  12 units
- 15-111 Intermediate/Advanced Programming  10 units
- 76-101 Interpretation and Argument  9 units
- 99-101 Computing Skills Workshop  3 units

**Units:** 44

**Spring**

- 21-122 Integration, Differential Equations and Approximation 10 units
- 21-127 Concepts of Mathematics  9 units
- 33-112 Physics for Science Students II  12 units
- 09-105 Intro to Modern Chemistry  10 units

**Units:** 41

**Sophomore Year**

**Fall**

- 15-211 Fundamental Data Structures and Algorithms  12 units
- 21-301 Combinatorics  9 units
- 21-341 Linear Algebra I  9 units
- 21-201 Undergraduate Colloquium  1 unit
- 03-121 Modern Biology  9 units
- xx-xxx Humanities Elective  9 units

**Units:** 49

**Spring**

- 15-212 Principles of Programming  12 units
- xx-xxx Discrete Math/Logic  9 units
- 21-201 Undergraduate Colloquium  1 unit
- xx-xxx Technical Elective  9 units
- xx-xxx Humanities Elective  9 units
- xx-xxx Humanities Elective  9 units

**Units:** 49

**Junior Year**

**Fall**

- 15-xxx Computer Science Elective  9 units
- 21-300 Basic Logic  9 units
- 21-355 Principles of Real Analysis I  9 units
- xx-xxx Humanities Elective  9 units
- xx-xxx Elective  9 units

**Units:** 45

**Spring**

- 15-xxx Computer Science Elective  9 units
- 21-373 Algebraic Structures  9 units
- 21-484 Graph Theory  9 units
- xx-xxx Humanities Elective  9 units
- xx-xxx Elective  9 units

**Units:** 45

**Senior Year**

**Fall**

- xx-xxx Discrete Math/Logic  9 units
- xx-xxx Technical Elective  9 units
- xx-xxx Humanities Elective  9 units
- xx-xxx Elective  9 units

**Units:** 45

**Spring**

- xx-xxx Discrete Math/Logic  9 units
- xx-xxx Technical Elective  18 units
- xx-xxx Humanities Elective  9 units
- xx-xxx Elective  9 units

**Units:** 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 modelling 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)**

- 21-120 Differential and Integral Calculus
- 21-122 Integration, Differential Equations and Approximation
- 21-127 Concepts of Mathematics
- 21-201 Undergraduate Colloquium
- 21-228 Discrete Mathematics (or 21-301 or 21-484)
- 21-241 Matrix Algebra
- 21-259 Calculus in Three Dimensions
- 21-260 Differential Equations
- 21-320 Symbolic Programming Methods
- 21-355 Principles of Real Analysis I
- 21-356 Principles of Real Analysis II (or 21-357)
- 21-369 Numerical Methods

**Five of the following distribution courses:**

(A minimum of 45 units)

- 15-211 Fundamental Data Structure and Algorithms
- 21-292 Operations Research I
- 21-370 Mathematics of Finance
- 21-371 Functions of a Complex Variable
- 21-372 Partial Differential Equations
- 21-380 Introduction to Mathematical Modeling
- 21-393 Operations Research II
- 21-476 Ordinary Differential Equations
- 21-470 Selected Topics in Analysis
Topics have included (a student may take more than one):
Calculus of Variations
Finite Difference Equations

21-660 Introduction to Numerical Analysis I
21-690 Methods of Optimization
21-xxx Mathematical Science Elective
36-410 Elementary Applied Probability

Other Courses: (19 units)
15-111 Intermediate/Advance Programming
36-225 Introduction to Probability and Statistics I (or 21-325)

MCS humanities, science and computer skills course (114 units)
Free electives: (sufficient to meet minimum of 360 units.)

Suggested Schedule

Freshman Year

<table>
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<th>Units</th>
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<tbody>
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Sophomore Year

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Junior Year

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<td>21-320 Symbolic Programming Methods</td>
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Senior Year

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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 Undergraduate Colloquium.

The Minor in Mathematical Sciences

The Minor includes six courses. 21-127 Concepts of Mathematics is a prerequisite for 21-228 and recommended for 21-241. The minimum preparation required for 21-355 Principles of Real Analysis I is 21-120/122 or equivalent courses. Students planning to include 21-373 Algebraic Structures as a Mathematical Sciences Elective should choose 21-341 Linear Algebra I, 21-241 and 21-341 cannot both count toward the minor.

21-127 Concepts of Mathematics
21-228 Discrete Mathematics (or 21-301 or 21-484)
21-241 Matrix Algebra (or 21-341)
21-355 Principles of Real Analysis I
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 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
21-301 Combinatorics
21-341 Linear Algebra I
21-484 Graph Theory

Two of the following:

21-229 Set Theory
21-374 Field Theory
21-441 Number Theory
21-602 Introduction to Set Theory
21-603 Introduction to Model Theory
21-610 Algebra I
21-700 Mathematical Logic II
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 Master Degree Research 18 units
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 Master 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 Master 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

Faculty
PETER B. ANDREWS, Professor of Mathematics — Ph.D., Princeton University; Carnegie Mellon, 1963—.
EGON BALAS, Thomas Lord University Professor of Operations Research — Ph.D., University of Brussels; Carnegie Mellon, 1968—.
ALBERT A. BLANK, Professor of Mathematics, Emeritus — Ph.D., New York University; Carnegie Mellon, 1969—.
TOM BOHMAN, Associate Professor of Mathematical Sciences — Ph.D., Rutgers University; Carnegie Mellon, 1998—.
DEBORAH BRANDON, Associate Teaching Professor of Mathematical Sciences— Ph.D., Carnegie Mellon University; Carnegie Mellon, 1991—.
CHARLES V. COFFMAN, Professor of Mathematics, Emeritus — Ph.D., Johns Hopkins University; Carnegie Mellon, 1962—.
GERARD CORNUEJOLS, University Professor of Operations Research and Mathematics — Ph.D., Cornell University; Carnegie Mellon, 1978—.
JAMES CUMMINGS, Associate Professor of Mathematical Sciences — Ph.D., Cambridge University; Carnegie Mellon, 1996—.
HASAN DEMIRKOPARAN, Lecturer in Mathematical Sciences — Ph.D., Michigan State University; Carnegie Mellon, 2005—.
TIMOTHY FLAHERTY, Lecturer in Mathematical Sciences — Ph.D., University of Pittsburgh; Carnegie Mellon, 1999—.
IRENE M. FONSECA, Mellon College of Science Professor of Mathematical Sciences — Ph.D., University of Minnesota; Carnegie Mellon, 1987—.
ALAN M. FRIEZE, Professor of Mathematical Sciences and Computer Science — Ph.D., University of London; Carnegie Mellon, 1987—.
JAMES M. GREENBERG, Professor of Mathematical Sciences, Emeritus — Ph.D., Brown University; Carnegie Mellon, 1995—.
RAMI GROSSBERG, Associate Professor of Mathematics — Ph.D., Hebrew University of Jerusalem; Carnegie Mellon, 1988—.
MORTON E. GURTIN, Alumni Professor of Mathematical Sciences, Emeritus — Ph.D., Brown University; Carnegie Mellon, 1966—.
DAVID HANDRON, Lecturer in Mathematical Sciences — Ph.D., Rice University; Carnegie Mellon, 1999—.
DAVID C. HEATH, Professor of Mathematical Sciences, Emeritus — Ph.D., University of Illinois; Carnegie Mellon, 1997—.
WILLIAM J. HRUSA, Professor of Mathematical Sciences — Ph.D., Brown University; Carnegie Mellon, 1982—.
WEINING KANG, Nehari/Duffin Visiting Assistant Professor of Mathematical Sciences — Ph.D., University of California at San Diego; Carnegie Mellon, 2005—.
DAVID KINDERLEHRER, Professor of Mathematical Sciences — Ph.D., University of California at Berkeley; Carnegie Mellon, 1990—.
DMITRY KRAMKOV, Professor of Mathematical Sciences — Ph.D., Steklov Mathematical Institute; Carnegie Mellon, 2000—.
JOHN P. LEHOCZKY, Professor of Statistics and Mathematical Sciences; Dean, College of Humanities and Social Science — Ph.D., Stanford University; Carnegie Mellon, 1969—.
GIOVANNI LEONI, Associate Professor of Mathematical Sciences — Ph.D., University of Minnesota; Carnegie Mellon, 2002—.
RICHARD C. MACCAMY, Professor of Mathematics, Emeritus — Ph.D., University of California at Berkeley; Carnegie Mellon, 1956—.
JOHN MACKAY, Associate Teaching Professor of Mathematical Sciences, Assistant Department Head of Mathematical Sciences — Ph.D., University of Hawaii; Carnegie Mellon, 2003—.
RICHARD A. MOORE, Professor of Mathematics, Emeritus — Ph.D., Washington University; Carnegie Mellon, 1956—.
ROY A. NICOLAIDES, Professor of Mathematical Sciences; Head, Department of Mathematical Sciences — Ph.D., University of London; Carnegie Mellon, 1984—.
WALTER NOLL, Professor of Mathematics, Emeritus — Ph.D., Indiana University; Carnegie Mellon, 1956—.
MARION L. OLIVER, Associate Teaching Professor of Mathematical Sciences — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2004—.
DAVID R. OWEN, Professor of Mathematics — Ph.D., Brown University; Carnegie Mellon, 1967—.
ROBERT L. PEGO, Professor of Mathematical Sciences— Ph.D., University of California at Berkeley; Carnegie Mellon, 2004—.
OLEG PIKHURKO, Assistant Professor of Mathematical Sciences, — Ph.D., Cambridge University, Carnegie Mellon, 2003—.
AGOSTON PISZTORA, Associate Professor of Mathematical Sciences — Ph.D., ETH Zurich, Carnegie Mellon, 1996—.
KAVITA RAMANAN, Associate Professor of Mathematical Sciences — Ph.D., Brown University; Carnegie Mellon, 2003—.
JOHN W. SCHAFFER, Professor of Mathematical Sciences — Ph.D., Indiana University; Carnegie Mellon, 1983—.
JUAN J. SCHAEFFER, Professor of Mathematics — Ph.D., Universiteit Zrich; Carnegie Mellon, 1968—.
ERNEST SCHIMMERLING, Associate Professor of Mathematical Sciences — Ph.D., University of California at Los Angeles; Carnegie Mellon, 1998—.
DANA SCOTT, Hillman University Professor of Computer Science, Philosophy, and Mathematical Logic, Emeritus — Ph.D., Princeton University; Carnegie Mellon, 1981—.
ROBERT F. SEKERKA, University Professor of Physics and Mathematics — Ph.D., Harvard University; Carnegie Mellon, 1969—.
STEVEN E. SHREVE, Professor of Mathematical Sciences — Ph.D., University of Illinois; Carnegie Mellon, 1980—.
DEJAN SLEPCEV, Assistant Professor of Mathematical Sciences — Ph.D., University of Texas at Austin; Carnegie Mellon, 2006—.
RICHARD STATMAN, Professor of Mathematical Sciences and Computer Science — Ph.D., Stanford University; Carnegie Mellon, 1984—.
SHLOMO TAASAN, Professor of Mathematical Sciences — Ph.D., Weizmann Institute; Carnegie Mellon 1994—.
LUC TARTAR, University Professor of Mathematical Sciences — Ph.D., University of Paris; Carnegie Mellon, 1987—.

GERALD L. THOMPSON, IBM Professor of Systems and Operations Research, Emeritus — Ph.D., Columbia University; Carnegie Mellon, 1959—.

JOHN TOLLE, Lecturer of Mathematical Sciences — Ph.D., University of Kentucky; Carnegie Mellon, 1996—.

RUSSELL C. WALKER Teaching Professor of Mathematical Sciences; Associate Head, Department of Mathematical Sciences — D.A., Carnegie Mellon University; Carnegie Mellon, 1984—.

NOEL S. WALKINGTON, Professor of Mathematical Sciences — Ph.D., University of Texas at Austin; Carnegie Mellon, 1989—.

WILLIAM O. WILLIAMS, Professor of Mathematical Sciences — Ph.D., Brown University; Carnegie Mellon, 1966—.
Department of Physics

Fred Gilman, Head
Office: Wean Hall 7325
Kunal Ghosh, Assistant Head for Undergraduate Affairs
Office: Wean Hall 7303
Hilary Homer, Student Programs Coordinator
Student Programs Office: Wean Hall 7319
http://info.phys.cmu.edu/

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 movements of galaxies, the motion of atoms and nuclei, and the complex structure of the assemblies of molecules that make life possible. The spectacular expansion of our comprehension of the physical world forms an impressive part of the intellectual and cultural heritage of our times. The opportunity to add to this heritage is an important source of motivation for young physicists. The application of discoveries in physics to the solution of complex modern technological problems offers a vast field in which physicists make decisive contributions. The interplay of pure and applied physics has always been fruitful and today ensures many rewarding career opportunities for physics students.

Carnegie Mellon's undergraduate curriculum in physics has been carefully designed to provide a firm knowledge of the basic principles of physics, an appreciation of a wide range of physical problems of current interest, and the capacity to formulate and solve new problems. In addition to classwork and problem solving, the curriculum includes studying physical phenomena in the laboratory. Physics students are strongly encouraged to go beyond the formal theoretical and experimental course work and become involved in research projects under the guidance of individual faculty members.

Students may choose from a variety of degree options:

- B.S. in Physics
- B.A. in Physics
- B.S. in Physics with Tracks in:
  - Applied Physics
  - Astrophysics
  - Biological Physics
  - Chemical Physics
  - Computational Physics

The objectives and requirements for each of these options are described in the paragraphs below. Each allows considerable latitude in the choice of electives.

Through the judicious choice of elective courses, a double major program combining physics and another discipline can be readily achieved. A minor in physics is also offered for those students who major in other disciplines. The student, with the help of their faculty advisors, can easily build a program that aims at specific career objectives.

The Department maintains an active and wide-ranging program of advising. Beyond aiding in academic planning, faculty 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, the student 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, professional work in industrial or governmental research and development, or for other employment in business or industry with a significant scientific component.

### Requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>33-104</td>
<td>Experimental Physics (1)</td>
<td>9</td>
</tr>
<tr>
<td>33-111</td>
<td>Physics I for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>33-131</td>
<td>Matter and Interactions</td>
<td>12</td>
</tr>
<tr>
<td>33-112</td>
<td>Physics II for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>33-132</td>
<td>Matter and Interactions II</td>
<td>12</td>
</tr>
<tr>
<td>33-201</td>
<td>Physics Sophomore Colloquim I and II (2 units each)</td>
<td>4</td>
</tr>
<tr>
<td>202</td>
<td>(1 unit each)</td>
<td></td>
</tr>
<tr>
<td>33-301</td>
<td>Physics Upper Class Colloquim III and IV</td>
<td>2</td>
</tr>
<tr>
<td>302</td>
<td>(1 unit each)</td>
<td></td>
</tr>
<tr>
<td>33-211</td>
<td>Physics III: Modern Essentials</td>
<td>10</td>
</tr>
<tr>
<td>33-228</td>
<td>Electronics</td>
<td>10</td>
</tr>
<tr>
<td>33-231</td>
<td>Physical Analysis</td>
<td>9</td>
</tr>
<tr>
<td>33-232</td>
<td>Mathematical Methods of Physics</td>
<td>9</td>
</tr>
<tr>
<td>33-234</td>
<td>Quantum Physics</td>
<td>10</td>
</tr>
<tr>
<td>33-331</td>
<td>Physical Mechanics I</td>
<td>10</td>
</tr>
<tr>
<td>33-338</td>
<td>Intermediate Electricity and Magnetism I</td>
<td>10</td>
</tr>
<tr>
<td>33-340</td>
<td>Modern Physics Laboratory</td>
<td>10</td>
</tr>
<tr>
<td>33-341</td>
<td>Thermal Physics I</td>
<td>10</td>
</tr>
</tbody>
</table>

#### Physics Electives - at least 36 units

- **Total Mathematics Units** (4) 3 8
- **Mellon College of Science Core** (7)
  - 03-121 Modern Biology | 9
  - 09-105 Introduction to Modern Chemistry | 10
  - 15-100 Introductory/Intermediate Programming | 10
  - 99-101 Computing Skills Workshop | 3

#### Total MCS Core 3 2

- **Humanities, Social Sciences, or Fine Arts Courses** (5) 7 2
- **Technical Electives** (6) 2 7
- **Free electives** (6) 2 8

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), and Advanced Quantum Physics I and II (33-445, 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 21-350.
(6) The MCS core courses may be taken in any order, but must be finished by the end of the junior year.
(7) Humanities, Social Sciences and Fine Arts (H&SS/FA) requirements follow the Mellon College of Science guidelines.
(8) Technical electives are any courses in MCS, SCS, Statistics, and CIT.
(9) 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>33-350</td>
<td>Undergraduate Research</td>
<td>Var.</td>
</tr>
<tr>
<td>33-398</td>
<td>Special Topics</td>
<td>Var.</td>
</tr>
<tr>
<td>33-451</td>
<td>Senior Research</td>
<td>Var.</td>
</tr>
<tr>
<td>33-458</td>
<td>Special Problems in Computation Physics</td>
<td>Var.</td>
</tr>
<tr>
<td>33-499</td>
<td>Supervised Reading</td>
<td>Var.</td>
</tr>
</tbody>
</table>

## Fall Only

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>33-224</td>
<td>Stars, Galaxies and the Universe</td>
<td>9</td>
</tr>
<tr>
<td>33-241</td>
<td>Introduction to Computational Physics</td>
<td>9</td>
</tr>
<tr>
<td>33-441/</td>
<td>03-439 Introduction to Biophysics</td>
<td>9</td>
</tr>
<tr>
<td>33-445</td>
<td>Advanced Quantum Physics I</td>
<td>9</td>
</tr>
<tr>
<td>33-467</td>
<td>Astrophysics of Stars and the Galaxy</td>
<td>9</td>
</tr>
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</table>

## Spring Only

<table>
<thead>
<tr>
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<th>Course Title</th>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>33-314</td>
<td>Physics of Musical Sound</td>
<td>9</td>
</tr>
<tr>
<td>33-332</td>
<td>Physical Mechanics II</td>
<td>10</td>
</tr>
<tr>
<td>33-339</td>
<td>Intermediate Electricity and Magnetism</td>
<td>10</td>
</tr>
<tr>
<td>33-342</td>
<td>Thermal Physics II</td>
<td>12</td>
</tr>
<tr>
<td>33-446</td>
<td>Advanced Quantum Physics II</td>
<td>9</td>
</tr>
<tr>
<td>33-448</td>
<td>Introduction to Solid State Physics</td>
<td>9</td>
</tr>
<tr>
<td>33-456</td>
<td>Advanced Computational Physics</td>
<td>9</td>
</tr>
<tr>
<td>33-466</td>
<td>Extragalactic Astrophysics and Cosmology</td>
<td>9</td>
</tr>
</tbody>
</table>

## Fall Only (Alternate Years)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>33-353</td>
<td>Intermediate Optics</td>
<td>12</td>
</tr>
<tr>
<td>33-650</td>
<td>General Relativity</td>
<td>9</td>
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## Spring Only (Alternate Years)

<table>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>33-444</td>
<td>Introduction to Nuclear &amp; Particle Physics (2007, 2009)</td>
<td>9</td>
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<tr>
<td>33-658</td>
<td>Quantum Computation</td>
<td>9</td>
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</table>

## Graduate Courses

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>33-755</td>
<td>Quantum Mechanics I</td>
<td>12</td>
</tr>
<tr>
<td>33-756</td>
<td>Quantum Mechanics II</td>
<td>12</td>
</tr>
<tr>
<td>33-758</td>
<td>Quantum Computation</td>
<td>12</td>
</tr>
<tr>
<td>33-759</td>
<td>Introduction to Theoretical Physics</td>
<td>12</td>
</tr>
<tr>
<td>33-761</td>
<td>Classical Electrodynamics</td>
<td>12</td>
</tr>
<tr>
<td>33-762</td>
<td>Classical Electrodynamics</td>
<td>12</td>
</tr>
<tr>
<td>33-765</td>
<td>Statistical Mechanics</td>
<td>12</td>
</tr>
<tr>
<td>33-769</td>
<td>Quantum Mechanics III</td>
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</tr>
<tr>
<td>33-770</td>
<td>Quantum Mechanics IV</td>
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<td>33-771</td>
<td>Quantum Mechanics V</td>
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</tr>
<tr>
<td>33-777</td>
<td>Introductory Astrophysics</td>
<td>12</td>
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<tr>
<td>33-779</td>
<td>Nuclear and Particle Physics I</td>
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</tr>
<tr>
<td>33-780</td>
<td>Nuclear and Particle Physics II</td>
<td>12</td>
</tr>
<tr>
<td>33-783</td>
<td>Theory of Solids I</td>
<td>12</td>
</tr>
</tbody>
</table>

## Notes

- 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.
- 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.
- 33-314 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>33-111</td>
<td>Physics I for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>or</td>
<td>33-131 Matter and Interactions I</td>
<td>12</td>
</tr>
<tr>
<td>11-100</td>
<td>Introductory Programming</td>
<td>10</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td>99-101</td>
<td>Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td>76-101</td>
<td>Interpretation and Argument (MCS Core 1 of 8)</td>
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### Spring

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>33-112</td>
<td>Physics II for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>or</td>
<td>33-132 Matter and Interactions II</td>
<td>12</td>
</tr>
<tr>
<td>33-104</td>
<td>Experimental Physics</td>
<td>9</td>
</tr>
<tr>
<td>21-122</td>
<td>Integration, Differential Equations and Approximation</td>
<td>10</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Humanities, Social Sciences, or Fine Arts Course (MCS Core 2 of 8)</td>
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#### Sophomore Year

<table>
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<tbody>
<tr>
<td>33-211</td>
<td>Physics III: Modern Essentials</td>
<td>10</td>
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<tr>
<td>33-231</td>
<td>Physical Analysis</td>
<td>9</td>
</tr>
<tr>
<td>33-201</td>
<td>Physics Sophomore Colloquium I</td>
<td>2</td>
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<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
<td>9</td>
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<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry</td>
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<tr>
<td>xx-xxx</td>
<td>H&amp;SS/FA Course (MCS Core 3 of 8)</td>
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### Junior Year

<table>
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<th>Course Title</th>
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<tr>
<td>33-331</td>
<td>Physical Mechanics I</td>
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<tr>
<td>33-330</td>
<td>Intermediate Electricity and Magnetism</td>
<td>10</td>
</tr>
<tr>
<td>33-341</td>
<td>Thermal Physics I</td>
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<tr>
<td>33-301</td>
<td>Physics Upper Class Colloquium</td>
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<tr>
<td>xx-xxx</td>
<td>H&amp;SS/FA Course (MCS Core 5 of 8)</td>
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<tr>
<td>xx-xxx</td>
<td>Physics, Technical, or Free Elective (1 of 10)</td>
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#### Spring

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>33-340</td>
<td>Modern Physics Laboratory</td>
<td>10</td>
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<tr>
<td>33-302</td>
<td>Physics Upper Class Colloquium</td>
<td>1</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Physics, Technical or Free Elective (2 of 10)</td>
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<tr>
<td>xx-xxx</td>
<td>Physics, Technical or Free Elective (3 of 10)</td>
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<tr>
<td>xx-xxx</td>
<td>Physics, Technical or Free Elective (4 of 10)</td>
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<td>xx-xxx</td>
<td>H&amp;SS/FA Course (MCS Core 6 of 8)</td>
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#### Senior Year

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<th>Course Title</th>
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<tbody>
<tr>
<td>21-xxx</td>
<td>Mathematics Elective</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Physics, Technical or Free Elective (5 of 10)</td>
<td>9</td>
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<tr>
<td>xx-xxx</td>
<td>Physics, Technical or Free Elective (6 of 10)</td>
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<tr>
<td>9xx-xxx</td>
<td>Physics, Technical or Free Elective (7 of 10)</td>
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<tr>
<td>xx-xxx</td>
<td>H&amp;SS/FA Course (MCS Core 7 of 8)</td>
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#### Spring

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<thead>
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<th>Units</th>
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<tr>
<td>xx-xxx</td>
<td>Physics, Technical or Free Elective (8 of 10)</td>
<td>9</td>
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<tr>
<td>xx-xxx</td>
<td>Physics, Technical or Free Elective (9 of 10)</td>
<td>9</td>
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<td>Physics, Technical or Free Elective (10 of 10)</td>
<td>9</td>
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<tr>
<td>xx-xxx</td>
<td>H&amp;SS/FA Course (MCS Core 8 of 8)</td>
<td>9</td>
</tr>
</tbody>
</table>

### 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 Track Advisor 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
  - 33-451 Senior Research

The topic in the research course must be in Astrophysics to be pre-approved by the Track Advisor. Under special circumstances, research for pay may count toward this requirement, though it cannot be counted toward the units required for graduation.

B.S. in Physics / Astrophysics Track

The B.S. in Physics/Astronomy 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
  - 33-451 Senior Research

The topic in the research course must be in Astrophysics to be approved by the Track Advisor. Under special circumstances, research for pay may count toward this requirement, though it cannot be counted toward the units required for graduation.

B.S. in Physics / Biological Physics Track

The B.S. in Physics/Biological Physics Track combines a rigorous foundation in undergraduate physics with courses in Biological Physics and Chemistry. It is particularly suitable for students preparing for post-baccalaureate careers in the expanding areas of biological and medical physics, or for graduate study in biophysics. The program is sufficiently flexible that it can be readily adapted to the requirements of individual students. The student will first meet with the Track Advisor to discuss interests and career goals and then choose electives which fulfill the requirements of the track.

The Biological Physics Track includes a number of courses which are also requirements for the pre-medical program. Students interested in both the Biological Physics Track and the pre-medical program should consult with both the Track Advisor 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 pre-approved by the Track Advisor.

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 Track Advisor to discuss interests and career goals and then choose electives which fulfill the requirements of the track.

The Chemical Physics Track incorporates a number of courses which are also requirements for the pre-medical program. Students interested in both the Chemical Physics Track and the pre-medical program should consult both with their Physics Department advisor and the Director of the Health Professions Program for help in planning their programs.

The 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:
- Only 9 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 / 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 Track Advisor 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
- 21-027 Concepts of Mathematics
- 21-369 Numerical Methods
- 15-211 Fundamental Data Structures and Algorithms
- 15-212 Principles of Programming

**Modifications from the requirements listed for the B.S. in Physics:**
- 18 units of Physics Electives are required
- No units of Mathematics Electives are required
- No units of Technical Electives are required
- Only 20 units of Free 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&S/FA courses are required
- The following courses in the MCS core are not required:
  - 03-121, 09-105, 99-101. However, 15-100 is 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 faculty advisor. 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, 122, 259).

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

Choose one course:
- 33-106 Physics I for Engineering Students
- 33-111 Physics I for Science Students
- 33-131 Matter and Interactions I

II. Introductory Physics II

Choose one course:
- 33-107 Physics II for Engineering Students
- 33-112 Physics II for Science Students
- 33-132 Matter and Interactions II

III. Modern Physics

- 33-211 Physics III: Modern Essentials

IV. Laboratory Experience

- 33-104 Experimental Physics

**Elective Courses**

Choose three courses from among the following list:

- 33-114 Physics of Musical Sound
- 33-224 Stars, Galaxies and the Universe
- 33-225 Quantum Physics and Structure of Matter
- 33-228 Electronics
- 33-231 Physical Analysis
- 33-232 Mathematical Methods of Physics
- 33-234 Quantum Physics
- 33-241 Introduction to Computational Physics
- 33-331 Physical Mechanics I
- 33-332 Physical Mechanics II
- 33-338 Intermediate Electricity and Magnetism I
- 33-339 Intermediate Electricity and Magnetism II
- 33-340 Modern Physics Laboratory
- 33-341 Thermal Physics I
- 33-342 Thermal Physics II
- 33-350 Undergraduate Research
- 33-353 Intermediate Optics
- 33-444 Introduction to Nuclear and Particle Physics
- 33-445 Advanced Quantum Physics I
- 33-446 Advanced Quantum Physics II
- 33-448 Introduction to Solid State Physics
- 33-451 Senior Research
- 33-456 Advanced Computational Physics
- 33-458 Special Problems in Computational Physics
- 33-466 Extragalactic Astrophysics and Cosmology
- 33-467 Astrophysics of Stars and the Galaxy
- 33-499 Supervised Reading
- 33-650 General Relativity
- 33-658 Quantum Computation

One of
- 33-350 Undergraduate Research
- 33-451 Senior Research

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—.

TIZIANA DIMATTEO, Associate Professor of Physics — Ph.D., University of Cambridge; Carnegie Mellon, 2004—.

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, Associate Dean for Graduate Affairs, Mellon College of Science — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1984—.

STEPHEN GAROFF, Professor 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, Head, Department of Physics — 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—.

LING-FONG LI, Professor of Physics — Ph.D., University of Pennsylvania; Carnegie Mellon, 1974—.

MATHIAS LOSCHE, Professor of Physics — Ph.D., Technical University of Munich, 1986; Carnegie Mellon, 2005—.

BARRY B. LUOKKALA, Teaching Professor of Physics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1990—.

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. MORNINGSnART, 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, Associate 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., Technical University of Berlin, Germany; 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—.

STEPHANIE TRISTRAM-NAGLE, Associate 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—.

**Emeritus 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—.

TRUMAN KOHMAN, Adjunct Professor of Physics, Emeritus — Ph.D., University of Wisconsin; Carnegie Mellon, 1948—.

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—.

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—.

JIAN-GANG ZHOU, Professor of Electrical and Computer Engineering — Ph.D., University of California San Diego; Carnegie Mellon, 1997—.
Curriculum — B.S. in Computer Science

One Communications course:
15-221 Technical Communication for Computer Scientists

One Applications course:
15-381 Artificial Intelligence: Representation & Problem Solving
15-384 Robotic Manipulation
15-385 Computer Vision
15-413 Software Engineering
15-415 Database Applications
15-437 Web Application Development
15-462 Computer Graphics
15-463 Computational Photography
15-482 Human Language Technologies
15-490 Computational Neuroscience
15-681 Artificial Intelligence: Machine Learning
16-362 Mobile Robot Programming Laboratory

Engineering and Natural Sciences

The following 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)
27-100 Engineering the Materials of the Future
33-104 Experimental Physics
85-310 Research Methods in Cognitive Psychology

The following MCS and CIT courses cannot be used to satisfy the Engineering and Natural Sciences requirement:

09-103 Atoms, Molecules, and Chemical Change
09-104 Fundamental Aspects of Organic Chemistry and Biochemistry
12-090 Technology and the Environment
18-202 Mathematical Foundations of Electrical Engineering
33-100 Basic Experimental Physics
33-115 Energy and Environmental Issues
33-124 Introduction to Astronomy
39-100 What is Engineering?

Computer Skills Workshop

The following course is required of all students to familiarize them with the campus computing environment:
99-xxx Computing Skills Workshop

**Required Minor**

A sequence of courses prescribed by the requirements of the particular department. Completion of a second major (or double degree) also satisfies this requirement. If permitted by the minor or second major department, courses taken in satisfaction of the minor or second major may also count toward any category other than Computer Science.

**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. Carnegie Mellon is currently engaged in a university-wide examination of general education under the rubric of Integrative Liberal Studies. The School of Computer Science fully supports this examination and expects that, when this university-wide examination concludes, that our general education requirements will be different than they are in this catalog. For now, though, the general education courses for SCS students are to meet the following distribution requirements:

**A. Writing Requirement (9 units)**

Complete the following course:

76-101 Interpretation and Argument

**B. Breadth Requirement (27 units)**

Complete three courses, one each from Category 1, Category 2, and Category 3:

**Category 1: Cognition, Choice and Behavior**

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<tr>
<td>70-211</td>
<td>Organizational Behavior</td>
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<td>80-130</td>
<td>Introduction to Ethics</td>
</tr>
<tr>
<td>80-150</td>
<td>Nature of Reason</td>
</tr>
<tr>
<td>80-180</td>
<td>The Nature of Language</td>
</tr>
<tr>
<td>80-181</td>
<td>Language and Thought</td>
</tr>
<tr>
<td>80-221</td>
<td>Philosophy of Social Science</td>
</tr>
<tr>
<td>80-230</td>
<td>Ethical Theory</td>
</tr>
<tr>
<td>80-241</td>
<td>Ethical Judgments in Professional Life</td>
</tr>
<tr>
<td>80-242</td>
<td>Conflict, Dispute Resolution</td>
</tr>
<tr>
<td>80-270</td>
<td>Philosophy of Mind</td>
</tr>
<tr>
<td>80-271</td>
<td>Philosophy and Psychology</td>
</tr>
<tr>
<td>85-100</td>
<td>Introduction to Intelligence in Humans, Animals, and Machines</td>
</tr>
<tr>
<td>85-102</td>
<td>Introduction to Psychology</td>
</tr>
<tr>
<td>85-211</td>
<td>Cognitive Psychology</td>
</tr>
<tr>
<td>85-221</td>
<td>Principles of Child Development</td>
</tr>
<tr>
<td>85-241</td>
<td>Social Psychology</td>
</tr>
<tr>
<td>85-251</td>
<td>Personality</td>
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<tr>
<td>85-261</td>
<td>Abnormal Psychology</td>
</tr>
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<td>88-120</td>
<td>Reason, Passion and Cognition</td>
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<tr>
<td>88-260</td>
<td>Organizations</td>
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**Category 2: Economic, Political and Social Institutions**

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<tr>
<td>36-303</td>
<td>Sampling, Survey and Society</td>
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<tr>
<td>70-332</td>
<td>Business, Society and Ethics</td>
</tr>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
</tr>
<tr>
<td>73-150</td>
<td>Principles of Economics with Calculus</td>
</tr>
<tr>
<td>79-223</td>
<td>Protest and Dissent in American History</td>
</tr>
<tr>
<td>79-331</td>
<td>Crime and Punishment</td>
</tr>
<tr>
<td>79-335</td>
<td>Drug Use and Drug Policy</td>
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<tr>
<td>79-345</td>
<td>American Environmental History: Critical Issues</td>
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<td>79-350/</td>
<td></td>
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<tr>
<td>88-326</td>
<td>Theories of International Relations</td>
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<tr>
<td>80-135</td>
<td>Introduction to Political Philosophy</td>
</tr>
<tr>
<td>80-136</td>
<td>Social Structure, Public Policy and Ethical Dilemmas</td>
</tr>
<tr>
<td>80-235</td>
<td>Political Philosophy</td>
</tr>
<tr>
<td>80-236</td>
<td>Philosophy and the Law</td>
</tr>
<tr>
<td>80-243</td>
<td>Environment Management and Ethics</td>
</tr>
<tr>
<td>80-341</td>
<td>Computers, Society, and Ethics</td>
</tr>
<tr>
<td>88-104</td>
<td>Decision Processes in American Political Institutions</td>
</tr>
<tr>
<td>88-110</td>
<td>Experiments with Economic Principles</td>
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<tr>
<td>88-205</td>
<td>Comparative Politics</td>
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<td>88-220</td>
<td>Policy Analysis 1</td>
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**Category 3: Cultural Analysis**

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<tr>
<td>57-173</td>
<td>Survey of Western Music History</td>
</tr>
<tr>
<td>70-342</td>
<td>Managing Across Cultures</td>
</tr>
<tr>
<td>76-227</td>
<td>Comedy</td>
</tr>
</tbody>
</table>

76-232 African-American Studies
76-239 Introduction to Film Studies
76-241 Introduction to Gender Studies
79-104 Introduction to World History
79-113 Culture and Identity in American Society
79-201 Introduction to Anthropology
79-206 Development of American Culture
79-207 Development of European Culture
79-209 Theory and Practice in Anthropology
79-218 The Roots of Rock & Roll
79-222 Religion in American Society
79-226 History and Cultures of East Asia
79-241 African-American History I
79-242 African-American History II
79-259 Introduction to Religion
79-270 Chinese Culture and Society
79-368 Poverty, Charity, and Welfare
79-384 Medicine and Society
80-100 What Philosophy Is
80-151 God in the West
80-250 Ancient Philosophy
80-251 Modern Philosophy
80-253 Continental Philosophy
80-254 Analytic Philosophy
80-255 Pragmatism
80-261 Aesthetics of Mass Art
82-273 Introduction to Japanese Language and Culture
82-294 Topics in Russian Language and Culture
82-303 French Culture
82-304 Francophone World
82-325 Introduction to German Studies
82-333 Introduction to Chinese Language and Culture
82-342 Spain: Language and Culture
82-343 Latin America: Language and Culture
82-344 US Latinos: Language and Culture
82-345 Hispanic Literary and Cultural Studies
82-346 Hispanic Literary and Cultural Studies

**C. Humanities and Arts Electives (36 units)**

Complete 3 non-technical courses of at least 9 units each from the departments of Business Administration or from any of the departments in the College of Humanities & Social Sciences or the College of Fine Arts. 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/bscs/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) courses may be used toward fulfilling graduation requirements.

**Summary of Degree Requirements:**

<table>
<thead>
<tr>
<th>Area</th>
<th>Courses</th>
<th>Units</th>
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<tbody>
<tr>
<td>Computer Science</td>
<td>14</td>
<td>148</td>
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<tr>
<td>Math/Statistics</td>
<td>5</td>
<td>47</td>
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<tr>
<td>Engineering/Science</td>
<td>4</td>
<td>36</td>
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<tr>
<td>Humanities/Arts</td>
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<td>63</td>
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<tr>
<td>Minor/Free Electives</td>
<td>7</td>
<td>63</td>
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<tr>
<td>Computer Skills Workshop</td>
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<td>3</td>
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**Total Units:** 360

**Suggested Course Sequence:**

**Fall Year**

<table>
<thead>
<tr>
<th>Week</th>
<th>Course Code</th>
<th>Course Title</th>
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<tr>
<td>15-111</td>
<td>15-111 Intermediate/Advanced Programming</td>
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<tr>
<td>15-128</td>
<td>15-118 Freshman Immigration Course</td>
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</tr>
<tr>
<td>21-120</td>
<td>21-120 Differential &amp; Integral Calculus</td>
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<tr>
<td>21-127</td>
<td>21-127 Concepts of Mathematics</td>
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</tr>
<tr>
<td>76-101</td>
<td>76-101 Interpretation and Argument</td>
<td></td>
</tr>
<tr>
<td>99-xxx</td>
<td>99-xxx Computing Skills Workshop</td>
<td></td>
</tr>
<tr>
<td>xx-xxx</td>
<td>xx-xxx Science/Engineering Course</td>
<td></td>
</tr>
</tbody>
</table>

**Spring Year**

<table>
<thead>
<tr>
<th>Week</th>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-211</td>
<td>15-211 Fundamental Data Structures and Algorithms</td>
<td></td>
</tr>
<tr>
<td>15-251</td>
<td>15-251 Great Theoretical Ideas in Computer Science</td>
<td></td>
</tr>
<tr>
<td>21-122</td>
<td>21-122 Integration, Differential Equations, and Approximation</td>
<td></td>
</tr>
<tr>
<td>xx-xxx</td>
<td>xx-xxx Science/Engineering Course</td>
<td></td>
</tr>
<tr>
<td>xx-xxx</td>
<td>xx-xxx Humanities and Arts Elective</td>
<td></td>
</tr>
</tbody>
</table>

**Total Units:** 52
Sophomore Year

Fall
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

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Spring
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
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

39

Spring
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
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
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
15-381 Artificial Intelligence: Representation and Problem Solving
15-384/5 Robotic Manipulation / Computer Vision
15-486 Artificial Neural Networks
15-681 Artificial Intelligence: Machine Learning
80-300 Minds, Machines, and Knowledge
80-316 Probability and AI
85-211 Cognitive Psychology
85-213 Human Information Processing and Artificial Intelligence
85-419 Introduction to Parallel Distributed Processing

Cognitive Modeling
05-432 Cognitive Modeling and Intelligent Tutoring Systems
05-811 Cognitive Modeling for HCI
85-211 Cognitive Psychology
85-213 Human Information Processing and Artificial Intelligence
85-392 Human Expertise
85-412 Cognitive Modeling

Computer Systems
15-410 Operating System Design and Implementation
15-411 Compiler Design
15-412 Operating System Practicum
15-441 Computer Networks
18-240 Fundamentals of Computer Engineering
18-447 Introduction to Computer Architecture

Entrepreneurship
15-390 Entrepreneurship for Computer Science
15-391 Technology Consulting in the Community

Graphics/Virtual Reality
05-331 Building Virtual Worlds
15-462 Computer Graphics
15-463 Computational Photography
15-464 Technical Animation
15-465 Animation Art and Technology
15-466 Computer Game Programming

Human-Computer Interaction
05-410 Introduction to Human-Computer Interaction Methods

Additionally, students who are interested in Human-Computer Interaction are encouraged to look at the description of the Double Major in Human-Computer Interaction on page 97 of the Undergraduate Catalog.

Language Technologies
11-741 Information Retrieval
11-751 Speech Recognition
15-482 Human Language Technologies
80-180 The Nature of Language

Additionally, students interested in Language Technologies are encouraged to look at the description of the Minor in Language Technologies on page 321 and the Minor in Linguistics on page 222 of the Undergraduate Catalog.

Robotics
16-311 Introduction to Robotics
16-362 Mobile Robot Programming Laboratory
16-363 Advanced Mobile Robot Programming

Additionally, students who are interested in Robotics are encouraged to look at the description of the Minor in Robotics on page 104 of the Undergraduate Catalog.

Scientific Computation
21-259 Calculus in Three Dimensions
21-260 Differential Equations
21-320 Symbolic Programming Methods
21-369 Numerical Methods
36-410 Introduction to Probability Modeling

Additionally, students who are interested in Scientific Computation are encouraged to look at the description of the Minor in Scientific Computing on page 288 in the Undergraduate Catalog as well as the following discipline-specific Computational Science courses:
03-310 Introduction to Computational Biology
09-560 Molecular Modeling and Computational Chemistry
33-241 Introduction to Computational Physics

Software Systems
15-312 Foundations of Programming Languages
15-410 Operating System Design and Implementation
15-411 Compiler Design
15-415 Database Applications
15-441 Computer Networks

Theory
15-312 Foundations of Programming Languages
15-453 Formal Languages and Automata
15-85x Graduate Theory course
21-301 Combinatorial Analysis
21-341 Linear Algebra
21-355 Principles of Real Analysis I
21-373 Algebraic Structures
21-484 Applied Graph Theory
21-600 Mathematical Logic I
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:**
- 15-111 Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
- 15-123 Effective Programming in C and UNIX
- 21-120 Differential & Integral Calculus
- 21-127 Concepts of Mathematics
- 21-241 Matrix Algebra (or 21-341, Linear Algebra)

**Double Major requirements:**
- 15-211 Fundamental Data Structures and Algorithms
- 15-212 Principles of Programming
- 15-213 Introduction to Computer Systems
- 15-251 Great Theoretical Ideas in Computer Science
- 15-451 Algorithm Design and Analysis

One Communications course:
- 15-221 Technical Communication for Computer Scientists

One Applications course:
- 15-381 Artificial Intelligence: Representation and Problem Solving
- 15-384 Robotic Manipulation
- 15-385 Computer Vision
- 15-413 Software Engineering
- 15-415 Database Applications
- 15-437 Web Application Development
- 15-463 Computational Photography
- 15-482 Human Language Technologies
- 15-490 Computational Neuroscience
- 15-681 Artificial Intelligence: Machine Learning
- 16-362 Mobile Robot Programming Laboratory

One Fundamentals of Algorithms course:
- 15-354 Computational Discrete Mathematics
- 15-355 Modern Computer Algebra
- 21-301 Combinatorics
- 21-373 Algebraic Structures
- 21-484 Graph Theory

One Fundamentals of Programming course:
- 15-312 Foundations of Programming Languages
- 15-313 Constructive Logic
- 15-453 Formal Languages and Automata
- 17-651 Models of Software Systems
- 21-300 Basic Logic
- 80-310 Logic and Computation
- 80-311 Computability and Incompleteness

One Systems Programming course:
- 15-410 Operating System Design and Implementation
- 15-418 Parallel Computer Architecture and Programming
- 15-441 Computer Networks
- 18-447 Introduction to Computer Architecture

Two Computer Science electives

One of the following Probability courses:
- 15-359 Probability and Computing
- 36-217 Probability Theory and Random Processes
- 36-225 Introduction to Probability and Statistics I
- 36-625 Probability and Mathematical Statistics I

Minor in Computer Science

The following courses are required for the Minor in Computer Science:

**Prerequisites:**
- 15-111 Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
- 21-127 Concepts of Mathematics

**Minor requirements:**
- 15-211 Fundamental Data Structures and Algorithms
- One of the following courses:
  - 15-213 Introduction to Computer Systems (requires 15-123 as a prerequisite)
  - 15-251 Great Theoretical Ideas in Computer Science

Three Computer Science electives

**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.

Language Technologies Minor

The following courses are required for the Minor in Language Technologies:

**Prerequisites:**
- 15-111 Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
- 21-127 Concepts of Mathematics
- 15-211 Fundamental Data Structures and Algorithms
- 15-212 Principles of Programming
- 15-251 Great Theoretical Ideas in Computer Science

**Minor requirements:**

Both of the following courses:
- 15-482 Human Language Technologies
- 11-721 Grammars and Lexicons

Two of the following electives:
- 11-617 LT in CALL
- 11-711 Algorithms for NLP
- 11-731 Machine Translation
- 11-741 Information Retrieval
- 11-751 Speech Recognition
- 11-752 Speech II
- 11-761 Language and Statistics
- 80-180 The Nature of Language
- 80-280 Linguistic Analysis

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.

Robotic Minor

The following courses are required for the Minor in Robotics:

Prerequisites:
15-111 Intermediate/Advanced Programming (students with no prior programming experience take 15-100 & 15-111)
15-123 Effective Programming in C and UNIX

Minor requirements:
16-311 Introduction to Robotics

One of the following courses:
15-384 Robotic Manipulation
24-355 Kinematics and Dynamics of Mechanisms

One of the following courses:
16-299 Introduction to Feedback Control Systems
18-370 Fundamentals of Control
24-451 Feedback Control Systems

Two of the following electives:
15-381 Artificial Intelligence: Representation & Problem Solving
15-385 Computer Vision
15-462 Computer Graphics
15-463 Computational Photography
15-681 Artificial Intelligence: Machine Learning
16-284 Humanoids
16-362 Mobile Robot Programming Laboratory
16-721 Advanced Perception
16-735 Motion Planning
16-778 Mechatronic Design
60-422 Advanced ETB: Robotic Art Studio
85-213 Information Processing and Artificial Intelligence
85-370 Perception

More information on the minor can be found at http://www.r.i.cmu.edu/education/ugrad_minor.html.

Double-Counting Restriction

Courses in the Robotics Minor may not also be counted towards another SCS 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 on page 54 of the Undergraduate Catalog.

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.

1. A first year student will be suspended if the QPA from each semester is below 1.75.
2. 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 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,** Assistant Professor — Ph.D., University of Washington; Carnegie Mellon, 2003—.

**VINCENT ALEVEN,** Systems Scientist — Ph.D., University of Pittsburgh; Carnegie Mellon, 1997—.

**DAVID ANDERSEN,** Assistant Professor — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2005—.

**ANASTASSIA AILAMAKI,** Assistant Professor — Ph.D., University of Wisconsin; Carnegie Mellon, 2001—.

**JOSEPH E. BECK,** Systems Scientist — Ph.D., Stanford University; Carnegie Mellon, 1978—.

**CHRISTOPHER ATKESON,** Professor — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2000—.

**SIMON BAKER,** Associate Research Professor — Ph.D., Columbia University; Carnegie Mellon, 2000—.

**ZIV BAR-JOSEPH,** Assistant Professor — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 2003—.

**JOHN BARES,** Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993—.

**JOSEPH E. BECK,** Systems Scientist — Ph.D., University of Massachusetts, Amherst; Carnegie Mellon, 2001—.

**HANS BERLINER,** Research Professor, Emeritus — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1974—.

**ALAN BLACK,** Research Scientist — 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 — AIGA Professor — M.F.A., Indiana University; Carnegie Mellon, 1982—.

**VLADIMIR BRAJOVIC,** Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1996—.

**STEPHEN BROOKES,** Professor — Ph.D., University College, Oxford; Carnegie Mellon, 1981—.

**RALF BROWN,** Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993—.

**RANDAL BRYANT,** University Professor, Dean, School of Computer Science— Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1994—.

**TIMOTHY CALLAHAN,** Systems Scientist — Ph.D., University of California, Berkeley; Carnegie Mellon, 2004—.

**JAMIE CALLAN,** Associate Professor — Ph.D., University of Massachusetts; Carnegie Mellon, 1999—.

**JAIME CARBONELL,** Allen Newell Professor; Director, Language Technologies Institute — Ph.D., Yale University; Carnegie Mellon, 1979—.

**KATHLEEN CARLEY,** Professor — Ph.D., Harvard University; Carnegie Mellon, 1984—.

**JACOBO CARRASQUEL,** Associate Teaching Professor — M.S., Carnegie Mellon University; Carnegie Mellon, 1984—.

**HOWIE CHOSET,** Associate Professor — Ph.D., California Institute of Technology; Carnegie Mellon, 1996—.

**MICHAEL CRISTEL,** Senior Systems Scientist — Ph.D., Georgia Institute of Technology; Carnegie Mellon, 1997—.

**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—.

**ROBERT COLLINS,** Associate Research Professor — Ph.D., University of Massachusetts; Carnegie Mellon, 1998—.

**ERIC COOPER,** Distinguished Service Professor — Ph.D., University of California at Berkeley; Carnegie Mellon, 1985—.

**ALBERT CORBETT,** Associate Research Professor — Ph.D., University of Oregon; Carnegie Mellon, 1999—.

**TOM CORTINA,** Lecturer — Ph.D., Polytechnic University; Carnegie Mellon, 2004—.

**ANASTASSIA AILAMAKI,** Assistant Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001—.

**LORRIE CRANOR,** Associate Research Professor — Ph.D., Washington University; Carnegie Mellon, 2004—.

**KARL CRAZY,** Associate Professor — Ph.D., Cornell University; Carnegie Mellon, 1998—.

**STEVE CROSS,** Associate Research Professor — Ph.D., University of Illinois; Carnegie Mellon, 1994—.

**ROGER DANNENBERG,** Associate Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1982—.

**ANIND DEY,** Assistant Professor — Ph.D., Georgia Institute of Technology; Carnegie Mellon, 2004—.

**M. BERNARDINE DIAS,** Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003—.

**ANTHONY DIGIOIA,** Associate Research Professor — M.D., Harvard Medical School; Carnegie Mellon, 1999—.

**JOHN DOLAN,** Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1997—.

**DAVID ECKHART,** Associate Teaching Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003—.

**WILLIAM EDDY,** Professor — Ph.D., Yale University; Carnegie Mellon, 1976—.

**ALEXEI EFROS,** Assistant 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 ESKELEZAI,** Systems Scientist — Ph.D., University of Paris; Carnegie Mellon, 1995—.

**SCOTT FAHLMAN,** Research Professor — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1978—.

**CHRISTOS FALOUTOS,** Professor — Ph.D., University of Toronto; Carnegie Mellon, 1998—.

**DAVID FARBER,** Distinguished Career Professor — M.S., Stevens Institute of Technology; Carnegie Mellon, 2003—.

**GARY FEDDER,** Professor — Ph.D., University of California at Berkeley; Carnegie Mellon, 1994—.

**STEPHENV FIEBENG,** Maurice Falk University Professor — Ph.D., Harvard University; Carnegie Mellon, 1988—.

**EUGENE FINK,** Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2004—.

**JODI FORLIZI,** Assistant Professor — M.Des., Carnegie Mellon University; Carnegie Mellon, 2000—.
JACK MOSTOW, Associate Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993—.

TODD MOWRY, Associate Professor — Ph.D. Stanford University; Carnegie Mellon, 1997—.

ROBERT MURPHY, Associate Professor — Ph.D. Carnegie 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, Santa Barbara; Carnegie Mellon, 2001—.

SRINIVASA NARASIMHAN, Assistant Professor — Ph.D., Columbia University; Carnegie Mellon, 2004—.

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ILLAH NOURBakhsh, Associate Professor — Ph.D., Stanford University; Carnegie Mellon, 1997—.

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DAVID O’HALLARON, Associate Professor — Ph.D., University of Virginia; Carnegie Mellon, 1989—.

CHRISTOPHER OLSTON, Assistant Professor — Ph.D., Stanford University; Carnegie Mellon, 2003—.

IRVING OPPENHEIM, Professor — Ph.D., Cambridge University; Carnegie Mellon, 1972.

RICHARD PATTIS, Associate Teaching Professor — M.S. Stanford University; Carnegie Mellon, 1997—.

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FRANK PFENNING, Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1986—.

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MICHAEL REITER, Professor — Ph.D. Cornell University; Carnegie Mellon, 2001—.

JOHN REYNOLDS, Professor — Ph.D., Harvard University; Carnegie Mellon, 1986—.

CAMERON RIVIERE, Associate Research Professor — Ph.D., Johns Hopkins; Carnegie Mellon, 1999—.

ALFRED RIZZI, Associate Research Professor — Ph.D., Yale University; Carnegie Mellon, 1998—.

JAMES ROBERTS, Teaching Professor — M.S., Carnegie Mellon University; Carnegie Mellon, 1985—.

DAVID ROOT, Lecturer — M.P.M., Carnegie Mellon University; Carnegie Mellon, 1998—.

CAROLYN PENSTEIN ROSE, Research Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2003—.

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TUOMAS SANDHOLM, Professor — Ph.D., University of Massachusetts, Amherst; Carnegie Mellon, 2001—.

MAHADEV SATYANARAYANAN, Carnegie Group Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983—.

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WILLIAM SCHERLIS, Professor — Ph.D., Stanford University; Carnegie Mellon, 1989—.

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TANYA SCHULTZ, Research Scientist — Ph.D., University of Karlsruhe; Carnegie Mellon, 2000—.

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REID SIMMONS, Research Professor — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.

SANJIV SINGH, Associate Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1995—.

DONALD SLATER, Lecturer — B.S., Pennsylvania State University; Carnegie Mellon, 2000—.

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STEPHEN SMITH, Research Professor — Ph.D., University of Pittsburgh; Carnegie Mellon, 1984—.

PETER SPIRITES, Professor — Ph.D. University of Pittsburgh; Carnegie Mellon, 1982—.

PETER STEENKISTE, Professor — Ph.D., Stanford University; Carnegie Mellon, 1987—.

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ANTHONY STENTZ, Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1989—.

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SCOTT STEVENS, Senior Systems Scientist — Ph.D., University of Nebraska; Carnegie Mellon, 1987—.

KLAUS SUTNER, Teaching Professor; Associate Dean for Undergraduate Education — Ph.D., University of Munich; Carnegie Mellon, 1995—.

LATANYA SWEENEY, Associate Professor — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1998—.

KATIA SYCARA, Research Professor — Ph.D., Georgia Institute of Technology; Carnegie Mellon, 1987—.

KYMIE TAN, Systems Scientist — Ph.D., University of Melbourne; Carnegie Mellon, 1998—.

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SCOTT THAYER, Systems Scientist — Ph.D., University of Tennessee; Carnegie Mellon, 2000—.

CHARLES THORPE, Research Professor; Dean, Qatar Campus — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1984—.

RAHUL TONGIA, Senior Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000—.

DAVID TOURETZKY, Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1984—.

MANUELA VELOSO, Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1987—.

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YIMING YANG, Professor — Ph.D., Kyoto University; Carnegie Mellon, 1996—.

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SUJATA TELAND, Lecturer — M.S.E. Carnegie Mellon University; Carnegie Mellon, 2004—.
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MANUELA VELOSO, Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1987—.
HOWARD WACTLAR, Alumni Research Professor of Computer Science — M.S., University of Maryland; Carnegie Mellon, 1967—.
DIETER WAELTERMANN, Senior Systems Scientist — Ph.D., University of Texas, Austin; Carnegie Mellon, 1991—.
ALEXANDER WAIBEL, Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1986—.
LARRY WASSERMAN, Professor - Ph.D., University of Toronto; Carnegie Mellon, 1988—.
LEE WEISS, Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983—.
DAVID WETTERGREEN, Associate Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000—.
RED WHITTAKER, Fredkin Research Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1989—.
JEANNETTE WING, Professor; Computer Science Department Head — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1985—.
JIE YANG, Research Scientist — Ph.D., University of Akron; Carnegie Mellon, 1997—.
YIMING YANG, Professor — Ph.D., Kyoto University; Carnegie Mellon, 1996—.
HUI ZHANG, Associate Professor — Ph.D., University of California, Berkeley; Carnegie Mellon, 1995—.
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The Tepper School of Business (TSB) at Carnegie Mellon University conducts educational programs not only at the undergraduate level (see p. 185 for the program in Economics and p. 233 for the program in Business Administration) but also at the masters, doctoral, and executive levels. The school attracts students of outstanding promise and produces professional leaders who are prepared to manage in a rapidly changing marketplace. From its inception more than 40 years ago, TSB has been at the forefront of innovation in management education. The school’s pioneering pedagogical achievements in scientific problem solving and interdisciplinary teamwork have been adopted by many prestigious business schools. TSB’s commitment to excellence has consistently earned the school a ranking among the top business schools in the nation.

The undergraduate and masters students in TSB gain a solid foundation in the fundamental scientific disciplines of economics, the behavioral sciences, and the management sciences. The program emphasizes the functional areas of accounting, information systems, finance, marketing, production management, and human resources management. In addition, students attain analytical problem-solving skills, computing skills, and written and oral communication skills. The curriculum culminates in the application of knowledge to real-world problems, so that students can integrate and apply what they have learned. TSB is not content with teaching traditional approaches but develops innovative courses and programs.

At TSB, research and education are closely related. The outstanding faculty of TSB develops new ideas and brings results of its research to the students, demonstrating the importance of critical thinking and of a continuing search for excellence. TSB has a strong and active faculty that confronts both applied problems and fundamental issues of long-range concern. The faculty is particularly renowned for cutting-edge work in operations research, economics, management information systems, finance, accounting, marketing, and operations management/production. TSB alumni have a remarkable track record of success and leadership in management and management education. They are represented internationally in the ranks of the Fortune 500 companies, as heads of dynamic entrepreneurial ventures, and as leading faculty members in America's top academic institutions. Moreover, TSB alumni provide a strong network for new graduates.

3-2 Program for Carnegie Mellon Students

All Carnegie Mellon undergraduates with outstanding academic performance are eligible to apply to the Tepper School of Business for TSB's prestigious MBA program. Students who are accepted bypass their senior year as undergraduates and earn both their bachelor's degree and their MBA degree in five years. Applicants to the 3-2 program are evaluated not only on their academic achievement but also on their maturity, commitment, sense of direction, and interpersonal and communications skills. Their experiences in summer internships and their extracurricular activities are also evaluated. Admission to the MBA program is highly competitive, and 3-2 applicants compete with the entire applicant pool for spaces in the program. Students interested in the 3-2 program should read the MBA catalog, available from the TSB Admissions Office (TSB Room 149-C). They should also talk with their individual departments concerning completion of their undergraduate requirements.

Full-Time Faculty

LINDA ARGOTE, David M. Kirr and Barbara A. Kirr Professor of Organizational Behavior and Director, Center for Organizational Learning and Innovation — Ph.D., University of Michigan; Carnegie Mellon, 1979—.

EGON BALAS, University Professor of Industrial Administration and Applied Mathematics; The 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 and Professor of Operations Management and Manufacturing — Ph.D., Northwestern University; Carnegie Mellon, 1979—.

DAVID FRAME, Visiting Assistant Professor of Economics — Ph.D., University of California at Los Angeles; Carnegie Mellon, 2002—.

PETER BOATWRIGHT, Associate Professor of Marketing — Ph.D., University of Chicago, Carnegie Mellon, 1997—.

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MILTON L. COFIELD, Executive Director, BS in Business Administration Program and Associate Teaching Professor of Business Strategy — Ph.D., University of Illinois; Carnegie Mellon, 2001—.

W. ROBERT DALTON, Associate Teaching Professor of Entrepreneurship — Ph.D., University of Missouri; Carnegie Mellon, 1985—.

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KENNETH B. DUNN, Dean and Professor of Financial Economics — Ph.D., Purdue University; Carnegie Mellon, 1979-1989; 2002—.

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DENNIS N. EPPLE, Head, BA/BS in Economics Program and Thomas Lord Professor of Economics — Ph.D., Princeton University; Carnegie Mellon, 1974—.

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PEI-YU CHEN, Assistant Professor in Information Systems — Ph.D., Carnegie Mellon, 2002—.

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DAHILL GRAY, Assistant Professor of Information Systems — Ph.D., Carnegie Mellon, 2002 —.

W. ROBERT DALTON, Associate Teaching Professor of Entrepreneurship — Ph.D., University of Missouri; Carnegie Mellon, 1985 —.

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LAURENS G. DEBO, Assistant Professor of Operations Management and Manufacturing — Ph.D., INSEAD, Fontainebleau, France; Carnegie Mellon, 2002 —.

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KENNETH B. DUNN, Dean and Professor of Financial Economics — Ph.D., Purdue University; Carnegie Mellon, 1979-1989; 2002—.

MARGARIDA DUARTE, Visiting Assistant Professor of Economics — Ph.D., University of Rochester; Carnegie Mellon, 2004—.

S. THOMAS EMERSON, Director, Donald H. Jones Center for Entrepreneurship and David T. and Lindsay J. Morgenthaler Professor of Entrepreneurship — Ph.D., Rice University; Carnegie Mellon, 2000—.

DENNIS N. EPPLE, Head, BA/BS in Economics Program and Thomas Lord Professor of Economics — Ph.D., Princeton University; Carnegie Mellon, 1974—.

MARIA MARTA FERREYRA, Assistant 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—.

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ROBERT F. CULBERTSON III, Adjunct Professor of Entrepreneurship — MSIA and MS Engineering, Carnegie Mellon; Carnegie Mellon, 1999—.
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CLIFFORD T. EARLY, Adjunct Professor of Law — J.D. University of Pittsburgh; Carnegie Mellon, 2000—.
THOMAS F. FAUGHT, JR., Adjunct Professor of Business Strategy — MBA, Harvard Business School; Carnegie Mellon, 2002—.
ANDREW HANNAH, Adjunct Professor of Entrepreneurship — MBA, University of Pittsburgh; Carnegie Mellon, 2002—.
JOSEPH S. HORNACK, Adjunct Professor of Taxation — M.S., Robert Morris College; Carnegie Mellon, 2000—.
HANS LANGE, Adjunct Professor of Consulting — MBA, Harvard University; Carnegie Mellon, 1991—.
JOHN LANKFORD, Adjunct Professor of Marketing — MBA, The University of Michigan; Carnegie Mellon, 1998—.
PETER ORESICK, Adjunct Professor of Graphic Communication — MFS in Writing, University of Pittsburgh; Carnegie Mellon, 2001—.
MICHAEL J. POCHAN, Adjunct Professor of Entrepreneurship — MSIA, Carnegie Mellon; Carnegie Mellon, 1999—.
VESNA PRASNIKAR, Visiting Professor of Strategy — Ph.D., University of Pittsburgh; Carnegie Mellon, 2000—.
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—.
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RICHARD P. SIMMONS, Distinguished Adjunct Professor of Business Management — B.S., Massachusetts Institute of Technology; Carnegie Mellon, 2002—.
JOEL STERN, Adjunct Professor of Finance — MBA, University of Chicago; Carnegie Mellon, 1996—.
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TIMOTHY J. ZAK, Adjunct Professor of Operations Management and Manufacturing — MBA, New York University; Carnegie Mellon, 2002—.
Undergraduate business administration at the Tepper School is intended for students interested in an undergraduate management educational experience which 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 a wide variety of educational goals.

The curriculum is designed around a central core of liberal studies, core functional business, economics, mathematics and computing course requirements. To these are added the ability to study in-depth in one of the core functional business areas such as finance, information systems, marketing, entrepreneurship or manufacturing management, or alternatively, to complete a minor or second major in another department of the university.

Studying abroad is now seen to be an essential part of the best undergraduate educational experience and our students are encouraged to do so through an extensive arrangement of international study partners in some of the best universities of the world. The globalizing business and political environment in which organizations of the future will pursue their goals make such experiences invaluable to those who will be leaders.

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. More than 50% eventually obtain an MBA, while many other go on to graduate study in law, economics, finance and policy studies at the best universities in the world in these fields.

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 management 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 general elective requirements.

#### Curriculum Overview

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<thead>
<tr>
<th>Category</th>
<th>Units</th>
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<tr>
<td>Functional Business Core</td>
<td>111</td>
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<tr>
<td>Economics Core</td>
<td>27</td>
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<tr>
<td>Mathematics/Computing Core</td>
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<td>Track Requirement</td>
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<td>General Electives</td>
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These requirements break down as follows:

#### Functional Business Core

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<tr>
<th>Course Code</th>
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<tr>
<td>70-100</td>
<td>Introduction to Business</td>
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<tr>
<td>70-122</td>
<td>Introduction to Accounting</td>
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<tr>
<td>70-201</td>
<td>Professional and Service Projects</td>
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<tr>
<td>70-311</td>
<td>Organizational Behavior</td>
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<tr>
<td>70-332</td>
<td>Business, Society and Ethics</td>
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<td>70-340</td>
<td>Business Communications</td>
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<td>70-345</td>
<td>Oral Communications</td>
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<td>70-371</td>
<td>Production/Operations Management</td>
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<td>70-381</td>
<td>Marketing</td>
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<td>70-391</td>
<td>Finance</td>
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<td>70-401</td>
<td>Management Game</td>
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<td>70-451</td>
<td>Management Information Systems</td>
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#### Economics Core

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<tr>
<th>Course Code</th>
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<tr>
<td>73-100</td>
<td>Principles of Economics</td>
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<td>73-200</td>
<td>Macroeconomics</td>
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<td>73-251</td>
<td>Economic Theory</td>
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</tbody>
</table>

#### Mathematics/Computing Core

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-100</td>
<td>Intro/Inter Programming</td>
<td>10</td>
</tr>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
<td>9</td>
</tr>
<tr>
<td>21-256</td>
<td>Multivariate Analysis and Approximation</td>
<td>9</td>
</tr>
<tr>
<td>21-257</td>
<td>Models and Methods of Optimization</td>
<td>9</td>
</tr>
<tr>
<td>70-207</td>
<td>Probability and Statistics</td>
<td>9</td>
</tr>
<tr>
<td>70-208</td>
<td>Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>99-101/102</td>
<td>Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>58</td>
</tr>
</tbody>
</table>

#### Breadth Requirements

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
- 79-104 Introduction to World History

**Required: One course from each category**

- Science & Technology;
- Cognition, Choice & Behavior;
- Political & Social Institutions;
- Creative Production & Reflection;
- Cultural Analysis.

**Required: An additional two courses from any of the above categories.**

**TOTAL OF NINE BREADTH COURSES ARE REQUIRED.**

#### Track Requirements

The track requirement may be satisfied by completing either of the following: (1) a BA Track (see below); (2) a BA approved minor with another department (a double major can substitute for a minor). A BA Track consists of a menu of courses (both required and elective) of which the student must complete, in most cases, six (54 units). Since the particular courses may vary, students should contact the BA office for an up-to-date list of BA Tracks and their associated courses. Presently, BA offers the following Tracks:

- Computing and Information Technology
- Entrepreneurship
- Finance
- General Management
- Graphic Media Management
- International Management
- Manufacturing Management and Consulting Marketing

#### General Electives

BA Students must complete a total of at least 364 units in order to graduate. To reach this total, students must complete additional general electives of their choosing. Normally, students must do 32-36 units of general electives, depending on their other course selections.
## Suggested Course Plan

What follows is a suggested course plan for BA students completing the degree with a track. Be careful to observe any prerequisite and corequisite requirements for each course. These are given in the course descriptions found at the back of this catalog.

### First Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>70-100 Introduction to Business</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>76-101 Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Breadth course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Breadth course</td>
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<tr>
<td></td>
<td>99-101/102 Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total units</strong></td>
<td><strong>49</strong></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>21-256 Multivariate Analysis and Approximation</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>73-100 Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>15-100 Intro/Inter Programming</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>79-104 Introduction to World History</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Breadth course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td><strong>Total units</strong></td>
<td><strong>46</strong></td>
</tr>
</tbody>
</table>

*70-101 and 79-104 can switch semesters, but cannot be taken together.

### Sophomore Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>21-257 Models and Methods of Optimization</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-122 Introduction to Accounting</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-207 Probability and Statistics</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>73-150 Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Breadth course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td><strong>Total units</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>70-208 Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-311 Organizational Behavior</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-340 Business Communication</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>73-200 Macroeconomics</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Breadth course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td><strong>Total units</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

*21-292 Operations Research offered in spring semesters only.

### Junior Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>70-371 Production and Operations Management</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-381 Marketing</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-391 Finance</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Breadth course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx General Elective</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td><strong>Total units</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>70-332 Business, Society and Ethics</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-345 Oral Communications</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-451 Management Information Systems</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-xxx Track course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td><strong>Total units</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

### Senior Year

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>70-xxx Track Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-xxx Track Course</td>
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</tr>
<tr>
<td></td>
<td>xx-xxx General Elective</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx Track Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td><strong>Total units</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>70-401 Management Game</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>70-xxx Track Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>70-xxx Track Course</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx General Elective</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>xx-xxx General Elective</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td><strong>Total units</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

### Additional Major Requirements

**Business Core**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-122 Introduction to Accounting</td>
<td>9</td>
</tr>
<tr>
<td>70-311 Organizational Behavior</td>
<td>9</td>
</tr>
<tr>
<td>70-332 Business, Society and Ethics</td>
<td>9</td>
</tr>
<tr>
<td>70-340 Business Communications</td>
<td>9</td>
</tr>
<tr>
<td>70-345 Oral Communications</td>
<td>9</td>
</tr>
<tr>
<td>70-371 Production/Operations Management</td>
<td>9</td>
</tr>
<tr>
<td>70-381 Marketing</td>
<td>9</td>
</tr>
<tr>
<td>70-391 Finance</td>
<td>9</td>
</tr>
<tr>
<td>70-451 Management Information Systems</td>
<td>9</td>
</tr>
<tr>
<td>70-401 Management Game</td>
<td>12</td>
</tr>
<tr>
<td>70-3xx/4xx Electives</td>
<td>2</td>
</tr>
</tbody>
</table>

**Mathematics/Computing Core**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>9</td>
</tr>
<tr>
<td>21-256 Multivariate Analysis and Approximation</td>
<td>9</td>
</tr>
<tr>
<td>21-257 Models and Methods of Optimization</td>
<td>9</td>
</tr>
<tr>
<td>70-207 Probability and Statistics</td>
<td>9</td>
</tr>
<tr>
<td>70-208 Regression Analysis</td>
<td>9</td>
</tr>
<tr>
<td>99-101/102 Computing Skills Workshop</td>
<td>3</td>
</tr>
<tr>
<td>15-100/102 Programming Course</td>
<td>3</td>
</tr>
</tbody>
</table>

**Economics Core**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-100 Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>73-150 Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-200 Macroeconomics</td>
<td>9</td>
</tr>
</tbody>
</table>

*Students in IS and CS must select a 70-4xx course from the Computing and Information Technology Track.

**Minor in Business Administration**

Applications for declaring a business minor are available online at the Undergraduate Business Administration Website.

**Mathematics/Statistics:**

Two semester courses in Calculus\(^7\)

One semester course in Statistics

**Required:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-311 Organizational Behavior</td>
<td>9</td>
</tr>
<tr>
<td>70-381 Marketing</td>
<td>9</td>
</tr>
<tr>
<td>73-100 Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>21-257 Models and Methods of Optimization</td>
<td>9</td>
</tr>
</tbody>
</table>

**Select Two:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-122 Introduction to Accounting</td>
<td>9</td>
</tr>
<tr>
<td>70-371 Production/Operations Management</td>
<td>9</td>
</tr>
<tr>
<td>70-391 Finance</td>
<td>9</td>
</tr>
<tr>
<td>70-342 Managing Across Cultures</td>
<td>9</td>
</tr>
<tr>
<td>70-430 International Management</td>
<td>9</td>
</tr>
<tr>
<td>70-436 Corporate Social Responsibility</td>
<td>9</td>
</tr>
<tr>
<td>70-451 Management Information Systems</td>
<td>9</td>
</tr>
<tr>
<td>70-480 International Marketing</td>
<td>9</td>
</tr>
<tr>
<td>70-481 Market Research</td>
<td>9</td>
</tr>
<tr>
<td>70-483 Advertising and Marketing Communications</td>
<td>9</td>
</tr>
<tr>
<td>70-484 Direct Marketing</td>
<td>9</td>
</tr>
</tbody>
</table>

\(^7\) Students seeking an additional major in BA may not substitute 70-440 for 70-401.

---

\(^6\) 70-100 and 79-104 can switch semesters, but cannot be taken together.

\(^7\) or 21-292 Operations Research offered in spring semesters only.

---

**Total units required:** 364
Minor in Management
(CFA students only)

Required Courses
70-311 Organizational Behavior
70-381 Marketing
73-100 Principles of Economics

Select 3:
70-342 Managing Across Cultures
70-430 International Management
70-436 Corporate Social Responsibility
70-480 International Marketing
70-481 Market Research
70-483 Marketing Communications
70-484 Direct Marketing

Minor in Supply Chain Management
(CIT Students Only)

This minor is offered to CIT students by the Tepper School of Business. The minor consists of business courses that are quantitative in nature and oriented to manufacturing and operations, making them well suited for engineering students. Given the increased interest by many companies in optimization, logistics and supply chain management, engineering students may find this minor to be an attractive option.

Select One:
21-257 Models and Methods for Optimization
21-292 Operations Research I

Required:
70-371 Production/Operations Management
70-471 Logistics and Supply Chain Management

Select One:
70-122 Introduction to Accounting
70-391 Finance
70-460 Mathematical Models for Consulting
70-474 Quality Principles and Techniques

*Please note that some courses require a statistics prerequisite

Business Administration Breadth Course Categories

[Note: one course required in each category; two additional courses also required in any category]

World History (one course required):
79-104 Introduction to World History

Writing/Expression (one course required):
76-101 Interpretation and Argument

Science and Technology (one course required):
(check catalog for pre- and co-requisites)
03-121 Modern Biology
03-122 Organismic Botany
03-124 Modern Biology Laboratory
03-125 Evolution and the History of Life
03-130 Biology of Organisms
03-240 Cell Biology
06-100 Introduction to Chemical Engineering
09-103 Atoms, Molecules and Chemical Change (non-major)
09-104 Fundamental Aspects of Organic Chemistry and Biochemistry (non-major)
09-105 Introduction to Modern Chemistry
09-106 Modern Chemistry II
12-100 Introduction to Civil and Environmental Engineering
15-211 Fundamental Structures of Computer Science I (prerequisites: 15-127, 21-127)
15-212 Fundamental Structures of Computer Science II

(prerequisite: 15-211)
18-100 Introduction to Electrical and Computer Engineering
19-101 Introduction to Engineering and Public Policy
24-101 Fundamentals of Mechanical Engineering
27-100 Materials in Engineering
33-102 Concepts of Modern Physics
33-xxx Physics I for Engineering Students
33-xxx Physics II for Engineering Students
33-xxx Physics I for Science Students
33-xxx Physics II for Science Students
33-114 Physics of Musical Sound
33-115 Energy and Environmental Issues (non-major)
33-124 Introduction to Astronomy

Cognition, Choice and Behavior (one course required):
80-110 Nature of Mathematical Reasoning
80-150 The Nature of Reason
80-180 The Nature of Language
80-181 Language and Thought
80-242 Conflict and Dispute Resolution
80-305 Rational Choice
85-102 Introduction to Intelligence in Humans, Animals, and Machines
85-211 Cognitive Psychology
85-213 Human Information Processing and Artificial Intelligence
85-219 Biological Foundation of Behavior
85-221 Child Development
85-241 Social Psychology
85-251 Personality
85-261 Abnormal Psychology
88-120 Reason, Passion, and Social Cognition

Political and Social Institutions (one course required):
36-203 Sampling, Surveys, and Society (prerequisite: 36-202 or 70-208)
79-231 American Foreign Policy: 1945 to Present
79-333 History of Biomedical Research
79-335 Drug use and Drug Policy
79-350 Theories of International Relations
79-365 Policy and Environmental Protection
80-135 Introduction to Political Philosophy
80-136 Ethics and Public Policy
88-104 Decision Processes in American Political Institutions
88-205 Comparative Politics
88-314 Politics Through Film
88-319 Vietnam: America's Lost War
88-324 Electoral Systems and Processes
88-326 International Relations
88-330 Political Economy of Inequality and Redistribution
88-345 The Rise of the Industrial Research and Development Complex

Creative Production and Reflection
(One Course Required)

(Some of the courses in this category are offered for fewer than 9 units. Students must take a minimum of 9 units to fulfill the requirement in this category. BA students are encouraged to select language courses to meet this requirement.)

48-095 Architecture for Non-Majors
51-261/262 Communications Design Fundamentals
51-263 Industrial Design Fundamentals
54-187/188 Introduction to Playwriting (6 units)
57-117 Choral Ensemble for Non-majors (6 units; audition required)
57-118 Instrumental Ensemble for Non-majors (6 units; audition required)
62-102/103 Modern Dance Workshop (6 units)
62-161/162 Photography, Video and Filmmaking
62-248 Music in American Society
70-240 Business Acting (same as 54-191/192 Acting for Non-Majors)
76-206 The Craft of Creative Writing
76-211 Books You Should Have Read by Now
76-245 Shakespeare: Histories and Tragedies
80-120 Reflections on Science
80-130 Introduction to Ethics
80-211 Arguments and Inquiry
80-241 Professional Ethics
80-242 Conflict and Dispute Resolution
80-243 Business Ethics
Cultural Analysis (one course required):
(check catalog for prerequisites)

76-201 Literature and the Social
76-227 Comedy
76-230 19th Century American Literature and Culture
79-113 Culture and Identity in American Social Life
79-201 Introduction to Anthropology
79-203 Introduction to Social History
79-204 Twentieth Century America
79-205 Twentieth Century Europe: Collapse and Renewal
79-206 Development of American Culture
79-207 Development of European Culture
79-216 Music and Counter Culture in the 1950s/1960s
79-218 The Roots of Rock and Roll
79-219 The Holocaust in Historical Perspective
79-220 Early Christianity
79-223 Protest and Dissent in American History
79-225 Religions of Asia
79-228 The American Built Environment, Part I: 1000-1800
79-230 Technology in American Society
79-232 Vietnam: America’s Lost War
79-241 African-American History I
79-242 African-American History II
79-250 Europe’s Two Revolutions
79-253 The Caribbean: History and Culture
79-255 Irish History
79-259 Native American History: 19th and 20th Centuries
79-260 Mayan America
79-270 Chinese Culture and Society
79-271 Modern China
79-290 Modern Latin America
79-301 Ritual Performance and Time
79-302 The Arts in Society: French Modernism
79-307 The Anthropology of Europe
79-325 Arts and Religion
79-326 Other People’s Lives: Biography, Autobiography, Microhistory
79-329 Sex, Population, Birth Control
79-331 Crime and Punishment in American History
79-340 History of Modern Warfare
79-345 American Environmental History
79-348 Gifts, Commodities, and Money
79-352 The Arab-Israeli Condition: War and Peace
79-356 African History: Earliest Times to the Origins of the Slave Trade
79-370 Gender and Science
79-374 Women in Modern India
79-375 Children and Childhood in America
79-379 Women in American History
79-392 The Family
79-395 The Arts in Pittsburgh
79-397 Religion and Politics in the Middle East
80-100 What Philosophy Is
80-151 God in the West
80-180 The Nature of Language
80-181 Language and Thought
82-4xx (Any 400-level Modern Language course)

Business Administration Policies

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.

Transferring to Business Administration From Other Colleges at Carnegie Mellon
Undergraduate students wishing to transfer into Business Administration will be considered for transfer on a space available/academic performance basis. Business Administration may refuse a transfer student’s application if there are space restrictions and/or if the student’s chance for success is determined to be questionable based on past academic performance. First year students will not be considered for transfer until spring mid-semester grades are posted. Transfer applications can be found online at the Undergraduate Business Administration website.

From other Universities
Transfer students from other universities are not accepted into the Undergraduate Business Administration program.

Non-Carnegie Mellon Courses
A student enrolled as a primary Business Administration major may take a maximum of three courses elsewhere and transfer the credit toward their Carnegie Mellon degree. Students must have these courses approved by the Business Administration office prior to taking the course. Credit (but not the grade) will transfer for courses with a grade of B or higher. Students may not receive credit for college courses taken prior to enrolling at Carnegie Mellon. Students completing a minor in business may receive transfer credit for one course at another university. Students completing an additional major in business may receive transfer credit for two courses at another university. No online courses 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 a Business Administration advisor at least once each semester to ensure that they are making normal progress towards their degree. It is the individual student’s responsibility to make sure that he or she fulfills the requirements for graduation.

The College Honors Program
Business students with outstanding academic records (a minimum overall QPA of 3.75) may undertake an Honors Thesis. Please see course description for 70-500.

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.
Undergraduate Economics Program

Dennis Epple, Program Head
http://www.tepper.cmu.edu/undergraduatecon/home

In our fast changing world, economists analyze and develop useful solutions to a wide range of important and interesting problems. They are active participants in the processes and institutions through which society addresses matters of current interest. Economists help political bodies, businesses and other organizations make better decisions through the development of market strategies, the implementation of regulatory structures, and the adoption of appropriate government policies. Increasingly, economists are taking advantage of new technologies, enabling them to directly design and implement new and emerging markets.

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 the their full support and services. Through this unique arrangement, our students benefit from the best of the liberal arts and professional approaches to education.

Degree Options

In order to accommodate students' wide variety of goals, three degree options are available: Bachelor of Arts in Economics, Bachelor of Science in Economics, and Bachelor of Science in Quantitative Economics. All three have been designed to provide students with a solid understanding of the central ideas of economics, while maintaining the flexibility necessary to meet the needs of a diversity of career paths. Graduates of the 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, finance, and related fields. For students who are majors in other departments, the program offers both a second major and a minor in economics.

Concentrations

Economics majors may elect to do a concentration in a particular area of economics. A concentration consists of a menu of courses from which the student is required to complete a minimum number (typically three or four). Of these courses, at most two can be used toward other major requirements. Since the particular courses may vary, students should contact the Undergraduate Economics Program for an up-to-date list of concentrations and their associated course lists. Presently, the Program offers the following concentrations:

- Innovative Markets and Technology
- Economics and Strategy
- Economics of Financial Markets
- Economics of Social Issues
- Economics in the Global Marketplace

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 a B.S. in Economics (including the H&SS general education requirements). 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 more. Interested students should meet with an economics advisor.

Honors Programs

Outstanding students are eligible for the honors programs in both the Tepper School of Business and the College of Humanities and Social Sciences. Invited students demonstrate and further develop their skills in economic analysis and research through the completion of a senior honors thesis. The students present their work at Carnegie Mellon's annual undergraduate research symposium Meeting of the Minds and graduate with "College Honors". Students may contact the individual colleges for eligibility requirements.

Accelerated Master's Degree Programs

These programs enable exceptional students to earn both an undergraduate degree and a masters degree by remaining one additional year at Carnegie Mellon. The Tepper School offers qualified students two accelerated professional degree options – one culminating in a Master of Science in Quantitative Economics, the other in a Master of Business Administration. Interested students should consult with their economics advisor for further information.

Degree Requirements

In addition to completing at least 360 units and the H&SS General Education requirements, recipients of an undergraduate degree in economics must complete courses in mathematics, probability & statistics, writing, economics theory, and economic analysis, as well as a set of advanced electives and other specialized courses. Specific requirements for the B.S., B.A., and B.S.Q.E. degrees are as follows.

B.S. in Economics

Mathematics Prerequisites 29 Units
Complete all of following:
21-120 Differential and Integral Calculus 10
21-122 Integration, Differential Equations, and Approximation 10
21-256 Multivariate Analysis and Approximation 9

Programming Prerequisite 10 Units
15-100 Introductory/Intermediate Programming 10

Probability Requirement 9 Units
Choose one:
73-207 Probability Theory for Economists 9
36-217 Probability Theory and Random Processes 9
36-225 Introduction to Probability and Statistics I 9

Writing Requirement 9 Units
Choose one:
73-270 Professional Writing for Economists 9
76-270 Writing in the Professions 9
76-271 Introduction to Professional and Technical Writing 9

Economic Theory Requirements 30 Units
Complete all of following:
73-150 Microeconomics 9
73-200 Macroeconomics 9
73-252 Advanced Microeconomic Theory 6
73-253 Advanced Macroeconomic Theory 6

Economic Analysis Requirements 18 Units
Complete all of following:
73-226 Quantitative Economic Analysis 9
73-261 Econometrics 9

Advanced Economics Electives 45 Units

Students must take five advanced elective courses, at least two of which have 73-252 or 73-253 as a prerequisite. 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 Project 9 Units
73-497 Senior Project 9

B.A. in Economics

Mathematics Prerequisites 19 Units
Complete all of following:
21-120 Differential and Integral Calculus 10
21-256 Multivariate Analysis and Approximation 9

Probability Requirement 9 Units
73-207 Probability Theory for Economists 9

Writing Requirement 9 Units
Choose one:
73-270 Professional Writing for Economists 9
76-270 Writing in the Professions 9
76-271 Introduction to Professional and Technical Writing 9

Economic Theory Requirements 27 Units
Complete all of following:
73-100 Principles of Economics 9
73-150 Microeconomics 9
73-200 Macroeconomics 9

Economic Analysis Requirements 18 Units
Complete all of following:
73-226 Quantitative Economic Analysis 9
36-303 Sampling, Survey, and Society 9

Economic History Requirement 9 Units
73-310 History of Economic Issues and Analysis 9

Advanced Economics Electives 36 Units
Students must take four advanced elective course. 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 list of courses designated as special electives is maintained and revised from time to time by the Undergraduate Economics Program.

B.S. in Quantitative Economics

Mathematics Prerequisites 29 Units
21-131 Analysis I 10
21-132 Analysis II 10
21-259 Calculus in Three Dimensions 9

Programming Prerequisite 10 Units
15-100 Introductory/Intermediate Programming 10

Probability Requirement 9 Units
21-325 Probability 9

Writing Requirement 9 Units
Choose one:
73-270 Professional Writing for Economists 9
76-270 Writing in the Professions 9
76-271 Introduction to Professional and Technical Writing 9

Economic Theory Requirements 30 Units
Complete all of following:
73-150 Microeconomics 9
73-200 Macroeconomics 9
73-252 Advanced Microeconomic Theory 6
73-253 Advanced Macroeconomic Theory 6

Economic Analysis Requirements 27 Units
Complete all of following:
73-226 Quantitative Economic Analysis 9
73-261 Econometrics 9
73-426 Advanced Quantitative Economic Analysis 9

Advanced Economics Electives 36 Units
Students must take four advanced elective course, at least three of which have 73-252 or 73-253 as a prerequisite. Advanced elective courses are those numbered 73-300 through 73-495.

Special Electives 18 Units
Students must take two special elective courses in mathematics. The list of courses designated as special electives is maintained and revised from time to time by the Undergraduate Economics Program.

Senior Project 9 Units
73-497 Senior Project 9

Sample Course Schedules

What follows 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. Course descriptions, prerequisites, and corequisites can be found at the back of this catalog.

Sample Schedule for B.S. in Economics

First Year

Fall 49 Units
21-120 Differential and Integral Calculus 10
36-201 Statistical Reasoning 9
73-100 Principles of Economics 9
73-101 1st Year Seminar in Economics 9
99-101 Computing Skills Workshop 3
xx-xxx elective 9

Spring 46 Units
15-100 Introductory/Intermediate Programming 10
21-256 Multivariate Analysis and Approximation 9
73-150 Microeconomics 9
xx-xxx elective 9
xx-xxx elective 9

* Although not a requirement for the degree, students considering an economics major are encouraged to meet their H&SS Freshman Seminar requirement by taking the 1st Year Seminar in Economics.

Second Year

Fall 46 Units
21-122 Integration, Differential Equations, and Approximation 10
73-200 Macroeconomics 9
73-207 Probability Theory for Economists 9
xx-xxx elective 9
xx-xxx elective 9
### Sample Schedule for B.A. in Economics

#### First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>49 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120</td>
<td>Differential and Integral Calculus</td>
</tr>
<tr>
<td>36-201</td>
<td>Statistical Reasoning</td>
</tr>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
</tr>
<tr>
<td>73-101</td>
<td>1st Year Seminar in Economics</td>
</tr>
<tr>
<td>99-101</td>
<td>Computing Skills Workshop</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>46 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-100</td>
<td>Introductory/Intermediate Programming</td>
</tr>
<tr>
<td>21-255</td>
<td>Multivariate Analysis and Approximation</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
</tbody>
</table>

* Although not a requirement for the degree, students considering an economics major are encouraged to meet their H&S Freshman Seminar requirement by taking the 1st Year Seminar in Economics.

#### Second Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>45 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-200</td>
<td>Macroeconomics</td>
</tr>
<tr>
<td>73-207</td>
<td>Probability Theory for Economists</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>45 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-226</td>
<td>Quantitative Economic Analysis</td>
</tr>
<tr>
<td>73-310</td>
<td>History of Economic Issues and Analysis</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
</tbody>
</table>

#### Third Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>45 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-303</td>
<td>Sampling, Survey, and Society</td>
</tr>
<tr>
<td>73-270</td>
<td>Writing for Economists</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Advanced Economics Elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
</tbody>
</table>

* A semester-long sequence consisting of two mini-courses, 73-252 Advanced Microeconomic Theory and 73-253 Advanced Macroeconomic Theory.

### Sample Schedule for B.S. in Quantitative Economics

#### First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>49 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-100</td>
<td>Introductory/Intermediate Programming</td>
</tr>
<tr>
<td>21-131</td>
<td>Analysis I</td>
</tr>
<tr>
<td>73-100</td>
<td>Principles of Economics</td>
</tr>
<tr>
<td>73-101</td>
<td>1st Year Seminar in Economics</td>
</tr>
<tr>
<td>99-101</td>
<td>Computing Skills Workshop</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>46 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-132</td>
<td>Analysis II</td>
</tr>
<tr>
<td>21-259</td>
<td>Calculus in Three Dimensions</td>
</tr>
<tr>
<td>73-150</td>
<td>Microeconomics</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
</tbody>
</table>

* Although not a requirement for the degree, students considering an economics major are encouraged to meet their H&S Freshman Seminar requirement by taking the 1st Year Seminar in Economics.

#### Second Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>45 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-226</td>
<td>Quantitative Economic Analysis</td>
</tr>
<tr>
<td>73-252/3</td>
<td>Advanced Economic Theory</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring</th>
<th>45 Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-426</td>
<td>Advanced Quantitative Economic Analysis</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Advanced Economics Elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>Special Elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
<tr>
<td>xx-xxx</td>
<td>elective</td>
</tr>
</tbody>
</table>

* A semester-long sequence consisting of two mini-courses, 73-252 Advanced Microeconomic Theory and 73-253 Advanced Macroeconomic Theory.
Fourth Year

Fall 45 Units
73-497 Senior Project 9
xx-xxx Advanced Economics Elective 9
xx-xxx Special Elective 9
xx-xxx elective 9
xx-xxx elective 9

Spring 45 Units
xx-xxx Advanced Economics Elective 9
xx-xxx elective 9
xx-xxx elective 9
xx-xxx elective 9
xx-xxx elective 9

Additional Major in Economics

The requirements for an 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. Interested students should meet with an economics advisor. Concentrations are not available for additional majors.

Minor in Economics

The requirements for a minor in Economics consist of mathematics requirements, a statistics requirement, and six economics courses, as follows:

Mathematics Requirements 19 Units
21-120 Differential and Integral Calculus 10
21-256 Multivariate Analysis and Approximation 9
21-259 Calculus in Three Dimensions 9

Statistics Requirements 18 Units
Choose one:
36-201 Introduction to Statistical Methods 9
36-207 Probability and Statistics for Business Applications 9
36-220 Engineering Statistics and Quality Control 9
or any course from the statistics requirement for B.S. in Economics.

Choose one:
36-208 Regression Analysis 9
36-226 Introduction to Probability and Statistics II 9
73-226 Quantitative Economic Analysis 9
88-250 Regression Methods in the Social Sciences 9

Advanced elective courses are those numbered 73-300 through 73-495.

Faculty

DANIELLE COEN PIRANI, Assistant Professor of Economics — Ph.D., University of Rochester; Carnegie Mellon, 2000—.

W. ROBERT DALTON, Associate Teaching Professor of Economics Emeritus — Ph.D., University of Missouri; Carnegie Mellon, 1985—.

ROBERT M. DAMMON, Professor of Financial Economics — Ph.D., University of Wisconsin; Carnegie Mellon, 1984—.

KENNETH B. DUNN, Dean, Professor of Financial Economics - Ph.D., Purdue University; Carnegie Mellon, 2003—;

DENNIS N. EPPEL, Thomas Lord Professor of Economics; Head, Economics Programs — Ph.D., Princeton University; Carnegie Mellon, 1974—.

MARIA FERRERYA, Assistant Professor of Economics — Ph.D., University of Wisconsin; Carnegie Mellon, 2002—.

CHRISTINA FONG, Research Scientist — Ph.D., University of Massachusetts; Carnegie Mellon, 2001—.

GEORGE-LEVI GAYLE, Assistant Professor of Economics — Ph.D., University of Pittsburgh; Carnegie Mellon, 2003—.

MARTIN GAYNOR, E.J. Barone Professor of Economics and Health Policy - Ph.D., Northwestern University; Carnegie Mellon, 1995—.

RONALD L. GOETTLER, Associate Professor of Economics — Ph.D., Yale University; Carnegie Mellon, 1997—.

LIMOR GOLAN, Assistant Professor of Economics — Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2002—.

CAROL B. GOLDBURG, Assistant Teaching Professor of Economics and Academic Advisor/Student Services Coordinator, Undergraduate Economics Program - Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005—.

MARVIN GOODFRIEND, Professor of Economics and President, Gailliot Center for Public Policy, Ph.D., Brown University; Carnegie Mellon, 2005—.

RICHARD C. GREEN, Richard M. and Margaret S. Cyert Professor of Economics and Management; Chair, Ph.D. Program - Ph.D., University of Wisconsin; Carnegie Mellon, 1982—.

PAUL J. HEALY, Assistant Professor of Economics — Ph.D., California Institute of Technology; Carnegie Mellon, 2005—.

BURTON HOLLIFIELD, Associate 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 Science — Ph.D., Cornell University; Carnegie Mellon, 1980—.

FINN KYDLAND, Professor of Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977—.

LESTER B. LAVE, Harry B. and James H. Higgins Professor of Economics and University Professor; Director, Carnegie Mellon Green Design Initiative; Co-Director, Carnegie Mellon Electricity Industry Center — Ph.D., Harvard University; Carnegie Mellon, 1963—.

ADAM LERRICK, The Friends of Allan H. Meltzer Chair in Economics; Director of The Gailliot Center for Public Policy — Ph.D. Massachusetts Institute of Technology; Carnegie Mellon, 2001—.

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—.

JOHN MILLER, Department Head, Social and Decision Sciences, Professor of Economics — Ph.D., University of Michigan; Carnegie Mellon, 1989—.

ROBERT A. MILLER, Professor of Economics and Strategy — Ph.D., University of Chicago; Carnegie Mellon, 1982—.

JOHN R. O’BRIEN, Associate Professor of Accounting and Experimental Economics — Ph.D., University of Minnesota; Carnegie Mellon, 1984—.

DUANE J. SEPP, Professor of Financial Economics — Ph.D., University of Chicago; Carnegie Mellon, 1986—.

HOLGER SIEG, Professor of Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2001—.

PATRICK SILEO, Associate Teaching Professor of Economics; Director, Undergraduate Economics Program; Director, Master of Science in Quantitative Economics Program— Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000—.
CHRISTOPHER SLEET, Associate Profess of Economics - Ph.D.,
Stanford University; Carnegie Mellon, 2005—.
CHESTER S. SPATT, Mellon Bank Professor of Finance; Director,
Center for Financial Markets (On Assignment AY 2004-2006 -
Chief Economist, Securities and Exchange Commission) — Ph.D.,
University of Pennsylvania; Carnegie Mellon, 1979—.
FALLAW B. SOWELL, Associate Professor of Economics —
Ph.D., Duke University; Carnegie Mellon, 1988—.
STEPHEN E. SPEAR, Professor of Economics — Ph.D., University
of Pennsylvania; Carnegie Mellon, 1982—.
CHRIS I. TELMER, Associate Professor of Financial Economics
— Ph.D., Queen’s University (Canada); Carnegie Mellon, 1992—.
WILLIAM B. VOGT, Assistant Professor of Economics and Public
Policy — Ph.D., Stanford University; Carnegie Mellon, 1996—.
SEVIN YELTEKIN, Assistant Professor of Economics — Ph.D.,
Stanford University; Carnegie Mellon, 2005—.
STANLEY E. ZIN The Richard M. Cyert and Morris H. DeGroot
Professor of Economics and Statistics; Professor of Economics
and Finance, — Ph.D., University of Toronto; Carnegie Mellon,
1988—.
Carnegie Mellon University in Qatar

Students to participate in courses and activities that support University in Qatar curriculum is well defined, there will be compatible with their life goals. Although the Carnegie Mellon students as they develop meaningful educational plans provided the necessary resources for students to make good demand on the main campus.

The campus offers two academic programs, Business Administration and Computer Science. To learn more about them, see their main campus college sections in this 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 both programs in Qatar.

Degree Offerings

Carnegie Mellon in Qatar offers two undergraduate degrees:
- Bachelor’s of Science in Business Administration
- Bachelor’s of Science in Computer Science

Policy Statement

Carnegie Mellon in Qatar complies with common University policies unless otherwise noted. The curriculum requirements for the Business Administration and Computer Science majors are identical to those of the Tepper School of Business and the School of Computer Science. Academic standards and actions apply to both programs.

Additional Activities or Class Sessions

Instructors may not require students to attend a particular event or take part in activities outside the regular scheduled hours of a class. It is possible to have a special event or exercise outside of a course’s regular class hours but attendance must be optional or several times must be available.

In addition, the time required for attending an event, taking part in an activity, or watching a DVD counts toward the time allotted for that course in the unit system. For example, the English course 76-101 Interpretation and Argument is a 9 hour course that has 3 hours of in class contact time a week and should on average require 6 hours of class work (for a total of 9 hours a week). Watching a 2-hour video would count against the 6 hours of expected out of class work.

Examinations

In-semester exams may only occur during regularly scheduled class hours. This means that exams may not run longer than the 50-minute or 80-minute class period for the course and that instructors may not schedule alternative exam times. It is possible to administer an exam that takes longer than scheduled class times if the instructor divides the test into two parts and students take them over different class dates.

The only exception to the in-semester testing policy is for students with identified learning disabilities that cause them to need additional time for tests.

Academic Advising

Academic advising is the process through which Carnegie Mellon provides the necessary resources for students to make good choices. The primary purpose of academic advising is to assist students as they develop meaningful educational plans compatible with their life goals. Although the Carnegie Mellon University in Qatar curriculum is well defined, there will be opportunities, both within and beyond curricular constraints, for students to participate in courses and activities that support their academic and personal development.

While the ultimate responsibility for making decisions about life and educational plans rests with each individual student, an academic advisor assists them by suggesting options and by discussing possible outcomes of the choices they make. Business or computer science students at Carnegie Mellon University in Qatar can expect that their academic advisor will:
- Help them define their academic, career and life goals;
- Help them evaluate progress toward their goals;
- Help them understand curricular requirements, guide them as they select courses, and help them identify other meaningful educational experiences;
- Help them determine whether or not they need assistance with study skills (time management, organizing course information, stress management, etc.), and, if necessary, refer them to institutional and community support services;
- Monitor their progress as they move through the undergraduate program.

Students are required to meet with their advisor at least once each semester to ensure that they are making normal progress towards their degree. It is the individual student’s responsibility to make certain that he or she fulfills the requirements for graduation.

Suggested Course Sequence

What follows are suggested course sequences for the BA and CS curriculums for Qatar campus students. These sequences vary in some cases in the order that students take courses from the suggested sequence on the main campus but meet the same four-year course requirements. Students are strongly encouraged to meet with their advisor to ensure that they are making normal progress towards a degree. They should be careful to observe any prerequisite and co-requisite requirements for each course. These are in the course descriptions found at the back of this catalog.

Business Administration Suggested Course Sequence

The Business Administration suggested course sequence includes placeholders for depth courses for a business track. Students may replace these courses with those of a different approved minor or additional major.

<table>
<thead>
<tr>
<th>Freshman Year</th>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-100 Intro/Inter Programming</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>21-120 Calculus</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>70-100 Introduction to Business</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>70-201 Professional and Service Projects*</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>76-101 Interpretation and Argument</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>79-104 Introduction to World History</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47</strong></td>
<td></td>
</tr>
</tbody>
</table>

* Business majors must complete 70-201, Professional and Service Projects, by the end of the sophomore year. Transfer students must complete the course within two years after entering the BA Department. The course involves career-related and service activities in which the student participates over a period lasting as long as four semesters. Students should not register until the semester in which they expect to complete their activities. This course does not count in determining whether business majors are carrying a full load.
Suggested Computer Science Course Sequence

The Computer Science suggested course sequence includes the courses for the Business Administration minor. Students may replace these courses with those of a different approved minor or additional major.

Freshman Year

<table>
<thead>
<tr>
<th>Fall</th>
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<tbody>
<tr>
<td>15-100 Introductory Programming</td>
<td>9</td>
</tr>
<tr>
<td>15-127 Concepts of Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-127 Differential &amp; Integral Calculus</td>
<td>9</td>
</tr>
<tr>
<td>76-101 Interpretation and Argument</td>
<td>9</td>
</tr>
<tr>
<td>79-104 Introduction to World History</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Humanities and Arts Elective</td>
<td>9</td>
</tr>
</tbody>
</table>

Sophomore Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-200 Advanced Programming</td>
<td>9</td>
</tr>
<tr>
<td>21-127 Concepts of Mathematics</td>
<td>9</td>
</tr>
<tr>
<td>21-256 Multivariate Analysis and Approximation</td>
<td>9</td>
</tr>
<tr>
<td>73-100 Principles of Economics</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Science/Engineering Course</td>
<td>9</td>
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</tbody>
</table>

Junior Year

<table>
<thead>
<tr>
<th>Fall</th>
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</thead>
<tbody>
<tr>
<td>15-211 Fundamental Data Structures/Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>70-122 Introduction to Accounting</td>
<td>9</td>
</tr>
<tr>
<td>36-217 Probability Theory and Random Processes</td>
<td>9</td>
</tr>
<tr>
<td>15-251 Theory Foundation</td>
<td>12</td>
</tr>
<tr>
<td>xx-xxx Humanities and Arts Elective</td>
<td>9</td>
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Senior Year

<table>
<thead>
<tr>
<th>Fall</th>
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</tr>
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<tbody>
<tr>
<td>15-451 Algorithm Design and Analysis</td>
<td>12</td>
</tr>
<tr>
<td>15-xxx Systems Elective</td>
<td>9/12</td>
</tr>
<tr>
<td>70-3xx Finance, Marketing, or Production</td>
<td>9</td>
</tr>
<tr>
<td>xx-xxx Science/Engineering Course</td>
<td>9</td>
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</table>

Minimum number of units required for the degree: 360

Academic Standards and Actions

Academic standards and actions apply to both programs

Academic Actions

Students carrying either a full-time course load (defined as 36 or more factorable units) or a part-time course load (defined as fewer than 36 factorable 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 action if they fail to make minimal progress toward their degree. Minimal progress is achieving a semester QPA of at least 2.00 while passing at least 36 units of factorable coursework. Students who begin a semester enrolled in 36 or more units and later drop below 36 units are subject to academic action regardless of their semester QPA. The criteria for first year students are different – they are not subject to academic actions unless they complete fewer than 36 factorable units or 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 QPA above a 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 their semester record suggests that they may do so by the end of the next semester.

Suspension
If a student fails to meet minimal standards 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 make a written request to return to Carnegie Mellon. This request must include transcripts for any courses taken at other colleges or universities during the suspension and letters of reference from any place of employment during that period. If their request is approved it is their responsibility to file a “Return from Leave of Absence Form” with the HUB. 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 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 department 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 down 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 Director of Undergraduate Programs 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 a four-year institution and at least a “B” at a two-year institution. Students must take functional Business Administration, Computer Science, Economics, and Mathematics/Statistics core classes at a four-year institution. Students may not receive credit for more than five non-CMU courses during their undergraduate career. The only exceptions are for students studying abroad or cross registering with other education City schools, they may petition to take up to five additional non-CMU courses.

Transfer Students
Students may transfer between the Business Administration and Computer Science programs or to the Qatar Campus from Carnegie Mellon’s Pittsburgh campus on a space available/academic performance basis. First year students, however, may not apply for transfer until they receive their spring mid-semester grades.

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 with outstanding academic records (a minimum overall QPA of 3.50 at the end of their junior year) 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 should identify a topic and faculty advisor in the spring of their junior year so that they may begin research the following summer. During their senior year, students earn 18 units of credit through independent study and participation in group seminars on research techniques. They then present a summary of their research project at the Undergraduate Research Symposium in May. They graduate with “College Honors” if the resulting thesis paper is of sufficient quality to meet the approval of a faculty committee.

Graduation Requirements
In order to graduate with a Bachelor of Science in Business Administration or Computer Science, students must meet all requirements specified for that program with a cumulative quality point average of at least 2.00 for all courses taken 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 Associate Dean.
All courses listed in this catalog are expected to be offered in the next two years.
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, officer 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
AS200 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, officer professionalism, military customs and courtesies, Air Force, 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:  0 units
The AS100 and AS200 Leadership Laboratory courses (LLABs) also 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:  0 units
The AS100 and AS200 Leadership Laboratory courses (LLABs) also 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:  0 units
The AS100 and AS200 Leadership Laboratory courses (LLABs) also 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:  0 units
The AS100 and AS200 Leadership Laboratory courses (LLABs) also 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.
Architectural Drawing I: A Tactile Foundation
Fall: 9 units
Prerequisites: 48-120
This 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 the course, but the course is supported by materials created by the instructor. IDM addresses topics such as digital drafting, construction drawings, advanced 3D modeling and HTML programming.

Prerequisites: 48120

Architectural Drawing II: A Tactile Foundation
Fall: 6 units
This course is the continuation of IDM. IDM2 introduces students to measured drafting and the process of creating a construction drawing set. The course will focus on a critical examination of a structure and its relationship to its surroundings.

Prerequisites: 48100

Architectural Drawing II: Understanding Appearance
Spring: 9 units
Prerequisites: 48120
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. This course covers units on free, falling, and current issues affecting architectural professionalism. Within this structure, continued emphasis is given to refining communication skills. A mandatory Leadership Laboratory component is a part of this course, providing an opportunity for the students to practice leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

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. This course covers units on free, falling, and current issues affecting architectural professionalism. Within this structure, continued emphasis is given to refining communication skills. A mandatory Leadership Laboratory component is a part of this course, providing an opportunity for the students to practice leadership experiences, giving students the opportunity to apply the leadership and management principles of this course.

Prerequisites: 21114 or 21120

Architectural Drawing II: Appearance
Spring: 9 units
Prerequisites: 48100
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 the course, but the course is supported by materials created by the instructor. IDM addresses topics such as digital drafting, construction drawings, advanced 3D modeling and HTML programming.

Prerequisites: 48120

Architectural Drawing II: Understanding Appearance
Spring: 9 units
Prerequisites: 48100
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 the course, but the course is supported by materials created by the instructor. IDM addresses topics such as digital drafting, construction drawings, advanced 3D modeling and HTML programming.

Prerequisites: 48120
48-137 Architecture Design Studio: Materials
Spring: 6 units
Architectural Design II: Understanding Appearance aims at building students' understanding of projective geometry, understanding of the appearance of architecture and the architectural design process. We will explore the artistic, conceptual, poetic, creative, and experiential aspects of architectural design. The course covers the portion of engineering mechanics that deals with equilibrium of rigid bodies. Taught by the School of Architecture, the course is very similar to statics courses offered by engineering colleges, but it is modified to place heavier emphasis on those topics pertinent to architecture, specifically: columns, cables, beams, trusses, frames, and moments of inertia. Textbook sections addressing gears and friction are omitted and machine elements are covered minimally. During the final two weeks, strength of materials and the family of lateral load types (braced frame, shear wall, rigid frame). Geometric structure types (such as cable nets, domes, shells, and air-supported structures) are introduced but are not given comparable in-depth treatment. There is an overall emphasis on free-hand and constructed linear perspective, Part 2 on shade, and shadow construction and chiaroscuro drawing, and Part 3 on pastel color drawing. Topics are introduced through lecture demonstrations and in-class exercises with subsequent application to studio assignments with 48-105.
Prerequisites: 48130 or 48132

48-200 Architecture Design Studio: Composition
Fall: 18 units
This studio is an introduction to architectural language and composition through the development of drawing techniques. The course introduces the use of free-hand and constructed linear perspective, Part 2 on shade, and shadow construction and chiaroscuro drawing, and Part 3 on pastel color drawing. Topics are introduced through lecture demonstrations and in-class exercises with subsequent application to studio assignments with 48-105.
Prerequisites: 48105

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48-205 Architecture Design Studio: Materials
Spring: 18 units
This studio is an introduction to architectural language and composition through the development of drawing techniques. The course introduces the use of free-hand and constructed linear perspective, Part 2 on shade, and shadow construction and chiaroscuro drawing, and Part 3 on pastel color drawing. Topics are introduced through lecture demonstrations and in-class exercises with subsequent application to studio assignments with 48-105.
Prerequisites: 48105 and 48210 Corequisites: 48-215

48-210 Statics
Fall: 9 units
Statics is a required course taught in the second year. Its prerequisites are calculus and physics. Statics is a prerequisite for structural design. The course covers the portion of engineering mechanics that deals with equilibrium of rigid bodies. Taught by the School of Architecture, the course is very similar to statics courses offered by engineering colleges, but it is modified to place heavier emphasis on those topics pertinent to architecture, specifically: columns, cables, beams, trusses, frames, and moments of inertia. Textbook sections addressing gears and friction are omitted and machine elements are covered minimally. During the final two weeks, strength of materials (stress and displacement) is covered briefly as an introduction to structural design.
Prerequisites: (21114 or 21120) AND (48115 or 33106)

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 technical and aesthetic knowledge related to the meaning and usage of materials and the act 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 systems, while the studio provides a simultaneous setting for the application and synthesis of this knowledge. The materials science content of the course examines the technical and aesthetic knowledge related to the meaning and usage of building materials with regard to their process of manufacture, their physical properties, their environmental performance and their methods of selection and specification. The architectural content of the course is related to the selection, design, preliminary sizing and methodology of construction systems in wood, masonry, steel, sitecast concrete and precast concrete, including the applicable fundamentals of enclosure systems.
Prerequisites: 12235 or 48210

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, spatial synthesis of structural systems, exploration of structural types, interaction with other building functions, and an introduction of codes and standards in actual design practice. The syllabus is broader than found in any existing text, but is supported by one required textbook and numerous additional sources including handouts prepared by the instructor. The overall objective of gaining insight into architectural forms associated with structural system design. More specific technical objectives include the command of structural analysis and structural member design as required in practice and as established in governing codes and standards; topics in member design include wood joists, beams, and columns; steel joists, beams, and columns; and reinforced concrete beams. Emphasis is placed on continuity with foundations established in Statics.
Prerequisites: 12207 or 48210

48-230 Architectural Drawing III: Perspective
Fall: 9 units
Architectural Drawing III: Perspective emphasizes free-hand perspective skill and its use as a design tool. Following a brief review of perspective construction from orthographic views at the outset, the course addresses perspective on the basis of three distinct understandings of perceptual psychology. In sequence, these three are: 1) A Kinesthetic Basis for Perspective: This work is built on the drawing pedagogy of Kimon Nicholaides. It aligns with the transactionalist understanding of perception, and it considers perspective as partly invented and partly discovered truth. 2) The Order of Appearance: This work 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: This work aligns implicitly with the position of Gestalt psychology. It treats perspective as an imposed schema. Each of these three sequences is introduced in lecture and developed through in-class exercises.
Prerequisites: 48105 or 48135

48-232 Architectural Drawing III: Perspective (for Drama students)
Fall: 6 units
Architectural Drawing III: Perspective emphasizes free-hand perspective skill and its use as a design tool. Following a brief review of perspective construction from orthographic views at the outset, the course addresses perspective on the basis of three distinct understandings of perceptual psychology. In sequence, these three are: 1) A Kinesthetic Basis for Perspective: This work is built on the drawing pedagogy of Kimon Nicholaides. It aligns with the transactionalist understanding of perception, and it considers perspective as partly invented and partly discovered truth. 2) The Order of Appearance: This work 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: This work aligns implicitly with the position of Gestalt psychology. It treats perspective as an imposed schema. Each of these three sequences is introduced in lecture and developed through in-class exercises.
Prerequisites: 48135 and 48137
relates to other types of architectural writing such as criticism and history, and especially how (if at all) it relates to the intellectual context and built works of its day, as well as to theories that came before and after it. We explore a wide variety of theoretical works, from treatises and building manuals to manifestoes and theatrical pieces. Students are encouraged to discern trends, cycles, and differences across time and in various geographic areas. We discuss the ways in which the architect uses theory to present ideas and context, with students often surprised at how relevant older ideas are to the present if read closely and interpreted appropriately.

Prerequisites: 48240

48-343 American Built Environment Since 1860
Intermittent: 9 units
This course examines the history of the American built environment from approximately 1860 to 1980. It can be used to satisfy one of the required courses in architectural history. The term "built environment" encompasses a wide range of human building on the landscape. It includes not only the construction of individual buildings, but also the fashioning of rural, urban, and suburban landscapes, and the infrastructure that links them. The American built environment can be interpreted as a series of architectural responses to perceived aesthetic, social, and planning problems. The resulting manmade landscapes are therefore not only seemingly objective artifacts of "what happened" but also subjective arguments about "what should have happened". In this course we will examine significant movements in the evolution of the American built environment from the late 19th through the late 20th centuries, paying particular attention to issues of the factors of class, gender, and race. Throughout the course we will seek to understand the perennial question of "what were they thinking?"

Prerequisites: 48240

48-344 Architecture of Henry Hornbostel
Intermittent: 9 units
This course addresses the architectural career of Henry Hornbostel (1867-1961) from the beginning of his architectural education at Columbia University in the late 1880s though his retirement from the profession in 1939 until the reevaluation of 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 elements of Modernism and Art Deco. Throughout his career, Hornbostel was consistently innovative, eclectic and not necessarily easy to classify, even though such labels like "Beaux-Arts" or "Modernist" offer us a convenient 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 displayed national and international Modernist and Art Deco. Throughout 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. Modernity and Postmodernism simply forgot. There is only a single monograph on Hornbostel and a comparatively small bibliography of recent publications. The exciting counterbalance to this relatively 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: 48240

48-348 History of Central American Architecture
Intermittent: 9 units
This course is a chronological and thematic survey of architectural and urban developments in the Central and South America from Pre-Columbian times through the 20th century. It can be used to satisfy one of the required courses in architectural history. When the Spanish conquistadors Hernan Cortes and Francisco Pizarro invaded the Americas during the early 16th century, they encountered two of the world's largest and most spectacular empires. The Aztec and Inca empires, however, were only the latest in a series of urban civilizations in a Mesoamerican tradition that stretched back approximately 1,500 years. The ensuing European architectural and urban imprints can be seen as both a victory of colonialism's political, social, economic, aesthetic, and cultural ideals, and as a fusion of European practices within indigenous conditions and traditions. Centuries later, as 20th-century Latin America grappled with the issues of industrialization, economic swings, and political and social revolutions, its architecture and urbanism again sought to reconcile conflicting visions of national, modern identity. This course surveys the architecture and urbanism of Central and South America from prehistory to the 20th century. The geographical and chronological scope of such a survey is far too vast for one semester so we will be focusing on certain areas and periods of intense building. We will primarily examine Mexico, Guatemala, Peru, and Brazil. The course is roughly divided into three major periods: (1) the Pre-Columbian cultures of the Maya, Aztecs, and Incas, (2) the Spanish and Portuguese colonial imprints of the 16th through the 18th centuries, and (3) the 20th-century search for an appropriate modernism.

Prerequisites: 48240

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 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 will use research methods and the ability to discern a problem, experience in applying their understanding of behavioral settings and the human condition to specific research focus. Students will experience and integrate student-generated research into 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 empirical/empirically inclined, with an emphasis on the material condition. The 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 reevaluation of 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 elements of Modernism and Art Deco. Throughout his career, Hornbostel was consistently innovative, eclectic and not necessarily easy to classify, even though such labels like "Beaux-Arts" or "Modernist" offer us a convenient 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 displayed national and international Modernist and Art Deco. Throughout 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. Modernity and Postmodernism simply forgot. There is only a single monograph on Hornbostel and a comparatively small bibliography of recent publications. The exciting counterbalance to this relatively 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: 48240

48-399 Passport
All Semesters: 1.5 units
Students enrolled in Passport will attend approved extracurricular lectures and workshops organized and sponsored by a variety of educational and cultural institutions throughout the city of Pittsburgh and region. Through first hand observation and participation, the primary intention of Passport is to engage students in contemporary ideas and debates, encourage and support interdisciplinary work and discourse, and to stimulate an active dialogue between a student's academic pursuits and their real world experience. Passport offers the student an opportunity to both further develop their interests in scholarship, research and practice.

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 (not just the client, occupant or architect) to the built environment. At the crux is how an architect develops a methodology to understand the individual or aggregated occupant and assemble decoded 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 interplay of constraints and 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: 48305

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 real world experience. Participating in Passport will strengthen students in contemporary ideas and debates, encourage and promote interdisciplinary work and discourse, and to stimulate an active dialogue between a student's academic pursuits and their real world experience. Passport offers the student an opportunity to both further develop their interests in scholarship, research and practice. 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 (not just the client, occupant or architect) to the built environment. At the crux is how an architect develops a methodology to understand the individual or aggregated occupant and assemble decoded 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 interplay of constraints and 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: 48305
constructability and technical innovation while combined with suitability to the user, studied in the previous semester of Occupancy.
Prerequisites: 48400 and 48412 Corequisites: 48-415

48-410  Environment II: Acoustics and Lighting
Fall: 9 units
This course introduces theoretical foundations and computational methods in architectural acoustics and lighting. Topics in acoustics include: a) review of physiological and psychological acoustics; b) sound absorption and transmission, b) sound transmission between rooms; e) design methods in room and building acoustics; f) fundamentals of vibration control; g) application of computer-aided simulation tools in building and room acoustics. Topics in lighting include: a) review of visual comfort criteria and lighting psychology, b) application of computer-aided simulation tools in lighting design, c) application of computer-aided lighting simulation tools in design, d) lighting engineering and design methods.
Prerequisites: 33106 or 48115

48-412  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 both new buildings along with a look at the various system types and equipment used - past, present, and future. The course parallels the AIA review of the professional license examination, and should become a future study guide for the exam.
Prerequisites: 48105

48-415  Advanced Building Systems
Spring: 9 units
Advanced Building Systems is a required course taught in the first-year seminar to facilitate the transition from the students' previous experience with conceptual thinking into the more rigorous second-year courses emphasizing engineering. This course introduces the concepts of Building Performance, delineating the full range of performance mandates required for today's architecture, including building sustainability. Advanced Building Systems highlights the state-of-the-art and major challenges and innovations in building technologies for structure, enclosure, mechanical, telecommunications, lighting, and energy systems. Through the study of sustainable design, relationships, opportunities, and conflicts of the performance mandates, and the integration of building systems necessary to achieve total building performance.
Prerequisites: 48305

48-440  The American Built Environment to 1860
Intermittent: 9 units
This course examines the history of the American built environment from approximately 1000 through 1860, examining various architectural, social, and cultural changes that occurred during this time period. The course utilizes a variety of sources, including buildings and structures from this period, as well as written records and oral histories to understand the development of American architecture. The course includes an analysis of how architecture reflects broader social, cultural, and economic trends in America.
Prerequisites: 48240

48-441  Frank Lloyd Wright
Intermittent: 9 units
Frank Lloyd Wright and Modern Architecture is an architectural history course that develops from a Spring 1999 seminar and project course titled "Frank Lloyd Wright and his Taliesin Legacy." The present course investigates the career and legacy of the famous American architect Frank Lloyd Wright within the context of modern architecture. We attempt to understand the great variety of work and ideas produced by Wright over the past 50 years, 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 his ideas; 4) the work of Richardson and Sullivan, the Shingle Style and International Style, Japanese and European modern architecture; 4) investigations of Wright's prose and poetry, 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 his 1200 disciples he trained through his Taliesin Fellowship.
Prerequisites: 48240

48-442  Asian Architecture
Intermittent: 9 units
Asian Architecture is an elective open to Architecture students. The course introduces fundamental forms of Asian architecture in India, China, Japan, and the Islamic nations, and examines the cross-cultural influence among these countries and others in Southeast Asia. Primary focus is on the architectural history of these regions as well as the plan and design and use of public space within the respective traditions. Overall, the course follows a chronological and geographic format. Course materials are divided into three periods: pre-modern, modern, and post-modern architecture. This course is meant to be a survey followed by successor courses such as Chinese Architecture and Japanese Architecture. In-class lectures elaborate on a wide selection of seminal readings by key authors on respective topics. A class field-trip to a local Hindu temple gives students a live experience of Indian religious architecture.
Prerequisites: 48240

48-445  The City in History
Intermittent: 9 units
This course is a chronological and thematic survey of major developments in urban design in the European and American context since the Middle Ages. This seminar can be used to satisfy one of the core required courses in architectural history. Cities are manmade artifacts, created for a purpose. Students examine the history of the design and redesign of cities and the reasons for those interventions. The changes for the past few thousand years are tremendous, leading to large cities and a variety of urban morphologies. Students explore the relationship between form and function by considering the social, political, economic, and aesthetic forces that have shaped urban spaces in American and European great cities from the Middle Ages through today's New Urbanism.
Prerequisites: 48240

48-446  Renaissance & Baroque Architecture
Intermittent: 9 units
This course examines European architecture from the early fifteenth century to the early eighteenth century: the periods designated by historians as Renaissance, Baroque, and Rococo. These periods are characterized by a series of changing approaches to classical architecture in building, but also remarkable innovations in building technology. This course explores the evolution of architectural styles and the forces behind them. Students will analyze the historical, social, and cultural context of these periods, as well as the artistic and technical innovations that led to the development of new architectural styles.
Prerequisites: 48240

48-447  History and Preservation
Intermittent: 9 units
This course examines the history of the built environment from the late eighteenth century through the modern era. The course covers the development of preservation theory and practice from the late 19th century to the present day, with a focus on the role of architectural history in the preservation of historic buildings and neighborhoods. Students will explore the historical, social, and political factors that have shaped the preservation movement, as well as the methods and techniques used in preserving historic buildings.
Prerequisites: 48240

48-448  History of Sustainable Architecture
Intermittent: 9 units
While the Modern Age has created a view of nature as separate from the built environment, relatively recent advances in theory and practice of environmental design creates a Spring that developed from a Spring 1999 seminar and project course titled "Frank Lloyd Wright and his Taliesin Legacy." The present course investigates the career and legacy of the famous American architect Frank Lloyd Wright within the context of modern architecture. We attempt to understand the great variety of work and ideas produced by Wright over the past 50 years, 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 his ideas; 4) the work of Richardson and Sullivan, the Shingle Style and International Style, Japanese and European modern architecture; 4) investigations of Wright's prose and poetry, 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 his 1200 disciples he trained through his Taliesin Fellowship.
Prerequisites: 48240
ancient Rome, Renaissance Italy, Enlightenment France, nineteenth century Germany, England and Italy, as well as numerous twentieth and twenty-first century examples.

Prerequisites: 48240

48-452  Real Estate Design and Development
Spring: 9 units
This course investigates the feasibility of an architectural project, simultaneously focusing on financial, cost and design considerations. Emphasis is placed on the integration of professional decision-making, project requirements, and client needs through case study project-based examples and guest lectures. The course is divided into four parts. First, students select three potential projects in the Pittsburgh area. Second, an initial feasibility analysis is conducted on each project based on the several criteria, including market, location and site evaluation, conceptual design, cost and rent comparables, and financial analysis. The model is used for further development during the remainder of the semester. Third, computer tools are used to study the strengths and weaknesses of the project, and the design development is carried out in conjunction with construction cost estimation at the unit-cost level of detail and sensitivity analysis of key variables. Finally, students prepare a final feasibility report based on their findings. The report incorporates materials from throughout the semester and contains an executive summary of investment strategy and rationale.

Prerequisites:

48-453  Urban Design
Spring: 9 units
This is a course of 32 illustrated lectures and discussions, with written and graphic assignments. The goal of the course is to introduce students to the concept that every city is a physical language of permanence, with a history of development that is always to make the city felicitous for the people who occupy it and whose culture the city represents. At the core of the course is training students to read and understand the language of the city. Pittsburgh is used as a ‘lab’ to demonstrate that built form, the physical context of the city, not only reveals the city’s cultural roots, but also is a reflection of the city’s cultural influences. The course is divided into four parts. First, students prepare a final feasibility report based on their findings. The report incorporates materials from throughout the semester and contains an executive summary of investment strategy and rationale.

Prerequisites:

48-455  Issues of Practice
Fall: 9 units
Issues of Practice is a required course taught in the fifth year. It consists of three modules: Professionalism, Emerging Professional’s Companion, and Excursions. The Professional module focuses on professional development during the remainder of the semester. Second, an initial feasibility analysis is conducted on each project based on the several criteria, including market, location and site evaluation, conceptual design, cost and rent comparables, and financial analysis. The model is used for further development during the remainder of the semester. Third, computer tools are used to study the strengths and weaknesses of the project, and the design development is carried out in conjunction with construction cost estimation at the unit-cost level of detail and sensitivity analysis of key variables. Finally, students prepare a final feasibility report based on their findings. The report incorporates materials from throughout the semester and contains an executive summary of investment strategy and rationale.

Prerequisites:

48-500  Architecture Design Studio: The Urban Laboratory
Fall: 18 units
The Urban Lab is an outreach program that works in existing urban neighborhoods, and/or in other communities in the Pittsburgh region. Our approach is a bottom up / grass roots effort, where community input is the most important reference for our work. Our final products are reports that contain policies, plans and graphics that capture projected visions for the future for these communities, and step-by-step recommendations for their implementation. There are 380 communities in the Pittsburgh region divided by topography, economics, class, and ethnic and racial differences. This fragmentation and separation has been and is a major regional problem. Such diversity, however, presents opportunities as well as challenges. In this project students will study both the factors that divide communities and the forces that promote connections between them, building upon the experience of the Urban Lab in studying regional issues on the local neighborhood scale.

Prerequisites: 49405

48-505  Studio X
Spring: 18 units
This studio focuses on changing projects presented by fifth year faculty. The goal of the studio is to take a project from a conceptual beginning to a fully explored and detailed conclusion.

Evidence and application of knowledge gained through other studios and courses is required in the design resolution and presentation.

Prerequisites: 48105

48-550  Model Making in Wood: Barns of Western Pennsylvania
Spring: 9 units
In the spring an independent study course is offered for students with higher competency who wish to design and fabricate objects

Prerequisites: 48105

48-551  Ethics and Decision Making in Architecture
Spring: 9 units
Ethical Decision Making in Architecture is a required course in the fifth year. It is a course in the sequence that is identified with the professional aspects of our student’s education, including among others the following courses: Psychology of Habitation, Design Economics, and Issues of Practice. It builds on an understanding of the issues of occupancy, economics and practice which are central to decision making in architecture and provided by the preceding courses. The text for the course is a manuscript by the instructor which is being developed into a manuscript for publication.

48-560  Computer Modeling
Intermittent: 9 units
This course explores the role and significance of advanced visualization of the design process, in doing so, projects from the current state-of-the-art to glimpses of the future. Advanced computer technology will help students to explore new ways of multimedia and virtual reality, through state-of-art modeling, animation, motion dynamics, compositing and video editing software – have provided the impetus to radically improve the human designer's ability to see and understand physical and virtual reality. A range of technical visualization skills together with the conceptual basis make these capabilities meaningful and useful.

Prerequisites:

48-563  Building Virtual Worlds
Fall and Spring: 24 units
Building Virtual Worlds (BVW) is a project course, where interdisciplinary teams build immersive (helmet-based) interactive virtual worlds, as well as a variety of other interactive content, using Entertainment Technology Center (ETC) platforms, such as the Jam-O-Drum, camera-based audience interaction techniques, Sony AIBO robotic dogs, and Quasi the robotic cat. The goal of the course is to teach students how to create immersive worlds using a variety of techniques. Students work in teams, experiencing first hand how the language of spatial and built diversity and tradition play out in the streets.

48-564  Furniture Design & Construction
Fall: 9 units
There are two distinct shop elective courses. The first has previously been offered only in the fall, but now will be offered in the spring as well. It is a structured course for students who wish to further their ability in designing and constructing functional objects by building on the skills they acquired in their first year. The course will extend their experience with basic techniques. General class assignments, exercises and demonstrations will be given.

Prerequisites: 48105

48-565  Model Making in Wood: Barns of Western Pennsylvania
using processes they research on their own. This is an advanced course for students who are already very familiar with basic shop procedures. The student is required to have a clear idea of projects and techniques that he or she wants to explore. A written course plan developed through discussion with director is required. There are regular class times and attendance is required, but the course of study is self-defined.

Prerequisites: 48105

48-568 Advanced AutoCAD and 3D Visualization Fall: 9 units
This class is designed to introduce a person to advanced CAD commands, 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, architectural, interior design integrations will all students to create integrated projects,3D video animations, and realistic renderings. At the conclusion of this course, students will have a new understanding of how their projects are an active part of the planning and design of the future. Prerequisites: 48120

48-569 GIS/CAFM Spring: 9 units
Geographic Information Systems (GIS) is a system of hardware, software, and procedures designed to support the capture, management, input/output, analysis, modeling and display of geospatially referenced data for solving complex planning and management problems. GIS applications use both spatial information (maps and data) and non-spatial studies. 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, accounting, architecture, and the behavioral & engineering sciences. 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. Prerequisites: 48120

48-570 Digital Media Elective Intermittent: 9 units
Digital technology has resided in the profession of architecture for over a decade, but remains primarily a tool for expediency and production. In the mid 90's, animation software developed for Hollywood was co-opted by hungry architecture students, frustrated by archaic software supposedly developed for architects. Just as Zaha Hadid's Hong Kong Peak design was declared unfeasible and "Papier" architecture, the work that had emerged from the students and young architects of this generation has received a similar response. However, recent advances in manufacturing, the steady growth of computing power, and falling software prices have popularized these forms and added to their legitimacy. This class is designed to introduce a person to advanced CAD commands, 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, architectural, interior design integrations will all students to create integrated projects,3D video animations, and realistic renderings. At the conclusion of this course, students will have a new understanding of how their projects are an active part of the planning and design of the future. Prerequisites: 48105 and 48120

48-571 Architectural Project Management Intermittent: 9 units
This is a hands-on management class that focuses on the elements of running a design project and a design firm, including decision making, negotiating a project, team and project structure, and drafting this with learned knowledge of a practice’s mission, staff dynamics and finances. Prerequisites: 48400

48-572 Zero Energy Housing Intermittent: 6 units
This elective will be dedicated to the construction of the 800 square foot, solar-powered Pittsburgh Synergy house to be entered into the Solar Decathlon competition in the Fall of 2005. Students are required to have their own basic equipment - steel-toed work boots, hard hat, safety glasses, tool belt, 20 oz framing hammer, 25 foot tape measure and speed square. Instructor permission required.

48-573 Color Theory Intermittent: 9 units
Color Theory is a course designed to build sensitivity to visual perception and application of color. It will provide an overview of the impact on physiological and psychological functions. The course will also integrate hands on manipulation of color as required by the term. The first half of the term will cover basic spatial and error processes using Josef Alber's Interaction of Color. Collage materials will be utilized to investigate color's flexibility and nuance. Lectures, discussions, and studio workshop will introduce readings and provide hands-on design experience. Prerequisites: 48130

48-574 Mapping Urbanism Intermittent: 9 units
The aim of this course is to provide future architects and urban designers with the critical tools necessary to examine the city as both a representation and a reality in flux. Physical, psychological and social processes and the relationships between them will be thoroughly examined through the juxtaposition of geography, history, sociology, and ideology. Investigations and readings will be processed and distilled into micro and macro readings, challenging the notion of site as a bounded place. The course will be conducted through an interdisciplinary framework and the use of a diverse set of tools. Weekly lectures will introduce students to alternate forms of urban writing and mapping. Students are required to have their own basic equipment - steel-toed work boots, hard hat, safety glasses, tool belt, 20 oz framing hammer, 25 foot tape measure and speed square. Instructor permission required.

48-575 Design/Build: Solar Decathlon Intermittent: Mini Session - 6 units
This elective will be dedicated to the construction of the 800 square foot, solar-powered Pittsburgh Synergy house to be entered into the Solar Decathlon competition in the Fall of 2005. Students are required to have their own basic equipment - steel-toed work boots, hard hat, safety glasses, tool belt, 20 oz framing hammer, 25 foot tape measure and speed square. Instructor permission required.

48-576 Color Theory Intermittent: 9 units
Color Theory is a course designed to build sensitivity to visual perception and application of color. It will provide an overview of the impact on physiological and psychological functions. The course will also integrate hands on manipulation of color as required by the term. The first half of the term will cover basic spatial and error processes using Josef Alber's Interaction of Color. Collage materials will be utilized to investigate color's flexibility and nuance. Lectures, discussions, and studio workshop will introduce readings and provide hands-on design experience. Prerequisites: 48130

48-577 Mapping Urbanism Intermittent: 9 units
The aim of this course is to provide future architects and urban designers with the critical tools necessary to examine the city as both a representation and a reality in flux. Physical, psychological and social processes and the relationships between them will be thoroughly examined through the juxtaposition of geography, history, sociology, and ideology. Investigations and readings will be processed and distilled into micro and macro readings, challenging the notion of site as a bounded place. The course will be conducted through an interdisciplinary framework and the use of a diverse set of tools. Weekly lectures will introduce students to alternate forms of urban writing and mapping. Students are required to have their own basic equipment - steel-toed work boots, hard hat, safety glasses, tool belt, 20 oz framing hammer, 25 foot tape measure and speed square. Instructor permission required.

48-578 Solar Decathlon: Construction Intermittent: 6 units
This elective will be dedicated to the construction of the 800 square foot, solar-powered Pittsburgh Synergy house to be entered into the Solar Decathlon competition in the Fall of 2005. Students are required to have their own basic equipment - steel-toed work boots, hard hat, safety glasses, tool belt, 20 oz framing hammer, 25 foot tape measure and speed square. Instructor permission required.

48-579 Contemporary London Architecture 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

Prerequisites: 48453

48-580 Color Theory Intermittent: 9 units
Color Theory is a course designed to build sensitivity to visual perception and application of color. It will provide an overview of the impact on physiological and psychological functions. The course will also integrate hands on manipulation of color as required by the term. The first half of the term will cover basic spatial and error processes using Josef Alber's Interaction of Color. Collage materials will be utilized to investigate color's flexibility and nuance. Lectures, discussions, and studio workshop will introduce readings and provide hands-on design experience. Prerequisites: 48130

48-581 Mapping Urbanism Intermittent: 9 units
The aim of this course is to provide future architects and urban designers with the critical tools necessary to examine the city as both a representation and a reality in flux. Physical, psychological and social processes and the relationships between them will be thoroughly examined through the juxtaposition of geography, history, sociology, and ideology. Investigations and readings will be processed and distilled into micro and macro readings, challenging the notion of site as a bounded place. The course will be conducted through an interdisciplinary framework and the use of a diverse set of tools. Weekly lectures will introduce students to alternate forms of urban writing and mapping. Students are required to have their own basic equipment - steel-toed work boots, hard hat, safety glasses, tool belt, 20 oz framing hammer, 25 foot tape measure and speed square. Instructor permission required.

Prerequisites: 48453
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 representation 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 urban design 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: 48105

48-583 History and the Literature of the Contemporary Architectural Speech

Intermittent: 9 units

This course will explore some of the history and literature that supports certain terms that have particular currency in today’s architectural vocabulary and debates. This class will explore the use and origins of such terms as New Urbanism, contextualism, postmodernism, sustainability, functionalism, technology, and space. The course will show that our current lexicon has origins in specific authors and texts, but that the current vocabulary applied to such terms do not imply the consensus that users often imagine. Most authors will be Western, dating from the twentieth century, but there will be some from the nineteenth (and a few from the twenty-first). This course is organized as a seminar. Students will be assigned approximately three to six articles or excerpts to read each week, which they are expected to read closely and critically and will present in class. The intention is to engage the readings. All students will be expected to be prepared to participate in discussion each class. In addition to reading assignments, students will write four short papers.

Prerequisites: 48105

48-587 Lighting Design

Intermittent: 9 units

Architectural Lighting Design is an elective course open to undergraduate and graduate students. It presumes no previous knowledge in lighting technology and practice. Students will access inspiration from these ongoing collective movements, but the possibility for various light and related materials they apply this knowledge to designing architectural applications.

Prerequisites: 48105

48-588 Synergistic Form

Intermittent: 9 units

In the spirit of realdisciplinary collaboration embodied in the Bauhaus, Constructivist, Metabolist and Situationist movements, this course will reference these 20th century experimental modernist art collectives. Students will take the roles of concept designers and creative director for an event at an 英文:

TTI’s “Monument to the Third International”, Kyionori Kikutake’s “Marine City”, Constant’s “New Babylon”, Kiesler’s “Endless House”, never constructed in full scale establish virtual worlds that are applications of light and its’ physical properties they apply this knowledge to designing architectural applications.

Prerequisites: 48105

48-593 Portfolios, Presentations, and Publications

Intermittent: 9 units

Under the Influence: Architecture & Art

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 basking in their success and diminished urban design, we will explore why they are applying their discoveries? What can we learn from these artists and their cross disciplinary collaborations? How do the OPEC’s and the OPEC’s begin to cross borders to develop new working methods and strategies that will advance our professional and creative practices? These are some of the questions that the course addresses.

Prerequisites: 48105

48-595 Under the Influence: Architecture & Art

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 basking in their success and diminished urban design, we will explore why they are applying their discoveries? What can we learn from these artists and their cross disciplinary collaborations? How do the OPEC’s and the OPEC’s begin to cross borders to develop new working methods and strategies that will advance our professional and creative practices? These are some of the questions that the course addresses.

Prerequisites: 48105

48-589 Innovative Product Development: Sustainable Design & Integrated Systems

Intermittent: 9 units

The distinctions between architecture, industrial design, and manufacturing are beginning to fade, leading to opportunities to create innovative integrated systems that meet emerging sustainability, technological, and organizational needs. The creation of service cores, stairs, vertical transport, kitchen and copy centers, conference rooms, atrium roofs, even mechanical cores can become manufactured products or product assemblies with superior performance and aesthetic detailing. Moreover, the design of the integrated systems can contribute to enhanced sustainability through material, energy and water conservation, enhanced environmental quality and even energy generation.

In this course, students will identify, design, develop and model new integrated, solutions for external modular service cores that address persistent issues in today’s existing and new construction. After conducting product reviews and field studies, students will develop performance specifications and design variations for componentized integrated systems. If the students take the best designs solutions for modular, plug and play, and sustainable stacking infrastructures into final documentation. The integrated kit-of-parts will be based on specification, visualizations, mock-ups, and inspiring the manufacturing community to market new high performance integrated solutions. This course is intended for upper level undergraduate and graduate students with strong understanding of systems and 3D visualizing capabilities.

Prerequisites: 48315

48-592 Details, Working Drawings and Prototypes

Intermittent: 9 units

Studio courses in the School of Architecture allow students to explore and represent design concepts for buildings that grow in size and complexity over the course of the undergraduate curriculum. Technology courses introduce the fundamentals of structure, construction and management. Students will be expected to provide just that opportunity through the process of the Spring competition. Using the Pittsburgh Synergy competition entry as the platform, we will develop details that address the issues of aesthetics, durability, performance and constructability. As required, we will build full scale mock-ups of the detail to gain better understandings of the relevant issues. Using these details, we can then develop a full set of construction documents, including specifications for the house. The last part of the course will select critical components that can be prototyped at full size for installation in the house during the design/build course in the spring. We will be developing the construction documents to conform with the Uniform Drawing System of the Construction Specifications Institute. Instructor permission required.
48-596 LEED Buildings and Green Design
Intermittent: 9 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 a green building rating system entitled Leadership in Energy and Environmental Design (LEEDTM) in order to define "green building" and establish 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 toward 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 highest rated state in terms of projects. The course will focus on the design and implementation of sustainable building strategies. The course will introduce the LEED rating system, starting with a 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: 48315

48-705 Architecture Design Studio: The Urban Laboratory Fall: 18 units
The fifth year urban design studio takes the optimistic view that the urban role of the architect derives its significance from its relationship with the society at large. The competing and even contradictory pressures of political, economic, and societal interests are viewed as the true source of challenge in architecture. This studio focuses on comprehensive urban design and architectural intervention in Pittsburgh as a laboratory, in light of the rich historical, contextual, economic, and political factors affecting its future. The studio employs a multi-disciplinary team structure to characterize and explore the opportunities for urban rejuvenation and sustainability.

48-711 Paradigms of Research in Architecture Fall: 9 units
This course is both an introduction to important models and methods of academic research particularly as they are related to building design issues and a forum for intellectual curiosity. During the initial ten weeks of the semester, the course presents an overview of the field and covers several models of research as they relate to the building design. These will include models of natural sciences, social sciences, sciences of the artificial, engineering, and aesthetics in building design. During the final five weeks of the semester faculty both CFA and CIT will be invited to make presentations about their areas of research and the methods they use. These presentations correspond in many respects to those covered in lectures.

48-722 Building Performance Modeling Fall: 12 units
This course introduces fundamentals and computational methods in building performance modeling. Topics include: modeling and design, overview of tools, energy modeling, integration of performance simulation in computer-aided design, introduction to the application of advanced computational building simulation tools, case studies and design assignments on the application of simulation in the evaluation and improvement of building performance.

48-725 Building Economics Fall: 9 units
This course investigates the feasibility of an architectural project, focusing on financial, cost, and design considerations. Its primary objective is twofold: to provide students with quantitative skills for analyzing the economic implications of their design decisions and to foster development of a critical perspective in making these decisions. The need for economic analysis to develop concurrently with design is emphasized throughout the course. Topics include site selection, building design, construction cost estimation, and real estate finance.

48-726 Environment II: Audacities and Lighting Fall: 9 units
This course introduces theoretical foundations, computational approaches, and design methods in architectural acoustics (room acoustics, building acoustics, vibration control) and architectural lighting (daylighting, electrical lighting). Topics in acoustics include: a review of physiological and psychological acoustics o prediction of outdoor and indoor airborne sound propagation o sound transmission between rooms o design methods in room and building acoustics o application of computer-aided simulation tools in building and room acoustics Topics in lighting include: o review of visual performance criteria and lighting psychology o analytical and numerical methods for the prediction of lighting conditions in interior spaces o lighting engineering and design methods o application of computer-aided lighting simulation tools in architecture Prerequisites: 33103 and 33106

48-728 Special Topics in BPD Intermittent: 9,12 units

48-729 Productivity, Health and the Quality of Buildings
Intermittent: 9-12 units
Given the growing demand for green buildings by federal and private sector clients, LEED buildings are built all over the world to deliver high performance, environmentally responsive, “green” buildings and communities. However, innovations in green building practices and technologies are still limited by first cost decision- making, and life cycle tools are still largely inaccessible to professionals. A new building investment decision support tool – BIDS™ – has been developed by the NSF/IUCRC Center for Building Performance at Carnegie Mellon University, with the support of the Advanced Building Systems Integration Consortium. This cost-benefit decision support tool presents the substantial cost-benefits of a range of advanced and innovative building systems designed to deliver – privacy and interaction, air quality, ergonomics, lighting control, thermal comfort, flexibility, and access to the natural environment - from field case studies, laboratory studies, simulation studies, and other research efforts. This course will explore the relationship of quality buildings, building systems, and productivity, health, and well-being. The course will engage students in the literature relating building design decisions to ten cost/performance impacts: energy, facilities management, organizational change, technological change, attraction/retention (quality of life) of employees, individual productivity, organizational productivity, safeguarding, waste, tax/income/stimulus/taxation/penalties. The student will then develop a “state-of-the-knowledge” paper in one of these key cost-benefit areas for key building design decisions in a building, system building, type, or land-use choice and profile a research project that could shed light on key cost-benefit areas to enhance national knowledge about the relationship of quality of the built environment to productivity, health, and well-being.

48-746 Graphics User Interface Design
Intermittent: 9 units
Graphics User Interface (GUI) can be critical to the success or failure of a computer system, as a well-designed GUI can free the user from learning complex command languages and allow interacting with the computer system efficiently. Traditionally, building a GUI has not been an easy task for non-professionals. With the mature of programming languages such as Java, it is becoming more common and easier to build a graphics user interface by using some easily accessible tools. This course is an introduction to the design of GUIs, with emphasis on the use of graphics and event driven programming model. The course will cover the programming language aspect, the success of a GUI depends on how it is used, symbols, color, and other static and dynamic graphics. We are planning to offer a course to exploring these issues. We will use Java as the programming language vehicle. The topics include, but not limited to, graphical component, selected user interface design patterns, and interface visual evaluation. Some lecture material will be based on canons/readings in the interface design literature. Your motivation will have to do with user gestalt. For any type of application, the interface affords conformance between user conceptions of the functionality of the interface, and user perception of the model of behaviour as projected by the interface. The course is PROJECT BASED. Every student is expected to complete a working visually appealing interface project by the end of the semester. The project will be a demonstration of ability to bring interface design principles to practice. The development environment is a combination of Flash (or a similar) for storyboarding the interface, and Java for the actual implementation. Both Flash and Java GUI will be taught/covered. PREREQUISITE is the ability to program in Java.

48-755 Spatial Constructions
Intermittent: 0-27 units
The purpose of this course is to enable you to explore spatial constructions from both the theoretical and practical standpoint that may be of use to the world at large. In order to do so, I will briefly introduce you to a variety of construction paradigms that are in any way related to spatial or geometric forms, with a slant towards design or composition. The emphasis, for the most part, will be on the ‘mechanical’ aspects of spatial constructions, and how these different approaches have evolved towards computer implementation. The goal of the course is not merely to provide spatial constructions skills, but, rather, and perhaps more importantly, to open up new areas or problems to research and explore.
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48-756   Object Oriented CAD
Fall:  12 units
This course extends the approach underlying our Microstation-based course Strategic Use of CAD to the task of object-oriented application development in CAD. The motivation is the realization that the switch from procedural application programming to object-oriented ones requires a significant cognitive retouching on the part of developers, who must know more than the syntax and semantics of the new programming language to be used: they have to be able to employ appropriate strategies that are specifically appropriate for the new paradigm. The software platform supporting the course will be IMDL, ProjectBanks and the CustomObjects framework offered by Bentley Systems, which actively supports the course. Goals (a) to introduce and test strategies of object-oriented application development in general and in the context of Microstation (b) to develop - as a course team project - an interesting application that illustrates our findings (c) to document our approach and findings so that others can learn from them. Pre-requisites: Programming experience in at least one programming language.

48-760   Spatial Constructions
Intermittent:  9 units
This course explores the role and significance of advanced visualization, integrated solutions for collaborative workplace environments, the current state-of-the-art to glimpses of the future. Advanced digital technology – in multimedia and virtual reality, through state-of-art modeling, animation, motion dynamics, composting and video editing software – have provided the impetus to radically improve the designer’s ability to see and understand physical reality. A range of technical visualization skills together with conceptual basis make these capabilities meaningful and useful.

48-763   Collaborative Work Environment
Intermittent:  9 units
Workplaces are changing in response to technological and organizational challenges, as well as the globalization of business, engineering, design and manufacturing processes. Interactive multi-media and web-based technologies create the possibility to work within ever changing teams, both locally and globally. This requires that built environments be dynamic and able to respond to changing organizational and evolving technological needs. All these inter-linked issues require a fundamental rethinking of collaborative work environments. Meeting places (MP), are evolving into project places (PP), and service places (SP - such as copy rooms and coffee areas) are evolving into new forms of collaborative work environments. The shifts in individual workspaces (IP) and electronic workspaces (EP) to support collaboration are equally significant. In this course, students will identify, design, develop and mock-up robust, integrative, solutions for collaborative workplace environments. Pre-requisite: Programming experience in at least one programming language.

Art

60-101   Concept Studio I
10 units
"The Self and the Human Being" The first of a sequence of eight 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.

60-102   Concept Studio II
Spring:  10 units
"Space and Time" A continuation of Concept Studio I with a focus on space and time through projects of increasing complexity. Such topics as biological time, historical time, psychological time, celestial time, clock time, and public space, private space, mathematical space, and virtual space are addressed through projects. Open to freshmen in the School of Art, or by instructor permission.

60-104   Contemporary Issues Forum
Fall:  6 units
Introduces students to contemporary issues in the visual arts. Thematic rather than chronological approach. Lecture/discussion format. Requires attendance at the school bi-weekly lecture series. Open to freshmen in the School of Art, or by instructor permission.

60-105   Pre-Industrial Visual Cultures to 1789
Spring:  9 units
An exploration of selected examples from the visual arts. Addresses ancient to pre-industrial times, across global cultures. Contextual issues investigated for both distinctive differences and cross-linkages in human experience and expression. Open to freshmen in the School of Art, or by instructor permission.

60-110   Electronic Media Studio I
Fall:  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
Spring:  10 units
An introduction to three-dimensional form and space. Various materials and methods are explored through projects covering a broad range of sculptural issues. Materials fee charged. Open to freshmen in the School of Art, or by instructor permission.

60-150   2 Media Studio I: Drawing
Spring:  10 units
A continuation of 60-150 2D Media Studio II: Drawing. Includes an expanded exploration of 2D materials, techniques, and processes. Emphasis on drawing as a foundation for various forms of artmaking. Open to freshmen in the School of Art, or by instructor permission.

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.

60-203   Sophomore Honors Project
Spring:  10 units
A non-medium-specific studio course which encourages students to develop independently generated projects. Open to sophomores in the School of Art with a minimum QPA of 3.0.

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 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 ONLY by the instructor permission.

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. Pre-requisites: 60-110, or by instructor permission.
60-230  3-D Media Studio II
Fall:  10 units
An introduction to light metalworking techniques, foundry processes and mixed media construction. A broad range of techniques and processes are introduced through demonstrations and placed into practice through assignments. Students gain a basic understanding of the language and processes of sculpture. Materials fee required. Prerequisite: 60-300. Open to School of Art sophomores, or by instructor permission.
Prerequisites: 60130

60-250  2D Media Studio III: 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 medium. Prerequisites 60150 and 60151, or by instructor permission.

60-251  2D Media Studio IV: Printmaking
Spring:  10 units
An introduction to the three major areas of printmaking: Intaglio, Lithography, and Serigraphy. Provides students with an overview of available techniques and a focus on the printmaking skills needed for the operation of print processes on contemporary art. Prerequisites: 60-150 and 60-151. Open to sophomores in the School of Art, or by instructor permission.

60-301  Art in Context
Fall:  10 units
Students affiliate artmaking with a context outside of the university and within the Pittsburgh community. Students develop a relationship with an organization and artmaking is carried out within the context of that organization. Students take this course for one or two semesters. Open to juniors in the School of Art, or by instructor permission.

60-303  Junior Honors Project
Spring:  10 units
A non-medium-specific studio course which encourages students to develop independently generated projects. Open to juniors in the School of Art with a minimum GPA of 3.0.

60-353  High and Popular Culture in the Arts
Intermittent:  9 units
Explores issues influencing art at the close of this century. Investigates the impact on culture and creative thinking by social, political and technological developments since World War II. Analyzes how the visual slang of mass culture has entered the language of modern art. Priority for art majors.

60-354  Art Aesthetics and Literature
Intermittent:  9 units
Surveys the development of modernist European aesthetics, as expressed in the applied forms of art and literature. Focuses on the parallelisms between visual and literary movements, and on the deviation of these movements from their philosophical counterparts. Discusses aesthetic systems, those arising out of German idealism, Existentialism, Psychoanalysis, and Phenomenology.

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 Doherty Hall, signed by a faculty member and the Assistant Head of the School of Art. Prerequisite: Art junior or senior status, or permission of instructor.

60-401  Senior Project
Fall:  10 units
Students initiate a comprehensive two-semester project in the first semester to be completed in the second semester of their senior year (60-402). Open to seniors in the School of Art, or by instructor permission.

60-415  Advanced ETB: 3-D Animation
Fall and Spring:  10 units
This studio will introduce students to the techniques of 3D computer modeling and animation including techniques for lighting, mapping, and rendering. The class will look at examples of animation emphasizing 3D object animation done with and without the computer. The students will have the opportunity to use techniques of 3D animation as a means of self expression. Prerequisites: 60-110 and 60-210, or by instructor permission.

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 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. Prerequisite: 60-110, 60-210, or by instructor permission. Prerequisites: 60110 and 60210

60-417  Advanced ETB: Video
Intermittent:  10 units
ADVANCED VIDEO -- This course offers an in depth exploration of video as a tool for creative expression. Topics for investigation and discussion will be chosen from the practical aspects of video production, history and social and political purposes that extend beyond and challenge common social purposes that extend beyond and challenge common culture. We will focus on the use of electronic technologies and are interested in exploring creative and interactive application to the field of art. We will also look at relevant historic and contemporary artists who have used video within the context of that organization. Students take this course for one or two semesters. Open to juniors in the School of Art, or by instructor permission.

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 mechatronics 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. Suggested Prerequisites: 60-110 (EMS1) and 60-210 (EMS2). Prerequisites: 60110 and 60210

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 learn how to build experimental electronic devices to be worn on the body for augmenting personal and collaborative experiences in the physical world. Projects may range from collaborative games and techno-chic fashion to self-monitoring art wear. This class is the use of electronic technology for creative, critical and social purposes that extend beyond and challenge common social purposes that extend beyond and challenge common interface devices (e.g. mouse, keyboard, monitor, etc?). The course includes techniques workshops to learn how to program microcontrollers and work with sensors and actuators, and student projects. This class is designed to accommodate students with a broad range of experience working with electronics, from beginners to those who have worked with electronic technologies and are interested in exploring creative and interactive application to the field of art. Undergraduate and graduate students from the School of Art, Human Computer Interaction Institute, School of Design and the Entertainment Technology Center are encouraged to enroll in this class. Please contact the Professor with any questions regarding prerequisites.

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. Pre-requisites: 60130 and 60230, or by instructor permission.

60-431 Advanced SIS: Installation Art (Michelle Iminatore) The Warhol will celebrate its 10th year this February. They have invited 10 contemporary artists to create works that are inspired by Warhol’s art, his artistic practice or his legacy in art and contemporary culture. Students want to see works from Warhol’s alma mater—Carnegie Mellon. Warhol’s diverse practices are narrowed down to five areas: collecting, collaborating, experimenting, reproducing, and documenting. This class will look at collecting from many angles: collecting materials, collecting as a research method, collecting to document time/memory, critiquing the collection, collection display, who collects, and using collection/collaborating as the wood content of the work. This class will have behind-the-scenes access to the installation of the fall Warhol show as well as to other resources of the museum. It will be an interdisciplinary learning about Warhol and other artists who use collecting/collaborations as a means for gathering materials, research or content; and the role of installation works that are inspired by the student’s interest in collecting or collections.

60-432 Advanced SIS: Site-Work
Intermittent: 10 units
Studio focus on work designed for a specific site. Object work, installations, and environmental work are included. Site analysis, environmental work, and social dimensions are addressed. Prerequisite: 60130, or by instructor permission.

60-433 Advanced SIS: Clay
Intermittent: 10 units
60-433 Advanced SIS: Clay (Joe Mannino). Studio focus on ceramic materials and processes as applied to sculptural issues. Fabrication, glazing, and kiln-firing are addressed. Material fee required. Prerequisite 60-130, or by instructor permission. Prerequisites: 60130

60-434 Advanced SIS: Foundry Art
Intermittent: 10 units
60-434 Advanced SIS: Foundry (Ron Bennett). Studio focus on modern metal casting foundry techniques. Objects are created in clay, wax, and plaster and cast into bronze or aluminum. Fabrication and welding techniques are presented. Materials fee required. Prerequisites: 60-230, or by instructor permission.

60-435 SIS: Metals
Intermittent: 10 units
60-435 SIS: Metals. 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, the process of 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 within the environment. Includes object making, installation, and site work with an emphasis on environmental materials, ecological materials, environmental impact and related issues. Students required to explore and develop proposal-making skills in order to implement their ideas in public places. Both individual and collaborative projects are assigned.

60-438 Advanced SIS: Intimate Objects
Intermittent: 10 units
60-438 Advanced SIS: Intimate Objects (Carol Kumata). Explores 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 promote. 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. Sophomore status. Priority to Art majors.

60-449 Advanced PDP: Special Topics
Intermittent: 10 units
60-449 Advanced PDP: Special Topics
Fall and Spring: 10 units

60-450 Advanced PDP: Drawing
Intermittent: 10 units
ADVANCED PDP: DRAWING (Christopher Sperandio)—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. Prerequisites: Drawing I (60150) and Drawing II (60151), or by instructor permission.

60-451 Advanced PDP: Anatomy/Drawing
Intermittent: 10 units
60-451 Advanced PDP: Anatomy/Drawing. 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 nude model, studying the human body and how to capture the likeness of that body. Prerequisite: 60-130.

60-452 Advanced PDP: Painting
Fall and Spring: 10 units
60-452 Advanced PDP: Painting. 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 a 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 and continue to develop our own individual practices to bring our work to fruition. Prerequisite: 60-250, or by instructor permission.

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 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 to the point that the image will be seen as a means of expressing ideas, emotions, and connoting ideas. Prerequisites: 60-150 and 60-160. Material fee required. Prerequisites: 60130

60-456 Advanced PDP: Lithography
Intermittent: 10 units
60-456 Advanced PDP: Lithography. Studio focus on the processes and issues of lithographic printmaking. Includes both traditional stone and aluminum plate processes along with photographic techniques.

60-457 Advanced PDP: Idea Generation
Intermittent: 10 units
60-457 Advanced PDP: Idea Generation. This course will support rapid development within each student’s self-directed body of work. The course will facilitate the development of that body of work by challenging it through a series of exercises designed to alter habits, question assumptions, provoke material and procedural experimentation, multiply avenues of approach, and expand on the conceptual issues inherent in the work. Materials and content will be determined by each student individually (primarily 2-D media but trans-media and crossover experiments will be encouraged). Sophomore status. Priority to Art students.

60-458 Advanced PDP: Serigraphy
Intermittent: 10 units

60-469 Advanced PDP: Special Topics
Intermittent: 10 units
60-469 Advanced PDP: Special Topics
Fall and Spring: 10 units

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60-471 Advanced PDP: Special Topic: MEDIA OF DRAWING — The aim of this course is to explore the definition of Drawing through a variety of traditional and untraditional drawing media. We will examine a variety of methodologies and approaches to drawing both historical and contemporary through slides, videos, readings, and field expeditions. Students will be inspired to invent, experiment and broaden their response to a large range of materials and structures, identify resources and develop a sustained body of work. We will work in-class from the model and observable sources as well as from conceptual frames which include: Time,
Mapping, Collaboration and Systems. All levels of students are welcome. There are no course pre-requisites. NOTE: This course will count as an Advanced PDP Studio for the Art Major (BFA, BHA, BSA). For the Art Minor, it will count as a Foundation or as an Advanced PDP Studio.

60-499 Studio Independent Study All Semesters: 10 units
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 permission of instructor.

60-590 Internship Fall and Spring: 1-9 units
Art Internships are open to all BFA, BHA and BSA Art students. Internships may take place with appropriate individuals or organizations within or outside of Carnegie Mellon University. The requirements for an internship are in the School of Art "Undergraduate Handbook" (available at the School of Art website). Prior to being enrolled for an internship, students must complete an Internship Proposal Form, which defines the goals of the internship. This form must be signed by their site supervisor and approved by the Assistant Head of the School of Art. Forms are available in the bins on the 3rd floor of CFA. Junior and Senior Art majors only.

Biological Sciences

03-050 Study Abroad Fall: 0 units
03-051 Study Abroad Spring: 0 units

03-101 Biological Sciences First Year Seminars Fall and Spring: Mini Session - 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. These topics include: 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.

03-121 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 Spring: 9 units
This course provides an integrated overview of botany at the level of the 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: 03121.

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 03-130. Experimentation using living organisms and/or their tissues, cells or molecules is an essential component of this course. Special permission required. Corequisites: 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 patterns (biological diversity in geological time); foundation theory of evolutionary process; relationships of the major domains/kingsdoms 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 protocistans, 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: 03121.

03-130 Biology of Organisms Spring: 9 units
This course will survey the major organ systems in higher animals and humans, 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 biological systems. Prerequisites: 03121.

03-201 Undergraduate Colloquium for Sophomores Fall: 1-3 units
This purpose of this seminar series is to update biology undergraduates about current and future research directions, 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: 1-3 units

03-210 Independent Study Fall and Spring: Mini Session - 6 units
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. Special permission required.

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: 03121 Corequisites: 09-217.

03-232 Biochemistry II 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 is 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: 09217 Corequisites: 09-106, 06-221.

03-240 Cell Biology Spring: 9 units
This course provides descriptive information and mechanistic details 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: 03121 and (03231 or 03232).

03-301 Undergraduate Colloquium for Juniors Fall: 1-3 units

03-302 Undergraduate Colloquium for Juniors Spring: 1-3 units

03-310 Introduction to Computational Biology Spring: 9 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 03-510, 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, 03-310, 03-311, 03-510 or 03-710.

Prerequisites: (21118 or 21112) AND 03121 AND (99101 or 99102 or 99103)

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 these methods. It is intended for students without computer programming experience. Topics included are accessing Internet molecular biology resources, restriction enzyme analysis, finding protein coding regions (open reading frames), sequence alignment, homology searching, finding sequence features (e.g., promoters), and elementary protein structure prediction. 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, 03-310, 03-311, 03-510 or 03-710.

Prerequisites: 03121 and (99101 or 99102 or 99103)

03-315 Magnetic Resonance Imaging in Neuroscience

Spring: 9 units

This 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, 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: 03121 AND (21117 or 21121 or 21122)

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. Selected methods in molecular biology and their applications in genetic analysis, biotechnology for forensic, agriculture and medicine are presented. The coding capacity, genes and genomes of diverse organisms for which total DNA sequence information is available are discussed. Special topics in human genetics, including mendelian and non-mendelian genetics, cancer, and psychopathology are introduced.

Fundamental concepts in population genetics and evolution are introduced.

Prerequisites: 03231 or 03232

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 concepts of molecular biology principles of each experiment. This course is designed to be taken during the junior year and is intended to prepare students for undergraduate research. Experimental methods and regulation, functions and/or their tissues, cells or molecules is an essential component of this course.

Prerequisites: (03231 or 03232) and 09222 Corequisites: 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 quantification of biological molecules are covered. During several experiments, students design their own projects. Experimental work includes living organisms and/or their tissues, cells or molecules is an essential component of this course.

Prerequisites: (03231 or 03232) and 03343

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, in 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. This course serves as an introduction to the major concepts, experimental methodologies, research questions, and model organisms in developmental biology.

Prerequisites: 03231 or 03232 and 03240 and 03330

03-350 Developmental Biology

Fall: 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 network and 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: 03240

03-360 The Biology of the Brain

Fall: 9 units

The goal of modern neuroscience is to understand the function of the central nervous system using a wide variety of techniques and levels of analysis. This integrative field is actively engaged in addressing questions ranging from the genetics and cell biology of neurons to the perception and behavior of organisms. Topics covered in this course will include the evolution, development and anatomy of the nervous system, the electrophysiology and cell biology of neurons, the function and plasticity of sensory and motor systems and the neuropsychology of brain disorders. This course will emphasize unanswered questions in neuroscience and focus on current experimental attempts to answer them.

Prerequisites: 03121

03-380 Virology

Fall: 9 units

The concepts and methods of virology are covered, with emphasis on animal viruses, within the broad framework of cellular biology, genetics, molecular biology, immunology, pathology, and epidemiology. The strategies that a 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. The effects that viruses inflict on these cells will also be examined, as will some of the host and host cell responses generated by such virus-cell interactions, including interferon induction and oncogenic transformation. In addition, a brief overview of procedures used for prevention and treatment of viral diseases via vaccines and antiviral drugs, respectively, will be presented.

Prerequisites: 03240 Corequisites: 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 and followed by acquired immunity. Both the structure and function of important molecules in the immune system, such as antibodies, major histocompatibility antigens, relevant receptors, complement and cytokines are discussed. Exploration of the development and function of both the humoral and the cellular immune responses conclude this portion of the course. The second half of the course focuses on applied immunology: hypersensitivity, autoimmunity, immunodeficiencies, cancer immunology, infectious disease, vaccines, and transplantation immunology. Student presentations at the end of the course facilitate description of additional topics in contemporary immunology.

Prerequisites: (03231 or 03232) and 03240

03-401 Undergraduate Colloquium for Seniors

Fall: 1-3 units

03-402 Undergraduate Colloquium for Seniors

Spring: 1-3 units

03-410 Independent Study Biological Study

Fall and Spring: 3-9 units
03-411 Topics in Research
Fall and Spring: 1-2 units
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: 1-2 units
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
This course develops the physical concepts that apply to the understanding of biological systems. The forces that play roles in biological systems are discussed and the role of thermal energy is especially emphasized. Topics discussed include protein structure, helix-coil transitions, double layer potentials, membrane structure and transport, Nernst-Planck equations and electrochemical potential, molecular motors, and action potentials and voltage sensitive channels. The capstone of the course is the understanding of the cell's biological and genetic functions. This treatment of biophysical phenomena and methods is based on physical principles, which will be treated with appropriate mathematics when necessary.
Prerequisites: 03121 and 09105 and 33111 and 33112

03-441 The Molecular Biology of Prokaryotes
Spring: 9 units
The course covers an introduction to the basic molecular techniques used in modern biology research. These are discussed against a background of the molecular and genetic analysis of prokaryotic microorganisms with particular attention to certain selected topics. Among the topics covered are: the transcriptional and translational regulation of gene expression at the molecular level in Escherichia coli, the use of prokaryotic replicons in molecular cloning, and the principles of self-assembly and catalyzed assembly of virus particles.
Prerequisites: (03251 or 03252) AND 03330

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, (2) control of gene expression at the level of transcription of mRNA from DNA, splicing of pre-mRNA, and translation of mRNA, and (3) chromosome structure, including origins of replication, centromeres, telomeres, transposons, and regulated chromosomal rearrangements.
Prerequisites: 03-445 Undergraduate Research
Fall and Spring: 1-18 units
Students may investigate research problems under the supervision of members of the faculty. Permission of a faculty advisor required.

03-450 Cellular and Genetic Mechanisms of Development
Spring: 9 units
The development of a single fertilized egg into a complex multicellular organism is an amazing biological phenomenon that we are only beginning to understand. This course will explore our current understanding of the cellular and genetic mechanisms that underlie this fundamental process. Focus will be on experimental approaches taken in model systems (C. elegans, Drosophila, mouse, etc.) to unravel the mysteries of development. Topics to be covered will include, but not limited to, aspects of signaling transduction pathway and their consequences, cell cycle regulation, and molecular control of developmental gene expression as they relate to developmental processes using examples from the primary literature. The course will be lecture based and include student presentations of current topics from the literature.
Prerequisites: 03330 and 03350

03-510 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, 03-310, 03-311, 03-510 or 03-710.
Prerequisites: 03121 AND (15200 or 15211)

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 latest genomic research. Course work includes four to six problem sets, one mid-term and final exam.
Prerequisites: (15211 and 03510) OR 15451

03-512 Computational Methods for Biological Modeling and Simulation
Spring: 9 units
This course covers a variety of computational methods important for modeling and simulation of biological systems. It is intended for all students. Students may substitute with either a biological or computational background 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 parameter tuning. Course work will include problems sets with significant programming components and independent or group final projects.
Prerequisites: 03510

03-513 Bioinformatics Data Integration Practicum
Spring: Mini Session
Spring: Mini Session
This course will provide a practical experience in integration of bioinformatics data of diverse types in collaboration with a pharmaceutical company or biotechnology company. At the beginning of the semester, the students will be presented with an oral description of the problem and data sets. During the semester students will work as part of independent teams to design, implement and evaluate an appropriate data integration system (with the opportunity for interaction with the company developers for advice and feedback). The course grade will be based on an oral presentation of the developed software system and a written report describing its development and evaluation. Selected students will have the opportunity to present their work to the company.
Prerequisites: (03310 or 03311 or 03510) AND 21511

03-534 Biological Imaging and Fluorescence Spectroscopy
Fall: 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; optical 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: (03231 or 03232) and 03240 and 09218 and (09144 or 09124)

03-545 Honors Research
Fall and Spring: 1-9 units
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: 03330

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, dehydration, embedding, sectioning, staining, 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, cryoultramicroscopy, 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.

03-700 MS Thesis Research
All Semesters: 3-36 units
An independent study on a project selected from a major area of research study with the advice and approval of the faculty advisor. Required of students enrolled in the Master of Science program.

03-710 Computational Biology
Spring: 12 units
This course covers a range of applications of computers to solve problems in biology and medicine. Specific topics covered are computational molecular biology (analysis of protein and nucleic acid sequences), statistical 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, 03-310, 03-311, 03-510 or 03-710.
Prerequisites: 03121 and (15200 or 15211)

03-711 Computational Molecular Biology and Genomics
Fall: 12 units
An advanced introduction to computational molecular biology, using an applied algorithms approach. The first part of the course will cover established algorithmic methods, including pairwise sequence alignment and dynamic programming, multiple sequence alignment, fast database search heuristics, hidden Markov models for molecular motifs and phylogeny reconstruction. The second part of the course will explore emerging computational problems driven by the newest genomic research. Course work includes four to six problem sets, one midterm and final exam. A project based on recent results from the genomics literature will be required of students taking 03-711.
Prerequisites: (15211 and 03510) OR 15451

03-712 Computational Methods for Biological Modeling and Simulation
Spring: 12 units
This course covers a variety of computational methods important for modeling and simulation of biological systems. It is intended for graduates and advanced undergraduates with either biological or computational backgrounds who are interested in developing computer models and simulations of biological systems. The course will emphasize practical algorithms and algorithm design methods drawn from various disciplines of computer science and applied mathematics that are useful in biological applications. The general topics covered will be models for optimization problems, model validation and parameter tuning. Course work will include problems sets with significant programming components and independent or group final projects.
Prerequisites: 03510

03-713 Bioinformatics Data Integration Practicum
Spring: Mini Session - 6 units
This course will provide practical experience in integration of bioinformatics data of diverse types in collaboration with a pharmaceutical company or biotechnology company. At the beginning of the semester, students will be presented with a description of the problem and data sets. During the semester students will work as part of independent teams to design, implement and evaluate an appropriate data integration system (with the opportunity for interaction with the company developers for advice and feedback). The course grade will be based on an oral presentation of the developed software system and a written report describing the development and evaluation of the system. Students will have the opportunity to present their work to the company.
Prerequisites: (03310 or 03311 or 03510) AND 15211

03-730 Advanced Genetics
Spring: 12 units
This course considers selected current topics in genetics at an advanced level. The emphasis is on classroom discussion of research papers, supplemented with individual and group exercises. Topics change yearly. Recent topics have included genome imprinting in mammals, chromatin boundaries and long range gene regulation, single in Drosophilia, and the kinetochore complex in yeast. Must obtain a minimum grade of B in 03-330 to take this course.
Prerequisites: 03330 and 03441 AND (03442 or 03742)

03-738 Physical Biochemistry
Fall: 12 units
The physical properties of biological macromolecules and the methods used to analyze their structure and function are discussed. Topics covered include: protein architecture, folding and molecular evolution; nucleic acid structure; introduction to structure determination by X-ray crystallography and NMR; biological spectroscopy with emphasis on the biological applications of absorption, fluorescence, NMR, and CD spectroscopies; the kinetics and thermodynamics of protein-ligand interactions; enzyme catalysis; the use of hydrodynamics, chromatography and electrophoresis in the characterization of biological macromolecules; and analysis of biological molecules at the single molecule level. One weekly session will be devoted to the detailed analysis of related research publications.
Prerequisites: (03231 or 03232) and (09214 or 09345)

03-740 Advanced Biochemistry
Spring: 12 units
This is a special topics course in which selected topics in biochemistry will be analyzed in depth with emphasis on class discussion of papers from the recent research literature. Topics change yearly. Recent topics have included network analysis of catalysis and conformational changes; intrinsically disordered proteins; cooperative interactions of aspartate transcarbamoylase; and the mechanism of ribosomal protein synthesis.
Prerequisites: 03438 or 03738

03-741 Advanced Cell Biology
Spring: 12 units
This course covers fourteen topics in which significant recent advances or controversies have been reported. For each topic there is a background lecture by the instructor, student presentations of the relevant primary research articles and a general class discussion. Example topics are: extracellular matrix control of normal and cancer cell cycles, force generating mechanisms in trans-membrane protein translocation, signal transduction control of cell motility, and a molecular mechanism for membrane fusion.
Prerequisites: (03231 or 03232) and 03240

03-742 Molecular Biology
Fall: 12 units
This course is an advanced section of 03-442. In addition to the three lectures per week, students attend a fourth class, time TBD by the class each year. Each week we will discuss a paper from the literature, which complements and extends the lecture material. We will learn and practice how to read and critically evaluate papers efficiently and productively. Papers will include classics as well as brand new material, e.g., research just published the week of class.
Prerequisites: 03441

03-744 Membrane Trafficking
Spring: 9 units
While the focus of this course is to analyze membrane/protein traffic along both the biosynthetic and endocytic pathways, our general goal is to teach students how to read and interpret the literature. In particular, we emphasize the conclusions and discuss their validity. The course is updated each year to include topics in which new and interesting developments have occurred. Emphasis is placed on where applicable how it is disrupted or subverted during disease processes. The course is of general interest to students, fellows, and faculty interested in cell biology, immunology, microbiology, pharmacology, and virology.
Prerequisites: 03240

03-751 Advanced Developmental Biology
Fall: 12 units
This course examines current topics in developmental biology at an advanced level. The course is team-taught by faculty from Carnegie Mellon University, the University of Pittsburgh Department of Biological Sciences, and the University of Pittsburgh Medical School. Each year several areas of current research are examined. Previous topics have included pattern formation, molecular signaling pathways, morphogen gradients,
of photography, cinema, video, and the Internet and their technologies are examined. The course also examines the origins addition to the traditional printing technologies, emerging graphic examines the processes used for various graphic products. In technologies used in the production of graphic media. Beginning: Spring: 9 units

This course provides a foundation for the study of graphic media production of graphic media. Topics of investigation include: by investigating the processes and materials used in the This course provides the knowledge and skills necessary for the introduction to financial statement analysis; and international This course examines the factors, which influence individual, group, and firm behavior in the context of business history, business ethics, and the role of business in various world cultures. For first-year business majors only. Students may not receive credit for both 70-100 and 70-101.

This course consists of career-related and community service activities in which the student participates over a period as long as four semesters. The student chooses activities posted on the BA web site, each of which is assigned a certain number of points. A minimum number of points must be accumulated in order to pass the course, and the course grade depends on the number of points accumulated above the minimum. Students may propose projects or activities that are not posted. Students should not register for the course until the semester during which they expect to complete their activities. The course is open to all students.

This course examines the factors, which influence individual, group, and firm behavior in the context of business history, business ethics, and the role of business in various world cultures. For first-year business majors only. Students may not receive credit for both 70-100 and 70-101.

This course provides the knowledge and skills necessary for the student to understand financial statements and financial records. Applications of these topics covered include perception, group behavior, decision-making, motivation, leadership, and organizational design and change. Prerequisites: 76101

This course examines the political, social and legal environment of the firm, within and outside the United States. Topics include restrictive trade practices, laws and directors’ responsibilities and liabilities, managerial decision making, business laws, property, labor unions, trade associations, employee rights and duties, the attorney-client relationship, advertising and the media, the role of regulatory agencies, multinational operations, basic ethical theories (Utilitarian, Kantian, Aristotelian), dealing with bribery and corruption, values in a business society, societal implications of business policies and corporate social responsibility. Prerequisites: 76101

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372 Course Descriptions

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 organizational structure; audience needs and expectations 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: 76101

70-343 Interpersonal Communication
Spring: 9 units
This course examines various types of interpersonal communication used in business situations. Topics covered will vary each semester, but can include business etiquette, ethics in business, 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. Guest and/or panelists will be required and may include conducting mock interviews, role playing business luncheons, and navigating business social events.
Prerequisites: 70340

70-345 Oral Communications
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: 70340 or 73270

70-346 Written Communications
Spring: 9 units
A course in the style and mechanics of composition. Written Communications aims to increase your confidence and facility as a professional writer. The course develops and sharpens your knowledge of writing standards and techniques, patterns of organization and development, strategies of structure and definition, principles of classical rhetoric and processes of revision. Through close reading, detailed language analysis, and repeated, guided practice in composition, Written Communications prepares you for the writing you will do in your professional career; the identification, construction and exploration of issues and ideas, crafted with the best possible means of support and expression and the most effective means of persuasion, given your purpose and audience.
Prerequisites: 76340 and (76100 or 76101 or 76104)

70-364 Business Law
Fall and Spring: 9 units
This course is a survey of the major legal principles and processes affecting business managers in the United States, with some reference as well to the laws of other countries. The topics include contract law, product liability, business property, employment, corporation law, environmental law, consumer protection, issuance of securities, secured transactions, commercial paper, bankruptcy, corporate crimes, business torts, antitrust regulation, international trade, business ethics and corporate social responsibility. The course draws examples from decided cases and from current business activities.
Prerequisites: 76101

70-365 International Trade and International Law
Fall: 9 units
This 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, noun sales convention, international trade organizations (IMF, WTO, World Bank, etc.), risk insurance, cultural factors, international E-Commerce and intellectual property.
Prerequisites: 73100 or 73110

70-366 Intellectual Property and E-Commerce
Spring: Mini Session - 6 units
This course covers the basics of doing business on the internet with emphasis on E-Commerce issues such as intellectual property, cybersquatting 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). 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: (21257 or 21292) and (70207 or 36202 or 36310 or 36220 or 36247)

70-381 Marketing I
Fall and Spring: 9 units
An introduction to the nature and fundamentals of marketing. Topics include an analysis of the factors influencing buyer behavior, marketing research, market segmentation, development of marketing strategies (new product, price, advertising and distribution decisions), and international marketing.
Prerequisites: 76101

70-391 Finance
Fall and Spring: 9 units
The course examines the role of the financial manager in the overall management and control of a firm. Stress is placed on the use of analytical models for improving the decision-making process. Both the short-term management of working capital and the long-term planning of capital structure and investment strategy are covered.
Prerequisites: (70207 and 21257 and 70122) or (70207 and 21292 and 70122)

70-392 Financial Economics
Spring: 9 units
A rigorous quantitative course covering the economic fundamentals of financial markets. The course covers individual decision making about saving and investment under uncertainty, and the equilibrium determination of asset prices for both complete- and incomplete-market settings. In addition, the course will cover topics in corporate financial decision making and the micro-structure of financial markets.
Prerequisites: 73251 and 70207

70-393 Financial Analysis and Securities Trading
Fall: 9 units
The Financial Analysis and Securities Trading (FAST) system is an educational technology that teaches applied principles of financial economics using a sophisticated network of personal computers and workstations. Students learn finance using both real-time data feeds as well as a simulated trading environment.
Prerequisites: 70391

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.
Prerequisites: 70414 or 70415 or 70416 or 70420 or 70421
This course is an applied strategy class that focuses on the implementation of a strategy using a simulation as a framework. The course is designed to integrate the concepts and techniques studied earlier in the curriculum, into a unified, general management framework. The course has 3 main educational objectives: 1.) to give the student an economic perspective and an environment in which to experiment, 2.) to teach strategic planning as a process with an implementation focus, 3.) to learn to cooperate within a high performance team. Students are divided into teams of 5 or 6 managers and given the task of operating a computer synthesized company for 3 simulated years. At the end of each year, the manage students report to a board of directors, who review performance, set compensation, approve future plans and provide shareholder oversight. Students are graded based on metrics similar to real executives: 1.) ability to achieve objectives, 2.) value creation for shareholders, 3.) creation of competitive advantage, 4.) accumulation of personal wealth.

Prerequisites: (70121 and 70371 and 70381 and 70391) or (70122 and 70371 and 70381 and 70391)

This course is an independent study course where students work on "actual"/real-life entrepreneurial businesses. "Experiential Entrepreneurship" is a concept which was founded at CMU – and has shown that students who attend an "entrepreneurship" course in an independent study form business plans that serve as roadmaps for building and their businesses. The business plans include strategies for commercializing and marketing their products and/or services, for building their management teams, and for financing their ventures and projects. The end objective is for the student teams to produce compelling plans that will enable them to convince the outside world that their ventures and projects represent opportunities that are viable with a substantial potential for success and with well understood and manageable risks. Students are encouraged to participate in business plan competitions and to seek financing for their projects. The course exposes students to the nuances of financing new ventures and getting them started legally.

Prerequisites: 70-414 or 70-415 or 70-420 or 70-422 or 15-390

Prerequisites: 15390 or 70414 or 70415 or 70420 or 70421

This course follows the entrepreneur throughout the money-raising process from concept to company. It 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 and evaluate ideas and opportunities. 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 created by teams from the class that can be developed into a business plan in a subsequent course entitled New Venture Creation or through independent study.

This course is designed help you understand the process of preparing and interpreting 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, communication methods available to managers, managers’ incentives and ability to exert discretion over reported earnings, and the interplay between a company’s corporate strategy and its financial reporting policies and practices. The course revolves around a number of topics of recent interest to the business community including the quality of earnings, mergers and acquisitions, bankruptcy, and published accounting and tax returns.

Prerequisites: 70122

This course is designed to familiarize the student with the problems and opportunities involved in operating a business that spans national borders. It addresses recent developments in world trade, changes in international investment patterns, the world financial environment, business policy and strategy for firms competing in the global marketplace, and theory behind international business. Issues in managing cross-cultural differences, global risk management, multinational finance, accounting, and taxation are also examined.

Prerequisites: 70-430 or 70-424

This course is designed to provide the student with the skills and tools required to build a self-sustaining business. It builds upon previous course work in accounting and 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 a 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 to the student’s/their business career.

Prerequisites: 70122 and 70371 and 70381 and 70391
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: 15100 or 15111 or 15112 or 15120 or 15125 or 15127

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. System analysts 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 such as system design, user oriented design and software maintenance. Students will work in teams to analyze, design, and build a small information system.
Prerequisites: 70451

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 will learn how information resources can be effectively managed and used to improve the productivity of organizations. They will be introduced to the role of 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: 70451

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 impacts of telecommunication technology in business.
Prerequisites: 70451

70-459 Web Business Engineering
Spring: 9 units
In this course students will learn how to set up a business on the Internet (World Wide Web) and how to use the Internet and other telecommunications technologies to sell businesses together for a project. A Virtual reality project will be assigned.
Prerequisites: 70451

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: 21257 or 21292

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: 70451

70-471 Logistics and Supply Chain Management
Spring: 9 units
This course shall highlight the architecture, processes and drivers of performance of modern supply chains in various industries. We will link the material and information flows and discuss key business processes related to bridging the demand and supply side. There is an extensive use of cases, computer models and emphasis on recent developments in the supply chains of Fortune 500 firms. Industry experts will also share their experiences and challenges.
Prerequisites: 70371

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 marketing and the concept of global marketing. Students will learn about the role of factors (economic, social, legal, and cultural) on marketing decisions such as market entry, product development, pricing, promotion or by new media and approaches, the proliferation of marketing communications is impacting consumers, culture and business performance and must be managed by marketers. Integrated marketing communications campaigns are the best way to effectively build brands. This course covers the role and execution of marketing communications within the context of overall marketing strategy and in conjunction with other elements of the marketing mix. Students acquire an understanding of marketing communications tools and apply them to a real client situation acting as an advertising agency team through the development and team presentation of an integrated marketing communications campaign.
Corequisites: 70-381
Prerequisites: 70208 or 70381 or 73360

70-484 Direct Interactive Marketing
Fall: 9 units
Direct and Interactive Marketing is a fast growing discipline that is changing and advancing the field of marketing in general. This consumer marketing course develops direct marketing planning skills, explores the future of the field including how interactive marketing is evolving with the Internet, and offers students further insight into marketing as a career field of choice. The course incorporates cases, lectures adn a team project to provide a comprehensive understanding of the meaning, uses, and contribution of direct marketing to the firm and consumer.
Prerequisites: 70381

70-485 Product Management
Spring: 9 units
This course focuses on problems and strategies specific to managing products and services. Emphasis primarily on the design and marketing of new products and services. The objectives of the course are to acquaint students with the new product development process; to introduce students to the concepts and techniques useful for making new product decisions; and to give students an opportunity to apply course concepts to the actual development of a new product or service by working on a comprehensive group project.
Prerequisites: 70381

70-486 Pricing
Spring: 9 units
Determining the price of a product or service is one of the most important marketing decisions. It is also one of the most complex and least understood aspects of marketing. While many marketing activities are geared toward creating value for the customer, sound pricing decisions are the fundamental tool for...
businesses to capture the value they create. In today’s hypercompetitive environment, even slight errors in determining the best price can lead to large financial losses. This course draws on the fundamental disciplines of microeconomics, statistics and psychology to shed light on good pricing practice. It surveys some popular pricing practices, explores their pitfalls, and identifies the fallacies they are based on. The first part of the course discusses the foundations for sound pricing decisions: costs, customer and competition. It then moves on to current pricing strategies, tactics and their applications: pricing over the product life cycle; product line pricing; pricing through the marketing channel; price discrimination; two-part tariffs and nonlinear pricing; price bundling; perceived value pricing; and competitive pricing. Finally, the course covers hot and state-of-the-art pricing topics such as Internet pricing, optimization and dynamic pricing, international pricing, relationship pricing. The institutional and legal environment and their impact on the firm’s pricing decision are derivative securities. Business cases, videos, guest speakers, games will be used to help students better master the course material.

Prerequisites: (70381) and (73100 or 73110)

70-492 Investment Analysis
Spring: 9 units
Students will gain an understanding of financial theories through learning the theory and development of basic computer programs that can be applied in a real world environment. Typical projects include obtaining the efficient frontiers for a given set of securities; deciding on the optimal investment strategy for a given set of securities; calculating option prices using Black-Scholes and Binomial option pricing models.
Prerequisites: 70391

70-495 Corporate Finance
Fall and Spring: 9 units
This course focuses on how firms make decisions on investments, financing and dividend payout policies, as well as other advanced topics in finance.
Prerequisites: 70391

70-497 Options
Fall: 9 units
This course is designed to provide students with (a) the skills and intuitive insights needed to identify and manage opportunities to appropriately employ derivative securities in the conduct of their business either for gain or risk management, (b) a working knowledge of the mechanics of the futures, options and swap markets and (c) a fundamental understanding of how derivative securities are priced.
Prerequisites: 70492

70-499 Internship
All Semesters: 1-18 units
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: 3-18 units
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 a 9-unit course to the BA Director. Enrollment by permission of the BA Program.

70-501 Honor Thesis II
Spring: 3-18 units
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 a 9-unit course to the BA Director. Enrollment by permission of the BA Program.

70-502 Independent Study in Management
All Semesters: 3-18 units
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: 3-18 units
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: 3-18 units
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: 3-18 units
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: 3-18 units
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: 3-18 units
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.

70-520 Publicity and Public Relations
Fall: 9 units
The course examines the concepts, principles, and ethics essential to the public relations profession. It discusses the diverse areas of public relations, from publicity and special events management to lobbying and issue raising. Through case studies, students learn how to solve problems using time-tested public relations strategies. The course also examines the elements of successful publicity. Students learn the tools of publicity, including pitch letters, news releases, and tip sheets. They also learn the basics of news writing, how to identify a news angle and how to write about it. Writing is an essential part of this course and students are evaluated, in part, on their written work.

Prerequisites: 76101 and 79104

70-635 Desktop Publishing
Spring: 9 units
Starting in the mid 1980's, desktop publishing has transformed the way that graphic media is produced. It enabled non-professionals with modest desktop equipment to produce files for high quality graphic output. This course examines the methods and applications of desktop publishing from two perspectives: from a project management perspective, and from a hands-on production perspective. The topics covered include: the new digital workflow, typography, file formats, trapping, software applications, imposition, preflighing, output issues.

70-637 Interactive Media Design Management
Fall: 9 units
Interactive media offers a powerful communication method by providing an immersive, self-guided multi-media environment. This lab-based course uses exercises in Macromedia Flash to build animations that demonstrate the capabilities of interactive media. The course provides an introduction to project management methods for interactive media Students learn how to conceptualize, manage, and execute an interactive media project that combines text, illustrations, photographs, animations, sound, and video.
70-639 Advanced Interactive Media Management
Spring: 9 units
This course extends the knowledge of Macromedia Flash learned in 70-637. This project-based course relies heavily on Action Scripting to make advanced interactive projects. (Prerequisite 70-637)
Prerequisites: 70637

70-640 Emerging Graphics Technologies
Fall: 9 units
Recent developments impacting the graphic communications industry are examined in this seminar course. Computer-to-plate technology, database publishing, on-demand printing, digital printing, www publishing, e-paper and multi-media production are among the topics under discussion.

70-641 Color Reproduction and Management
Spring: 9 units
In today's business world, the accurate reproduction of color in various media is both a challenge and a necessity. This course examines the issues related to color reproduction and the methods by which consistent color appearance can be maintained across a variety of traditional and electronic media. Topics include: the perception and measurement of color; the capture, separation, and manipulation of color images; and color management techniques for a variety of media including print, the WWW, and television.
Prerequisites:

70-643 Publishing on the World Wide Web
Fall and Spring: 9 units
In just over a decade, the World Wide Web has become an essential venue for businesses. This course examines a variety of topics related to web publishing including: the design and usability of web sites; the appropriate use of file formats; business practices across the web; the integration of other media; the increased use of mobile devices; strategies for search engines; and others. Classroom instruction is supported by laboratory exercises where students make and publish functional and effective web pages.

70-650 Independent Study: Graphic Communications Management
All Semesters: 3-18 units
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.

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.
Prerequisites: Corequisites: 03-121

42-200 Sophomore BME Research Project
Fall and Spring: 3-12 units
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 the ethical 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: 42101

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 basic exploration of anatomy and structure. Basic physical laws and principles will be explored as they relate to physiological function. Prerequisites: 03-121 Modern Biology, or permission of instructor.
Prerequisites: Corequisites: 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 covered in 42-101 Introduction to Biomedical Engineering and expose students to four areas of biomedical engineering: bioimaging, biomaterials, biomechanics, and cellular and molecular biotechnology. Several corecutting modules will also be 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.Experimental studies may substitute 03-124 Modern Biology Laboratory.
Prerequisites: Corequisites: 03-121, 42-101

42-300 Junior BME Research Project
Fall and Spring: 3-12 units
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 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 biomaterials and responses will be covered. Applications of biomaterials to be discussed include tissue engineering and artificial organs. Prerequisites: None, but 09-105 Introduction to Modern Chemistry and 42-101 Introduction to Biomedical Engineering will be useful. Also known as 27-311.

42-312 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 assessing 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.

42-321 Cellular and Molecular Biotechnology
Spring: 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: (42-203 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.

42-334 Introduction to Computational Biology

Spring: 9 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 also intended for students without computer programming experience (students with a desire to apply programming methods to these problems should take the more advanced course, Computational Biology). Contents covered are computational molecular biology (analysis of protein and nucleic acid sequences), biological modeling and simulation (including computer models of neuron behavior, biochemistry, 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: 42-340/341-310, 03-311, 42-434/03-310 or 42-734/03-710. Prerequisites: (21-112 Calculus II OR 21-118 Calculus of Approximation) AND 03-121 Modern BioSci AND (99-101 OR 99-102 OR 99-103 OR Computing Skills Workshop). Prerequisites: (21118 or 21112) AND 03121 AND (99101 or 99102 or 99103)

42-341 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 reports from 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: 21260 and 24262

42-347 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. Pre-requisite: None, but 42-202 Physiology is useful. Junior or Senior status or permission of instructor.

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 Pre-requisite: Physiology

42-400 Senior BME Research Project

Fall and Spring: 3-18 units

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 BME Design

Spring: 12 units

42-401 The Biomedical Engineering Design course focuses on integrated product development. A multidisciplinary team will consist of a variety of BME engineering students. The course consists of several modules including identifying, understanding, conceptualizing and realizing a product opportunity. All product development will respond to the needs of appropriate market segments; resulting products will be deemed useful, usable and desirable by those segments. Students will produce a form model, functional prototype, marketing plan, and manufacturing plan of their product. Pre-requisite: BME Double Major Senior status.

42-413 Biomaterial Interfaces

Spring: 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 the course requirements but are interested in learning more about complex fluids or biointerfacial phenomena.

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. The course will cover the study 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. The course will consist of a mixture of equal parts of animal lab work and lectures. Prerequisite: senior standing in Biomedical Engineering, or consent of instructor.

42-422 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 of student and participant presentations of dissolved problems and projects to develop new technologies. Pre-requisite: None, but 42-202 Physiology is useful. Junior or Senior status or permission of instructor.

42-424 Biological Transport

Spring: 9 units

Analysis of transport phenomena in life processes on the community, organ and organism levels. Material covered: Fick's Laws; electrolyte diffusion; coupled diffusion and chemical reactions; membrane transport mechanisms; osmosis; Donnan equilibrium; receptor-mediate binding; ultrafiltration and nephron function; blood flow; pharmacokinetic modeling. Prerequisites: 06-262 Mathematical Methods of Chemical Engineering OR 21-260 Differential Equations. Useful, but not required: 06-261 Fluid Mechanics, 12-355 Fluid Mechanics, or 24-231 Fluid Mechanics. (Renumbered from 42-622) Prerequisites: 06422 and 42321

42-431 Biomaging

Spring: 12 units

This course is designed to provide students with hands-on experience in investigating host responses to materials. The course will consist of a mixture of equal parts of animal lab work and lectures. Prerequisite: senior standing in Biomedical Engineering, or consent of instructor.

42-431 Cellular and Molecular Biotechnology OR (03-232 Biochemistry OR 06-422 Chemical Reaction Engineering). (Renumbered from 42-622) Prerequisites: 06422 and 42321

42-431 Biorheology

Spring: 12 units

This course is designed to provide students with hands-on experience in investigating host responses to materials. The course will consist of a mixture of equal parts of animal lab work and lectures. Prerequisite: senior standing in Biomedical Engineering, or consent of instructor.

42-431 Cellular and Molecular Biotechnology OR (03-232 Biochemistry OR 06-422 Chemical Reaction Engineering). (Renumbered from 42-622) Prerequisites: 06422 and 42321

42-431 Biomedical Engineering Design course focuses on integrated product development. A multidisciplinary team will consist of a variety of BME engineering students. The course consists of several modules including identifying, understanding, conceptualizing and realizing a product opportunity. All product development will respond to the needs of appropriate market segments; resulting products will be deemed useful, usable and desirable by those segments. Students will produce a form model, functional prototype, marketing plan, and manufacturing plan of their product. Pre-requisite: BME Double Major Senior status.
wavelets. - Think in basic time-frequency terms. - Describe how Fourier theory fits in a bigger picture of signal representations. - Use basic multirate building blocks, such as a two-channel filter bank. - Characterize the discrete wavelet transform and its variations. - Construct a time-frequency decomposition to fit the signal you are given. - Explain how these tools are used in various applications. - Apply these concepts to solve a practical problem through an independent project. Prerequisites: 18-396. Corequisites: None Cross-listed courses: 18-496 Prerequisites: 42202

42-434 Computational Biology Spring: 9 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 for the immune system behavior, and the 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 Fundamentals of Discrete Structures and Algorithms). Prerequisites: 03121

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 project 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)

42-501 Special Topics Fall: 9-12 units
42-501 Special Topics: Bone Tissue Regeneration Fall: 9 units
The course will include a description of the micro- and macro-anatomy of bone, its embryology, and wound healing. Traditional bone grafting materials will be discussed and reviewed and presented with clinical challenges. In vitro methods and animal wound models will be discussed for designing and developing bone regeneration therapies. Pertinent literature articles will be reviewed and grant writing will be discussed, using the NIH R01 format. Prerequisites: 42-301 Physiology OR 42-735 Physiology, 03-121 Modern Biology OR 03-232 Biochemistry, OR permission of instructor

42-502 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) mechaanochemical coupling in signal transduction; (6) mechanical force trafficking; and (7) 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. Also known as 24-799

42-503 Advanced Bioimaging Fall and Spring: 9 units
This course will cover state-of-the-art signal processing techniques, especially those based on wavelets and related developments. Wavelets unite brilliant theory, efficient algorithms and successful applications. The stress will be on biomedical and communications systems. The students will be expected to complete an independent project during the course. Prerequisites: 18-797.

42-504 Special Topics Spring: 9 units
The topic for the spring's course is 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, pharmacology, biotechnology, and biotechnology. Students can take this course for credit or sign up as an audit. The latter choice might be suitable for those who have satisfied their course requirements but are interested in learning more about complex fluids or bio-interface phenomena. (Cross-listed course: 06-905)

42-505 Special Topics: Introduction to Molecular and Cellular 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 recombinant protein products. The course will be offered in the Fall, will be on the principles, properties and applications of ceramics and metals as biomaterials.

Prerequisites: 09-105 Modern Chemistry and 09-217 Organic Chemistry I. This course also known as 27-510. Prerequisites: 09105 and 09217

42-511 Biomaterials Fall: 9 units
The course addresses basic and applied concepts of metals and ceramics as biomaterials. The latter choice might be suitable for those who have satisfied their course requirements but are interested in learning more about complex fluids or bio-interface phenomena. (Cross-listed course: 06-905)

42-560 Undergraduate Projects Fall and Spring: 3-12 units
Students elect to do a Biomedical Engineering course for credit either with a CMU faculty member, a faculty member of the University of Pittsburgh or the College of Osteopathic 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

42-604 Biological Transport Spring: 9 units
Analysis of transport phenomena in life processes on the molecular, cellular, and organism levels. Material covered: Fick's Laws; electrolyte diffusion; coupled diffusion and chemical reaction; membrane transport mechanisms; osmosis; Donnan equilibrium; receptor-mediated binding; lateral diffusion in membranes and reduction of dimensionality; ultrafiltration and nephron function; compartmental modeling; pharmacokinetics. Prerequisites: Ordinary differential equations.

42-621 Biotechnology and Environmental Processes Fall: 9 units
This course has two sections: The first half of the course covers microbial physiology and metabolism, fermentation and restoration, metabolic regulation, biochemical versions, recombinant DNA methodology and gene cloning. The second half of the course covers separation and purification, kinetics, and design of biological reactors, mass transfer limitations within cell suspensions, and control of fermentation processes. Prerequisites: 03-121 Modern Biology OR 03-231/03-232 Biochemistry OR permission of instructor.
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 problems are also included. The format of the course is a mixture of equal parts lectures, 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 Engineering or permission of instructor. Useful, but not required, background in 03-231 Biochemistry I.

42-644 Medical Devices
Spring: 9-12 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, friction, 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 medical 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. Pre-requisites: Junior or Senior status.

42-651 Air Quality Engineering
Fall: 9 units
This course covers the problems and methodologies of environmental management. We study air pollution, characterization of pollutant sources, behavior of aerosol and gaseous pollutants in the atmosphere and microclimate. Consideration is also given to the role of climate in pollutant transport, human health effects focusing on the respiratory systems, methods of air pollutant measurement, standards and regulations of air pollution, including procedures by which regulatory agencies develop and enforce standards. Prerequisite: 12-330, or equivalent.

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 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: 21260

42-723 Biological Processes in Environmental Systems
Spring: 12 units
42-723 is a 12 credit course that presents the theory of microbial processes relevant to environmental systems. Fundamental microbiology, kinetics of suspended and fixed film systems, and processes in environmental biotechnology are the major topics. The microbiological theory presented is applicable to biological processess in engineered and natural systems. The major applications discussed in this course focus on pollution prevention and waste water treatment including: activated sludge, biolim processes, tertiary nutrient removal and methanogenesis. While applications in this course focus on traditional environmental engineering and wastewater treatment, the fundamental model development for suspended and attached growth is directly applicable to large scale bioprocesses in many fields. The textbook is Rittmann and McCarty (2001). If you have any questions or want more details, please feel free to contact Dr. Jeanne VanBriens (jeanne@andrew.cmu.edu) Also known as 12-723.

42-731 Advanced Bioimaging
Fall: 12 units
The goals of this course are to provide students with the following: the ability to use mathematical techniques such as linear algebra, Fourier theory and sampling in more advanced signal processing settings; fundamentals of multiresolution and wavelet techniques; and in-depth coverage of some bioimaging applications such as compression and denoising. Upon successful completion of this course, the student will be able to: explain the importance and use of signal representations in building more sophisticated signal processing tools, such as wavelets; think in basic time-frequency terms; describe how Fourier theory fits in a bigger picture of signal representations; use basic multirate building blocks, such as a two-channel filter bank; characterize the discrete wavelet transform and its variations; construct a time-frequency decomposition to fit a given signal; explain how these tools are used in various applications; and apply these concepts to solve a practical bioimaging problem through an independent project. Pre-requisite: 18-791, or permission of instructor. (Also known as 18-79X)

42-735 Medical Image Analysis
Spring: 12 units
The fundamentals of computational medical image analysis will be explored, leading to current research in applying geometry and statistics to segmentation, registration, visualization, and image understanding. Student will develop practical experience through projects using the National Library of Medicine Insight Toolkit (ITK), a new software library developed by a consortium of institutions including CMU. In addition to image analysis, the course will describe the major medical imaging modalities and include interaction with practicing radiologists at UPMC. Prerequisites: Permission of the instructor, knowledge of C++, vector calculus and basic probability. (Also known as 16-725)

42-801 Biomedical Engineering Seminar
Fall and Spring: 0 units
The Graduate Seminar is required every semester for all students in residence. It provides opportunities to learn about research in various and related fields being conducted at other universities and in industry. All graduate students must register for this course during each semester of full-time study. Attendance is mandatory.

42-882 Directed Study
All Semesters: 9-48 units
Students work with a faculty member affiliated with the Program at the University. Emphasizing resourcefulness and initiative, the students with their advisors evolve a project with both research and development aspects. Pre-requisite: Consent of advisor. Variable units.

CFA Interdisciplinary
62-141 Black and White Photography I
All Semesters: 9 units
This course introduces students to the basics of black and white photography through an understanding of camera operation, film exposure and darkroom technique. Seeing photographically, as well as the craft of photography is emphasized. The course concentrates on photography as a fine art: what is unique to it and the concerns that transfer to other visual arts, such as composition, tonal values, etc. The course aims to equip students with an understanding of the formal issues and the expressive potentials of the medium. The course is composed of student presentations, class discussions, shooting assignments, darkroom sessions and class critiques. Students are graded on their participation in the class, attendance, the quality of their ongoing assignments and their final projects. Lab fee ($70) and 35mm manual camera required. Each student is responsible for the cost of paper and film. No prerequisites. Course is by special permission. Please contact Emily Rafalak at emilyg@andrew.cmu.edu.

62-162 Introduction to Digital Photography
All Semesters: 10 units
Students will learn the basics of using a digital and hybrid traditional/digital workflow to create photographic images. Students will use digital methods of image capture as well as traditional film photography to create images. Students will learn the basics of how to use Adobe Photoshop as a way to manipulate digital photographic images. Students will also learn how to make high quality digital prints of their work. The class will focus equally on the technical aspects of how to work digitally and on the aesthetic value of the images that are created. Previous photographic experience is beneficial, though not required. Special permission required.
62-163 Input/Output: Digital Art & Image
Spring: 9 units
Through course projects, students will explore image construction and manipulation as translated through the computer. Students will engage readings, research, gallery visits, visiting artists and lectures; these will provide an historical and critical context for looking at and making artwork that uses photographic, digital and print processes. While image capture, software and printing techniques will be addressed, the course will emphasize a conceptual approach to projects. Students should be familiar with the basic operations of the Macintosh. Lab fee: $100

62-190 BHA/BSA Integrative Seminar
Fall: 9 units
This course is designed to create an environment for interdisciplinary learning and collaboration for students in the Bachelor of Humanities and Arts (BHA) and Bachelor of Science and Arts (BSA) degree programs. In addition to art-science projects, the course will invite photographers for special presentations. Grading is based on attendance, assignment critiques, and the final portfolio. Alternate individual tutorial/classroom demonstration/evaluation. The project topic must be pre-approved by the faculty member who agrees to supervise the project, and the final project must 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 Proposal Form" signed by the student and the faculty advisor, along with a proposal, to the Associate Director of BHA and BSA Programs.

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. Alternate individual tutorial/classroom demonstration and group critique structure. Students will gain experience with a variety of formats; experimental methods and media will be encouraged. Following or equivalent of a large format camera is recommended by the end of the course. Prerequisites: Black and White Photography I 62-141 or consent of instructor. Lab Fee $70. Special Permission only. Contact Emily Rafalak at emilyg@andrew.cmu.edu
Prerequisites: 62141

62-325 View Camera
Intermittent: 9 units
The nature of a 4 x 5" 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 an individual sheet of film make 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 photography and printing. Prerequisites: 62141 and any 200 level photo course. Special permission only. Contact Emily Rafalak at emilyg@andrew.cmu.edu
Prerequisites: 62141

62-377 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 all format cameras 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 paperoid. 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. Special Permission only. Corequisites: 62-241, 62-141

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 world 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.

62-381 Color Photography and Digital Output
Intermittent: 10 units
In this course students will combine both traditional practices in color photography (shooting film) with more progressive methods (digital output). Students will gain an understanding of color theory and aesthetic direction, while better defining their individual voices. In the end, students will have a well executed body of work, finely printed, using Adobe PhotoShop and high-end digital output devices. Prerequisite: 62141. Special permission only. Contact Emily Rafalak at emilyg@andrew.cmu.edu
Prerequisites: Corequisites: 62-141

62-390 BHA/BSA Undergraduate Research Project
All Semesters: 3,6,9,12 units
The BHA/BSA Undergraduate Research Project is for Bachelor of Humanities and Arts (BHA) and Bachelor of Science and Arts (BSA) 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 the final project must 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 Proposal Form" signed by the student and the faculty advisor, along with a proposal, to the Associate Director of BHA and BSA Programs.

62-400 BHA/BSA Summer Senior Project
All Semesters: 9 units
The BHA/BSA Senior Project allows Bachelor of Humanities and Arts (BHA) and Bachelor of Science and Arts (BSA) 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 or arts and sciences. The creation and completion of such a project can be an important integrative and fulfilling capstone for BHA and BSA students. Senior Projects are semester-long or year-long (9 units for one semester; 18 units for two semesters), 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 "Senior Project Proposal Form" signed by the student and faculty advisor, along with a proposal, to the Director of BHA and BSA Programs for final approval.

62-590 BHA/BSA Internship
All Semesters: 3,6,9,12 units
An internship is a supervised professional work experience with clear links to a student’s academic goals. BHA and BSA students may choose to complete a BHA/BSA internship for elective credit with appropriate individuals or organizations within or outside of Carnegie Mellon University. Junior and senior BHA and BSA 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 "BHA/BSA Internship Proposal Form" signed by their site supervisor and approved by the Associate Director of the BHA and BSA Programs.

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 nemesis. Our goal is to preserve 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 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.

Prerequisites: None.

39-101 CIT First-Year Seminar
Fall: 0 units
This course is intended to prepare CIT graduates for the fast pace world of modern industry. The focus of these sessions are adaptation skills that will make them successful in the workforce and the classroom.

39-200 Business for Engineers
Fall and Spring: 9 units
This course is intended to prepare CIT graduates for the fast pace world of modern industry. The focus of these sessions are management, entrepreneurship and ethics. Students will become familiar with analyzing financial statements, stock market reports and stock options while developing verbal and written presentation skills.

39-250 CIT Undergraduate Projects
Fall: 0-18 units
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: 0-18 units
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.

39-278 Introduction to Engineering Reports
Fall: 1-5 units
This course focuses exclusively on technical writing reports for engineering situations. The course emphasizes the principles of clear, direct, and well-organized technical writing as well as the need of key grammatical and syntactical constructs.

39-279 Introduction to Engineering Presentation
Fall: Mini Session - 4 units
This course aims at the basics of constructing and presenting clear, well organized, and well delivered technical presentations. This course splits its emphasis between Structuring Contents and Elements of Delivery. Structuring Contents will stress adherence to the standard organization of Introduction, Body, and Summary. It will also highlight the importance of adapting content to a speaker's purposes and audience. The Elements of Delivery will examine the nuances of physical and vocal delivery. Physical elements such as posture, gestures, eye contact, expressions, body language and the handling of visuals will be discussed in depth. Vocal delivery and its categories of volume, rate of speech, range, and articulation will also be probed. Finally, the role of visuals, specifically PowerPoint slides, will be explored in depth. Each student will present one individual presentation on their engineering courses and one team presentation on their major department. Students will also critique student presentations of their classmates and take part in presentations of previous semesters. A written mid-term examination will be included. 4 units

39-390 CIT Co-Op
All Semesters: 0-3 units
This course is open to students at Carnegie Mellon considering experiential learning opportunities important educational options for its undergraduate students. One such option is the internship, which provides a student with an extended period of experience with a company. Therefore, projects can be of significant depth in experience. To participate, students must complete a CIT Co-op Approval form (located in Scaife Hall 110) and submit for approval. All co-ops must be approximately 8 months in uninterrupted length. If the course is approved, the CIT Undergraduate Studies Office will add the course to the student’s schedule, and the student will be assessed tuition for 0-3 units. 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 CIT Undergraduate Office. If the reports are approved, a "P" grade will be assigned. International students should also be authorized by the Office of International Education (OIE). More information regarding CPT is available on OIE’s website.

39-405 Engineering Design: The Creation of Products and Process
Fall: 12 units
Introduction of concepts, methods and tools for successful engineering design, providing a fundamental understanding of the design process. Emphasis on the interdisciplinary nature of the design process and design methods and skills to be used by a broad range of engineering disciplines. Major topics: the design process, current industrial practices, design activities and problem-solving techniques, problem representations, design management and computer-based design environments.

39-499 Summer Curricular Practical Training
Summer: 3 units
This course is open to students at Carnegie Mellon considering experiential learning opportunities important educational options for its undergraduate students. One such option is the internship, which provides a student with an extended period of experience with a company. Therefore, projects can be of significant depth in experience. To participate, students must complete a CIT Co-op Approval 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 0-3 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. If the course is approved, a "P" grade will be assigned. 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: 1-3 units
This course, open by invitation only, will provide the opportunity for close interaction with a faculty member through independent research in a number of disciplinary and interdisciplinary areas.

39-600 Integrated Product Development
Fall: 12 units
This course focuses on team-based integrated product development among engineering, business, and design disciplines. The course is open to seniors and graduate students in engineering, industrial design, and management MBA students. The course generally has about a dozen students from each discipline. The course consists of four modules including identifying, conceptualizing, and introducing a product opportunity. In recent years we have partnered with industrial sponsors to address a customer opportunity, resulting in patent applications. The emphasis in the course is on the early, "fuzzy" stage of product development. The course gives structure to these stages and helps direct the process to be more efficient downstream. Students are expected to produce four phase written
and oral reports. At the end of the semester the team will develop a form prototype, function prototype, marketing plan and manufacturing plan for the product. This course has gained an international reputation as a leading course in new product development. Course admission by permission of professor only; all students will be waitlisted until admission decisions are made. Students should contact the professor for an application for the course.

39-606  Engineering Product Design Projects Spring:  12 units

In this project course students form interdisciplinary teams, each of whose goal is the design of a product. Industry and government (often local) help us to define projects of real interest to them. They also help to set time and financial limits. Many projects typically run for two semesters, students can take the course for one or two semesters, as their schedules allow. Students must consider many issues for their projects -- What are the product opportunities? What makes their product special? How must it look and feel? Is it technically legitimate? Can it be manufactured economically? How should it be marketed?

39-647  Special Topics in Design All Semesters:  3-18 units

This course is to be used for Interdisciplinary Engineering Design Independent Study. It can be added by permission only through collaboration with the student, Independent Study project advisor, and the CIT Dean’s Office.

39-648  Rapid Design and Prototyping of Computer Science Projects Spring:  12 units

This course deals with rapid prototyping, manufacture, and applications of a new generation of wearable computers, with head-mounted display. The design of wearable computers is a multidisciplinary process including: Electronic design, mechanical design, software development, and human-computer interaction. Two classes of wearable computers will be further developed: embedded, custom designed VuMan series, and general purpose Navigator series. Electronic design includes the custom designed computer board, electronic interfacing, and power supply. Industrial designers and mechanical engineers team to design and manufacture with a variety of conformable/lightweight housings. A software development environment and user interface builders support software and application design. Current applications include: Global Position Sensing, Hypertext documents, speech recognition, wireless communications, and digital imaging.

39-650  CIT Special Topics Fall:  9-12 units

This is a project-oriented course with emphasis on the analysis and design of sensor networks. Topics include problem definition, requirements analysis, design, and deployment. Particular attention will be paid to: the management of the strategic and operational impacts as systems project, systematic and structured methodologies used for system analysis, and the evolutionary and reliability needs of a deployed sensor network. Currently available sensor networks include: Global Position Sensing, Hypertext documents, speech recognition, wireless communications, and digital imaging.

Carnegie Mellon University-Wide Studies

99-101  Computing Skills Workshop Fall and Spring:  Mini Session -  3 units

Computing Skills Workshop (CSW) is a 3-unit required class that ALL incoming undergraduate students take when they arrive on campus. The course is comprised of mostly Carnegie Mellon specific information and helps students understand what resources are available to them and what responsibilities they have as a user in our computing community. Class is held twice/week for 50 min for 1/2 of the semester. There is very little work required outside of class, so students are expected to attend all classes. This course is only offered during the Fall and Spring semesters. There are no test-out opportunities or summer programs. Advanced Placement Computing Courses cannot be credited/substituted for this requirement.

99-102  Computing Skills Workshop Fall and Spring:  3 units

Computing Skills Workshop (CSW) is a 3-unit required class that ALL incoming undergraduate students take when they arrive on campus. The course is comprised of mostly Carnegie Mellon specific information and helps students understand what resources are available to them and what responsibilities they have as a user in our computing community. Class is held twice/week for 50 min for 1/2 of the semester. There is very little work required outside of class, so students are expected to attend all classes. This course is only offered during the Fall and Spring semesters. There are no test-out opportunities or summer programs. Advanced Placement Computing Courses cannot be credited/substituted for this requirement.

99-103  Computing Skills Workshop Fall and Spring:  Mini Session -  3 units

Computing Skills Workshop (CSW) is a 3-unit required class that ALL incoming undergraduate students take when they arrive on campus. The course is comprised of mostly Carnegie Mellon specific information and helps students understand what resources are available to them and what responsibilities they have as a user in our computing community. Class is held twice/week for 50 min for 1/2 of the semester. There is very little work required outside of class, so students are expected to attend all classes. This course is only offered during the Fall and Spring semesters. There are no test-out opportunities or summer programs. Advanced Placement Computing Courses cannot be credited/substituted for this requirement.

99-200  Tutoring, Mentoring and Role Modeling-- A Community Service Course Spring:  6 units

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 2 hours per week, in a time slot of your choosing, usually through the East End Tutoring Program (http://www.andrew.cmu.edu/~eastend/). To promote your effectiveness, the course covers 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). Tutors will also be helping younger students, and that is personally rewarding to do so. Tutors also often express that it is refreshing to step outside the grind of Carnegie Mellon life and do something worthwhile in the community.

99-250  Seminar for Peer Tutors Fall and Spring:  4.5 units

The purpose of this training course is to provide undergraduates with the knowledge and skills necessary to become peer tutors. Students will be exposed to the goals and objectives of the program and will gain the knowledge and experience necessary to become an effective peer tutor. Peer helpers 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 (http://acad-dev.mac.cc.cmu.edu/acad-dev/jobs.htm) 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

The purpose of this training course is to provide undergraduates with the knowledge and skills necessary to become supplemental instruction (SI) leaders. Students will be exposed to the goals and objectives of the program and will gain the knowledge and experience necessary to become an effective SI leader. SI leaders 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 (http://acad-dev.mac.cc.cmu.edu/acad-dev/jobs.htm) 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

The purpose of this training course is to provide undergraduates with the knowledge and skills necessary to become effective academic counselors (AC’s). Students will be exposed to the goals and objectives of the program and will gain the knowledge and experience necessary to become a professional academic counselor. AC’s 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 (http://acad-dev.mac.cc.cmu.edu/acad-dev/jobs.htm) and then be interviewed by the instructor(s) to determine if the student possesses the basic qualifications.

99-451  Fluency and Communication Skills for Nonnative Speakers of English All Semesters:  Mini Session -  3 units

This course is designed to help graduate students who are non-native speakers of English gain the skills needed to work as Teaching Assistants. The focus will be two-fold: 1) students will
have the opportunity to develop robust teaching fluency, and 2) they will gain a better understanding of the culture of the American classroom, their role as teacher, and lean how teaching and learning are defined in the US academy. We will make extensive use of interactive discussions, video modelling, teaching demonstrations, readings, and practice lessons to help students develop the ability to communicate as teachers. Each student will be required to be videotaped teaching the sample lessons to the class, and then meet individually with the instructor to review the tapes. Prerequisite: permission from the Intercultural Communication Center (ICC).

99-452 Language and Culture for Teaching All Semesters: Mini Session - 3 units This course is to strengthen the oral communication skills of graduate non-native speakers of English so that they can communicate more successfully in academic, professional and multicultural environments. Classroom activities focus on developing robust fluency and help students develop an awareness of various communicative styles and cultural assumptions. The in-class learning activities include videotaped, prepared speeches, discussions and pronunciation practice. We also examine language-learning techniques so that students can become more informed, self-paced learners. Prerequisite: Permission from the Intercultural Communication Center (ICC).

Center for the Arts in Society

64-100 Critical Histories of the Arts Fall and Spring: 9 units Instructor: Ting Chang, PhD. Considers diverse forms of the creative, performing and literary arts throughout history and the world. Addresses how the arts influence and overlap one another in relation to broader cultural and social institutions and processes. Examines the intersection of historical movements and creative traditions, connecting them to present practices. Engages with concepts, theories, and modes of thought in a critical analysis of the production and interpretation of the arts across temporal, geographical and cultural contexts.

64-300 CAS Fall Fellow Intermittent: 9 units Title: Imaging the City Instructor: Carl DiSalvo, PhD. The phrase "imaging the city" broadly refers to the use of visual means to represent and communicate the human experience of and interaction with the urban environment. In this course we will examine practices and theories of "imagining the city" drawing on diverse disciplinary fields including art, urban planning, architecture, human geography, science & technology studies, urban studies, and critical theory. A specific emphasis of this class will be to examine how emerging modes and technologies of capturing, constructing, and sharing images of the city change, or might change, how we envision the urban environment and how we use images of the city for civic expression, representation, and action. In this course we will ask questions such as: What constitutes an image and the city? How are images of the city activated toward social and political ends? And how do new images of the city made possible through emerging technologies change the practice of imaging the city and what it now constitutes the urban 'seen'? Central to this course will be investigating how transformations of urban experience, technological developments, and social and political agendas co-mingle in the aesthetic practices of imaging the city.

64-301 CAS Fall Fellow Intermittent: 9 units Title: Poetry and Performance Instructor: Susan Somers-Willett, PhD. From the bard to the beatniks, performance has been an important part of how poets write, read, and are received by public audiences. However, the majority of literary criticism considers poetry as merely a textual entity. Is our experience of a poem ever just textual? How do our understandings of poetry expand when we consider orality and performance as important aspects of a poem? How do we distinguish a poetry reading from a "performance"? How are traditional forms of poetry transformed by current aesthetic movements and cultural practices such as hip-hop, spoken word, and poetry slams, and how is such verse informed by identity and social politics? In this course we consider the functions of textuality, orality, and performativity in the work of twentieth-century and contemporary American poets and how as social functions of verse in various periods in American history. To facilitate our discussion of these issues, we will read essays and poetry by a wide variety of authors. In addition to writing two papers on original topics, you will also be required to attend at least two performance events outside of class and write an analysis of each. Later in the semester, you will perform a poem for the class and write about your reflections of the experience. Or, if you prefer, the writing experience is not required of students; rather, you will put what you’ve learned about poetry in performance into action in this final assignment, and it will be expected that students with a range of different backgrounds will approach the assignment from various perspectives.

64-302 CAS Fall Fellow Intermittent: 9 units Title: Formation and Locations of Modern Korean Society and Culture Instructor: Suyang Park, PhD. This course examines the rapid transformation that Modern Korean society and culture have undergone since the end of the 19th century. Located between old and new Asian empires such as China and Japan, while later succumbing to a United States-led hegemonic order in East Asia, South Korea’s modern history is characterized by its experience of colonization, decolonization, the Korean War, territorial division, military authoritarianism, rapid industrialization, the anti-authoritarian minjung (or grassroots) dissident movement, and the formation of a dynamic post-minjung civil society. The course provides an in-depth analysis of significant issues, including the so-called ‘Military Comfort Women’ taken by the Japanese army during the Second World War, the Kwangju Massacre, contentious US-Korean relations, South Korea’s emerging democracy, emigration, and the “Korean Wave” phenomenon as shown by the success of the Korean film and cultural industry that has swept through Asia and beyond since 1997. Through the analysis of diverse materials such as art works, poetry, testimonies, memoirs, and intellectual history, the course will investigate the significant roles and locations of culture, arts and ideas in this historical transformation and their differential power to mark the historical time and space of a society.

64-450 Hitchcock and His Films Intermittent: 6 units Examines the continued importance of one of cinema’s greatest directors. In addition to a brief overview of his life, the course explores Hitchcock’s innovative use of the camera to create his idea of “pure cinema” and its connection to psychological and moral issues. The course also analyzes how audience-centered his films, and the influence of audience manipulation on the impact of his films that sustain in his films. Films include "The Lodger," 39 Steps," "Shadow of a Doubt," "Notorious," "Rope," "Strangers on a Train," Rear Window" "Vertigo," "North by Northwest," "Psycho," "The Birds," and "Frenzy."

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: 21-120, 09-105

06-200 Sophomore Research Project Fall and Spring: 3-12 units Research 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 by the student and the faculty advisor. 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; expansion of gases; specific heat capacities of gases; thermodynamic property relationships; changes of state; phase equilibrium and stability in single component systems; vapor pressure and boiling point elevation; and new Asian empires such as China and Japan, while later succumbing to a United States-led hegemonic order in East Asia, South Korea’s modern history is characterized by its experience of colonization, decolonization, the Korean War, territorial division, military authoritarianism, rapid industrialization, the anti-authoritarian minjung (or grassroots) dissident movement, and the formation of a dynamic post-minjung civil society. The course provides an in-depth analysis of significant issues, including the so-called ‘Military Comfort Women’ taken by the Japanese army during the Second World War, the Kwangju Massacre, contentious US-Korean relations, South Korea’s emerging democracy, emigration, and the “Korean Wave” phenomenon as shown by the success of the Korean film and cultural industry that has swept through Asia and beyond since 1997. Through the analysis of diverse materials such as art works, poetry, testimonies, memoirs, and intellectual history, the course will investigate the significant roles and locations of culture, arts and ideas in this historical transformation and their differential power to mark the historical time and space of a society.

06-222 Sophomore Chemical Engineering Seminar Fall: 1 units This course provides an overview of the chemical engineering profession. It discusses the rationale for the curriculum, career pathways, resume writing, written communication skills, 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 discussed. A case-study project based on new technological advancements is also required.

Prerequisites: 06100 and 21259 Corequisites: 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 dynamic systems 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: 06221 and 21122

06-300 Junior Research Project Fall and Spring: 3-12 units 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 advisor. A final written report or oral presentation of the results is required.

Prerequisites: 06-607, 09-221

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: 06221

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. Radiation and thermal radiation, with application to heat and mass transfer processes. Development of dimensionless quantities for engineering analysis is emphasized.

Prerequisites: 06262 or 21260

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: 06321 and 06323

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: 06262

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: 06261 and 06323

06-400 Senior Research Project Fall and Spring: 3-36 units 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 reviewed by the faculty advisor of the student. A final written report or an oral presentation of the results is required.

Prerequisites: 06321 Corequisites: 06-422


Prerequisites: 06321

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: 09347

06-423 Unit Operations Laboratory Fall: 9 units A series of open-ended laboratory projects illustrate the principles of unit operations and process control. Experiments are designed to be relevant to current industrial, environmental, and safety practices. Examples include distilling mixtures, such as ethanol and water; removing pollutants from stack gasses; controlling pH in tank systems with flow; testing mixture explosion properties; operating liquid-liquid extraction systems, such as ethanol and water; designing reactors based on the reaction kinetics of ethane hydrogenolysis; and separating oxygen and nitrogen in air using a hollow-fiber membrane. Oral and written reports are required.

Prerequisites: 06361 and 06362

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 problem solving in wetting, lubrication, foaming, adhesion, coatings and corrosion.

Corequisites: 06-607, 09-221

06-461 Process Design Project Spring: Mini Session - 6 units Computer-aided design of a large industrial project involving synthesis of process, energy and material balances and economic evaluation. An extensive report on the project must be submitted.

Prerequisites: 06421

06-462 Economics and Optimization Spring: Mini Session - 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.

Corequisites: 06-461

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: 09221 and (06609 or 09509)

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
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: 06262 and 09347

06-608 Safety Issues in Science and Engineering Practice
Fall and Spring: 9 units
Examines the students to personal safety issues encountered in normal science and engineering practice. Topics covered include mechanical, electrical, chemical, radiation, and biological hazards, to give an awareness of these hazards and appropriate action to be taken in the event of an accident.

06-609 Physical Chemistry of Macromolecules
Fall: 9 units
This course develops fundamental principles of polymer science. Emphasis is placed on physio-chemical concepts associated with the macromolecular nature of polymeric materials. Engineering aspects of the physical, mechanical and chemical properties of these materials are discussed in relation to molecular structure. Topics include an introduction to macromolecular science and a critical 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 prerequisites listed may seek permission of the instructor.
Prerequisites: 09347

06-610 Rheology and Structure of Complex Fluids
Fall: 9 units
This course will cover the basic concepts of rheology and mechanical behavior of fluid systems. Both the experimental and theoretical aspects of rheology will be discussed. The basic forces influencing complex fluid rheology and rheology will be outlined and discussed; including excluded volume, van der Waals, electrostatic and other interactions. Methods of characterizing structure will be covered including scattering techniques, optical polarimetry and microscopy. Examples will focus on several types of complex fluids including polymeric solutions and melts, gelling systems, suspensions and self-assembling fluids.
Prerequisites: 06609 or 09509

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: 06422 and 09347

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 of atmospheric physics and the fundamental to the particular problem. Students will formulate testable mathematical models incorporating that chemistry and physics, and compare these to existing atmospheric data sets. The current understanding. The emphasis of this course is to develop an understanding of how to pose a testable hypotheses in a complex chemical environment using 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) to the hydrogen, and then by extension predict how the system will respond to perturbations. 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: 06262 and 09105

06-621 Biotechnology and Environmental Processes
Fall: 9 units
First half of the course: microbial physiology and metabolism, fermentations and respiration, metabolic regulation, biocorversion, 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: 03231 and 06262

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: 06621 or 46261

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, aerosol, and radical 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: 06262 and 09105

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 a special emphasis on the gas and liquid states. Strengths and limitations of molecular simulation methods will be discussed. Topics will include basic statistical mechanics, molecular potential functions, Molecular Dynamics methods, Monte Carlo methods, computation of phase coexistence curves, and Brownian Dynamics.
Prerequisites: 06262 and 06321

Civil & Environmental Engineering

12-090 Technology and the Environment
Spring and Summer: 9 units
Technical elective for undergraduate, non-engineering majors. Overview of major environmental issues and their association with modern technology. Topics in the course include automobiles and associated air emissions and fuel consumption, information technology and electricity usage, electricity generation and alternative sources to reduce air emissions and wastes, CFCs and their influence on the ozone layer, and various issues related to land use patterns such as agriculture and infrastructure. Methods for using technology to improve environmental conditions also discussed. Within this framework the course aims to build fundamental problem solving skills, basic familiarity with engineering calculations, and understanding of everyday environmental issues. The overall purpose is to instill an appreciation of the complexity of issues and viewpoints surrounding technology development and associated environmental impacts.

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 accrues to regular courses and project exercises, the course includes guest speakers and class demonstrations. 3 hrs., rec., 1 hr. lab. Co-requisites: 21-120, 33-106.
Prerequisites: Corequisites: 21-120, 33-106

12-235 Statics
Spring: 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 computer architectures for flowsheeting systems.
Prerequisites: 06262 and 06361
simple statically determinate trusses, beams, frames, cables and other physical systems; friction. 3 hrs. rec. Corequisites: 12-100, 21-122, 33-106
Prerequisites: Corequisites: 21-122, 12-100, 33-106
12-251 Introduction to Environmental Engineering Fall: 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, surface and ground water, and soil systems. Pertinent environmental laws are described; simple quantitative engineering models are developed, and qualitative descriptions of environmental engineering control technologies are presented. 3 hrs. rec. Prerequisites: 06-101 or 12-100
Corequisites: 06101 or 12100
12-252 Introduction Environmental Engineering Lab Fall: 3 units
(Required for CEE students, not for others) Laboratory and field experiments that illustrate the basic principles of environmental engineering. 1 hr. lab. Corequisites 12-251

12-271 Introduction to Computer Applications in Civil & Environmental Engineering Fall: 9 units
Introduction to the use of computer-based applications in civil engineering, using generic tools such as spreadsheet, equation solvers and computer graphics. Discussion of the role of computer-based methods in civil engineering practice. 3 hrs. rec. Prerequisites: 12-120 and 33-106
Prerequisites: 21115 and 21116 and 33106
12-301 CEE Projects Fall: 12 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 course is intended to develop skills and understanding related to the application of engineering and science principles, approximations, empiricism, and experience to engineering projects; basic theory and practice of design; the importance and challenge of team efforts and effective communication; and the utility of measurements, modeling, visualization, quality control, and engineering graphics. 4 hrs. rec. Prerequisites: 12-235 and 12-251 and 12-271
Prerequisites: 12235 and 12251 and 12271
12-331 Solid Mechanics Fall: 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: 12-235 Corequisites: 21-259
Prerequisites: 12235 Corequisites: 12-259
12-332 Solid Mechanics Lab Fall: 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. 1 hr. lab. Prerequisites: 12-335 Corequisites: 12-331
Prerequisites: 12235 Corequisites: 12-331
12-335 Soil Mechanics Spring: 9 units
Sampling, testing and identification of soils. Physical, chemical and hydraulic characteristics. Stress-strain relationships for soils. Permeability, seepage, consolidation, and shear strength, with applications to deformation and stability problems, including earth dams, foundations, retaining walls, slopes and landfill. 3 hrs. rec. Prerequisites: 12-331 Corequisites: 12-335
Prerequisites: 12231 Corequisites: 12-335
12-336 Soil Mechanics and Materials Laboratory Spring: 3 units
Examination of material properties and behavior of soils. Experiments include soil classification, permeability, compaction, consolidation and strength tests. 1 hr. lab. Prerequisites: 09-105, 12-331 and 33-107
Prerequisites: 09105 and 12331 and 33107
12-355 Fluid Mechanics Spring: 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: 21-260, 21-259
Corequisites: 21-260, 21-259
12-356 Fluid Mechanics Lab Spring: 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. 1 hr. lab. Corequisites: 12-355
Corequisites: 12-355
12-358 Materials Lab Fall: Mini Session - 3 units
Examination of materials properties and behavior of concrete, masonry, and timber. 2 hr. lab. 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. 2 hrs. rec., 2 hrs. lab. Prerequisite: Senior Standing in Civil and Environmental Engineering or instructor approval for Design Minors.
12-411 Engineering Economics Fall: Mini Session - 6 units
Basic concepts of economic analysis and evaluation of alternative engineering projects for capital investment. Consideration of time value of money and common merit measures such as net present value and internal rate of return. Selection of independent projects and mutually exclusive proposals, using various methods of analysis. Capital budgeting and project financing. Influence of price level changes, depreciation and taxation on choice of alternatives. Uncertainty and risk in operation and financing. Important factors affecting investment decisions for private and public projects. 3 hrs. rec. Prerequisite: 21-115 or 21-116 and Senior Standing in Civil and Environmental Engineering
Prerequisites: 21115 and 21116
12-604 Special Topics: Transportation Engineering Spring: 9 units
Introduction to traffic engineering and highway design providing a 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 codes, building codes; preparation of drawings and specifications; laboratory demonstration and experiments. 2 hrs. rec., 2 hrs. lab. Prerequisites: 12-331 or permission of the instructor.
Corequisites: 12-331
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. 3 hrs. rec. Co-requisite: 36-220 or equivalent.
Prerequisites: 36211
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: 12331 and 12358 and 27357

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: 12331

12-636 Geotechnical Engineering
Spring: 9 units
Emphasis is on three major components of geotechnical engineering: (1) planning and design of exploration programs, interpretation of field and laboratory test data for use in geotechnical site characterization; (2) problem definition (e.g., slope stability, settlement analysis, etc.) and development of idealized analytical models; and (3) applications of analytical and numerical methods, particularly computer methods, applied to analysis and design. 3 hrs. rec. Prerequisites: 12335

12-651 Air Quality Engineering
Fall: 9 units
Problems and methodologies for studies of environmental management, with 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 atmospheric chemistry 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 uncertainty is included. Tutorials at specific places in the course. 3 hrs. rec. Prerequisites: 12-251, 12-355 Co-requisite: 36-220
Prerequisites: 12251 and 12355 and 36211

12-659 Water Quality Engineering
Fall: 9 units
An introduction to the fundamentals and engineering aspects of water quality. Basic principles of water chemistry; physical, chemical and biological phenomena affecting water quality; and prediction of the fate of pollutants in water. The water cycle is introduced with emphasis on water quantity changes that may occur in treatment processes and in natural-water environments including water and wastewater treatment systems and groundwater. 3 hrs. rec. Prerequisites: 09-105, 12-251 Co-requisite: 12-355.
Prerequisites: 09105 and 12251 Corequisites: 12-355

12-656 Water Quality Engineering Lab
Spring: Mini Session - 3 units
Examination of water quality using titrimetric, spectrometric, potentiometric, and chromatographic techniques. Illustration of principles of dilute aqueous chemistry and processes for affecting water quality. 2 hrs. lab. Corequisites: 12-655

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 stormwater collection systems. 3 hrs. rec. Prerequisites: 12251 Corequisites: 12-355

12-658 Hydraulics Structures
Spring: 9 units
Theory and practice of design or riverine and coastal structures, including dams, levees, bridge piers, culverts, jetties and groins, spillways, bulkheads, breakwaters, marinas, and harbors. Key related concepts from surface and ground water hydrology, and wave mechanics. 3 hrs. rec. Corequisites: 12-355

12-659 Special Topics: Matlab
Fall: Mini Session - 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 topics will be depicted using interactive scientific software called MATLAB.

Chemistry

09-101 Introduction to Experimental Chemistry
Fall and Spring: Mini Session - 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 course will apply concepts in organic synthesis, quantitative analysis using visible spectrophotometry, kinetics, acid-base chemistry, thermodynamics, transition metal chemistry, chromatography, and protein biochemistry. 1 hr. lec., 3 hrs. lab.

09-102 Special Topics
Spring: Mini Session - 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 demonstrations and laboratory and computer experiences. Topics vary, but have included: Forensic Chemistry in the Criminal Justice System, Macromolecules for Nanotechnology, and has complied with Once 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 majors who have had a high school course in chemistry. Objectives are to provide students with an understanding of basic chemical principles and to show how these are applied in so many different and practical applications. Major topics include: measurements, matter, atomic theory and the Periodic Table, chemical bonding, stoichiometry and chemical reactions, properties of aqueous solutions, states of matter (solids, liquids and gases), and acid-base chemistry. Additional topics may include: chemical equilibrium, the Arrhenius and kinetic-molecular theory, reaction rates, and nuclear chemistry. Students should gain confidence in applying scientific reasoning concepts to situations beyond the course. 3 hrs. lec., 1 hr. rec.

09-104 Fundamental Aspects of Organic Chemistry and Biochemistry
Spring: 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. While it is useful to have occasional "pop quizzes" the course will not include formal exams, assessment will be largely based upon attendance, "pop quizzes" and groups sets. The papers/slide sets, will be submitted in both hard copy and electronic attachment form. Initially a preliminary presentation will announce the individual choice of topics. Deadlines for submission of papers/slides will be given at the first meeting. 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
The course provides an introduction to some basic concepts of chemical equilibria and thermodynamics. Topics may include gas phase equilibria, acid-base chemistry, solubilities, oxidation-reduction reactions, enthalpy, entropy, free energy, colligative properties, and electrolyte behavior. Chemical kinetics is introduced to complement the study of thermodynamics. 3 hrs. lec., 2 hrs. rec.
Prerequisites: 09105 or 09107
bonding and strategies for the design of supramolecular assemblies. Readings from monographs and classroom lectures by the instructor will cover this material. Students will then begin to read about applications of supramolecular chemistry from the scientific literature, learning to compare articles, to evaluate the quality of the data and interpretations reached by the authors, to use the knowledge gained from these readings and discussions to predict the outcomes of related experiments, and to ultimately be able to design their own experiments. The course is intended to answer research questions. Meeting hours set by instructor, enrollment limited with priority given to sophomore chemistry majors.

Prerequisites: 09217
Corequisites: 09-218

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. The experimental work emphasizes the techniques of quantitative chemical analysis. Included are projects involving 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: 09106

09-222 Laboratory II: Organic Synthesis and Analysis
Spring: 12 units
This second course in the laboratory sequence introduces some important laboratory methods for synthesis and purification of organic compounds, as well as practical applications of spectroscopy and chromatography for characterization of organic compounds. Use of the chemical literature is included.

2 hrs. lec., 6 hrs. lab.
Prerequisites: 09217 and 09221 Corequisites: 09-218

09-231 Mathematical Methods for Chemists
Fall: 9 units
This course covers mathematical techniques that are important in the chemical sciences. The techniques will be covered in the context of chemical phenomena, and combine topics from 3-dimensional calculus, differential equations, linear algebra and statistics. This course does not count toward the minor in chemistry.

3 hrs. lec.
Prerequisites: 09106 and (21122 or 21123)

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. Presentations are evolutions in research. Selected topics include: the fundamentals of group theory; experimental and theoretical aspects of reactions and reaction mechanisms. The experimental work emphasizes the techniques of quantitative chemical analysis. Included are projects involving 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: 09217 and 09221 Corequisites: 09-218
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 reviewed and a brief connection to thermodynamics is made. 3 hrs. lec., 1 hr. rec.
Prerequisites: (09105 or 09107) and (21259 or 09231)

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: 09106 and (21259 or 09231)

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 is limited to chemical engineering majors. 5 hrs. lec.
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: 09345 or 09347

09-510 Introduction to Green Chemistry Spring: 9 units
The new field of Green chemistry focuses upon the reduction and elimination of hazards from chemical products and processes. Sustainability ethics will be introduced and discussed--these are central to all sustainability related education. The “principles of green chemistry” will be presented and analyzed. The chemical nature and action of certain pollutants of the atmosphere, land, and water, will be highlighted along with prospects for their minimization, and approaches for their eradication. Particular attention will be paid to the design and potential replacements for persistent bioaccumulative pollutants. A historical and technical analysis of costs to society of hazards and bad management practices associated with the lead and chlorine industries will be presented in detail. The recently discovered mechanism of toxicity called “endocrine disruption” will be introduced and its vast implications for the design of chemical products and processes will be explored: a resulting concept is that chemists need to learn how to protect the health of babies in the design and development of chemical products and processes as a critical element of developing the technological dimension of a sustainable civilization. A new platform oxidation technology with potential to reduce toxic effluents in multiple industrial sectors will be examined. The instructor in a laboratory setting: this technology has been invented at Carnegie Mellon. A significant effort has been made by the instructor to produce a course suitable for an interdisciplinary audience. This course is recommended for students in the junior and senior year. (Graduate Course: 12 units, 09-710) Prerequisites: 09218 and 09348

09-514 Advanced Organic Chemistry Spring: 9 units
This course will examine the following advanced topics in organic chemistry: orbital interactions as applied to structure and reactivity, conformational analysis, computational methods, structure elucidation by NMR and IR spectroscopy, reaction mechanisms and special topics of current interest such as electron transfer and recently developed synthetic methods. Problem solving will be emphasized, especially with respect to orbital interactions, NMR spectroscopy and reaction mechanisms. Individual projects in computational chemistry will also be undertaken.

09-517 Organotransition Metal Chemistry Fall: 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 catalysis and organometallic chemistry of industrial processes and organic synthesis. (Graduate Course: 12 units, 09-717) Prerequisites: 09348

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 synthetic and functional aspects of nucleic acids and carbohydrates together with their applications. Later in the course, students will get to explore some of the ongoing research in functional genomics. Students will be required to meet the instructor in a laboratory setting: this laboratory work will be assigned on a regular basis. The homework assignments will require data interpretation and experimental design. (Graduate Course: 12 units, 09-718) 3 hrs. lec. Prerequisites: 09218 and 09219

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 synthetic and functional aspects of proteins, peptides 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 chemical methodologies that have been developed in this area. The introduction to combinatorial chemistry in the context of drug design will also be presented. Students will be required to keep abreast of the current literature, and homework will be assigned on a regular basis. The homework assignments will require data interpretation and experimental design. Students enrolled in the graduate level course (09-719) will be required to write and present an original research proposal, 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: 09218

09-520 Global Atmospheric Chemistry: Fundamentals and Data Analysis Methods Fall: 9 units
This course will explore global atmospheric chemistry through a series of case studies: Stratospheric Ozone, Global Methane and CO2, 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 of this course 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 utilized in the context of problem of urban and regional air quality. (This course is also listed as 06-620.) Prerequisites: 21260 or 09231 Corequisites: 09-347, 09-348

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 the 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 studies will be introduced, with application toward the determination of electronic and molecular structure and enzymatic mechanisms. (Graduate Course: 12 units, 09-721) Prerequisites: 09344 and 09348

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 complexes and other metal-enzyme systems from a mechanistic viewpoint. Much attention is devoted to kinetic methods of investigation of homogeneous reactions and mechanisms of oxidative catalysis. Redox properties and electronic structures of metal complexes will be reviewed. The relationships between electronic structures, catalytic properties, and the 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: 12 units, 09-722) Prerequisites: 09348

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 to the fields of research that are of interest to the instructor. Homework assignments will be written on a regular basis. The homework assignments will require data interpretation and experimental design. (Graduate Course: 12 units, 09-725) 3 hrs. lec. Prerequisites: 09348

09-541 Spectroscopy Intermittent: 9 units
This course emphasizes the use of modern optical methods in the study of molecular properties and reactivity. Basic topics such as the use of the optical methods in the analysis of vibrational and electronic spectra are covered in detail. In addition, recently developed techniques such as time-resolved and nonlinear spectroscopies are discussed as are applications of optical
methods to problems in chemistry, biology and materials science. (Graduate Course: 12 units, 09-841)

Prerequisites: 09344 and 09345

09-543 Mass Spectrometry: Fundamentals, Instrumentation and Techniques
Intermittent: Mini Session - 6 units
This 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, ESI and MALDI), mass analyzers (diagnostic, quadrupole, time-of-flight, ion traps) and detectors are covered. Applications are focused in the areas of small molecule, proteomics and polymer characterization. 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. Various MS scan modes, i.e., SIM, SRM and MRM, and basic spectra analysis are covered. Students are exposed to QIT and RRKM theory and select gas phase reactions. The lecture is supplemented with the use of a “virtual Mass Spectrometry Laboratory” Internet tool, remote control of mass spectrometers and laboratory. 3 hrs. lec., 1.5 hrs. lab.
Prerequisites: 09214 or 09345 or 33341

09-545 Rheology and Structure of Complex Fluids
Intermittent: 9 units
A survey of the mechanical properties of polymeric materials in their many forms: melt, rubber, glass, crystalline, solution, mixtures, and composites with other materials. The dependence of structure on viscosity, viscoelasticity, and plasticity failure. The role of rheological properties in characterization, testing, fabrication, and use of polymeric materials. (Graduate Course: 12 units, 09-745)
Prerequisites: (09344 or 09347) AND (09509 or 06609)

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: (15113 or 152600) and 09344 and 09345

09-604 Introduction to Chemical Kinetics
Spring: Mini Session - 6 units

09-611 Chemical Thermodynamics
Fall: Mini Session - 6 units
A focused course on chemical thermodynamics. The basic thermodynamic functions will be introduced and discussed. The formal basis for thermochimistry will be presented. Single component phase equilibrium will be considered. The thermodynamic basis of solutions will be developed and applied to solution methods. Hetero- and homonuclear systems and equilibrium will be developed and applied to a wide variety of reactions. Finally, a few special topics such as self-assembled systems will be presented.

09-612 Introduction to Quantum Chemistry
Spring: Mini Session - 6 units
Introduction to quantum principles. The main topics to be covered include Schroedinger equation, particle in a box, the harmonic oscillator, and rigid rotor. Applications to vibrational, electronic, and NMR spectroscopy. Treatment of time-reversal symmetry and time-dependent quantum theory are introduced as well.

09-702 Statistical Mechanics and Dynamics
Intermittent: 12 units

09-705 Chemosensors and Biosensors
Intermittent: 12 units
Chemosensors and biosensors rely on “recognition” and “signaling” elements to transduce a molecular-scale binding event into an observable signal. Students in this course will be introduced to current research and technology for detecting chemical and biological analytes in a variety of contexts, including environmental, testing, biological probing and medical diagnostics. Recognition elements ranging from small organic molecules to antibodies will be presented, while various detection modes, including fluorescence, gravimetric and colorimetric, that illustrate different signaling elements will be discussed and compared. Issues to be addressed include sensitivity, selectivity and efficiency. Each sensor will be analyzed in terms of the physical chemistry, organic chemistry and/or biochemistry underlying its function.

09-711 Physical Organic Chemistry
Intermittent: 12 units
The study of the structure and reactivity of organic molecules from a physical and theoretical standpoint. Introduction to molecular orbital theory and the study of mechanisms in pericyclic, electron-transfer, photochemical and heterolytic reactions by the use of physical methods such as kinetics, isotope effects, substituent effects and spectroscopic methods.

09-712 Synthetic Organic Chemistry
Intermittent: 12 units
General synthetic strategies are discussed with a focus on C-C bond formation, functional group transformations, unnatural products and mechanisms.

09-720 Physical Inorganic Chemistry
Intermittent: 12 units
This course develops principles of magnetoochemistry and inorganic spectroscopy. Electronic absorption, magnetic circular dichroism, resonance Raman, NMR, EPR, Mössbauer and magnetization and x-ray methods will be introduced with application toward the determination of electronic structures of transition metal complexes.

Intermittent: 12 units
Proximal probe techniques are revolutionizing physical and biological sciences, owing to their ability to explore and manipulate matter at the nanoscale, and to operate in various environments (including liquids). Proximal probe techniques rely on the use of nanoscale probes, positioned and scanned in the immediate vicinity of the material surface. Their development is often viewed as a first step towards nanotechnology, since they demonstrate the feasibility of building purposeful structures one atom or one (macro)molecule at a time. This course is designed for the students of chemistry, biology, physics and engineering, who are interested in the fundamentals of proximal probe techniques and in their applications in various areas, converging into a rapidly developing, interdisciplinary field of nanoscience. It will provide physical background of such basic techniques as Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), and Near-Field Scanning Optical Microscopy (NSOM) and of their variants. Throughout the course, the working “virtual” AFM computer model will be assembled in classroom by each student and then used extensively to gain thorough understanding of AFM operation principles. Special emphasis will be placed on modes of operation facilitating chemical contrast and contrast based on other material properties. (No prior experience with computer programming required).

Computer Science
15-050 Study Abroad
All Semesters: 0 units
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: 0-3 units
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 employers 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.

15-100 Introductory/Intermediate Programming
All Semesters: 10 units
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 15-111. 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 15-100 and instead enroll in 15-111. NOTE: students who receive a grade of C or less in 15-100 should discuss whether they are adequately prepared for 15-200 with their academic advisor.

15-111 Intermediate/Advanced Programming
All Semesters: 10 units
An introduction to the process of program design and analysis using the Java programming language for students with some prior programming experience. (Functions, (First-Class) Functions, and higher order functions, and recursive data structures.) Other topics to be covered include an overview of fundamental programming concepts using Java as well as object-oriented programming, data abstraction, algorithms, and bringing sophisticated methods for specifying, constructing, and reasoning about computer programs. Via formal studies, experience with programming in the Java language is used to illustrate how different design goals can lead to radically different languages and models of computation. Prerequisites: 15-111 or 15200

15-200 Advanced Programming/Practicum
All Semesters: 9 units
This course assumes prior programming experience in Java (at the level of 15-100) and is designed to expand and deepen students’ knowledge of computer science and sharpen their programming skills through the implementation of a large project. The course extends to object-oriented programming techniques, 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. This course, along with 21-127, serves as a prerequisite for 15-211. NOTE: students who receive a grade of C or less in 15-100 should discuss whether they are adequately prepared for 15-211 with their academic advisor.

Prerequisites: 15100

15-211 Fundamental Data Structures and Algorithms
All Semesters: 12 units
Fundamental programming concepts are presented together with supporting theoretical foundations and 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.

Prerequisites: 15111 or 15200 and 21127

15-212 Principles of Programming
Fall and Spring: 12 units
This course presents the 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 structures such as first-class functions; and for building large programs using advanced module composition. It also introduces the use of formal methods for specifying and verifying programs.

Prerequisites: 15211

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, system concepts, computer arithmetic, memory organization and management, networking technology and protocols, and supporting concurrent computation.

Prerequisites: 15113 and 15211

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 and oral presentations for multi-level audiences. Assignments include technical definitions, descriptions, instructions, process explanations, abstracts, memos, and research projects. Assignments may incorporate recent computer science research at Carnegie Mellon, projects in related technical courses, and professional case studies.

Prerequisites: 76101

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. As of the Spring, 2007 semester, this course will be renumbered 15-210.

Prerequisites: (15100 or 15111) and 21127

15-312 Foundations of Programming Languages
Fall and 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: 15212

15-317 Constructive Logic
Spring: 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 intuitional 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: 15212

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: 15251

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 systems 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: 15251
15-359 Special Topic: Probability and Computing
Spring: 12 units
Probability theory has become indispensable in computer science. In areas such as artificial intelligence and computer science theory, probabilistic methods and ideas based on randomization are central. In other areas such as networks and signal processing, probability is becoming a 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, and various randomized algorithms, sampling random variables and computer simulation, and Markov chains and their many applications, from Web search engines to mathematical models of proteins. The course will assume familiarity with basic calculus and linear algebra.
Prerequisites: 15211 and 15251

15-381 Artificial Intelligence: Representation and Problem Solving
Spring: 9 units
This course is about the theory and practice of Artificial Intelligence. We will study modern techniques for computers to represent task-relevant information and make intelligent (i.e. satisfying or optimal) decisions towards the achievement of goals. The search and problem solving methods are applicable throughout a large range of industrial, civil, medical, financial, robotic and information systems. We will investigate questions about AI systems such as: how to represent knowledge, how to effectively generate appropriate sequences of actions and how to search among alternatives to find optimal or near-optimal solutions. We will also explore how to learn 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. Our treatment of these topics introduces additional aspects of AI, including natural language processing, web-based search engines, industrial applications, autonomous robotics, and economic/game-theoretic decision making.
Prerequisites: 15212

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: (15111 or 15200) and (18202 or 21241 or 24511)

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 feature extraction, image representation, edge detection, grouping, discrimination, inference of depth and shape, learning, 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 be guided by 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 Matlab programs to solve real vision problems.
Prerequisites: 15113 and (18202 or 21241)

15-391 Technology Consulting in the Community
Fall and Spring: 9 units
In this course, the student develops technical consulting and management skills while collaborating on site with a community leader of a non-profit community consulting project. This service-learning course de-emphasizes coding, asking the student instead to analyze a complex organization, then design and implement a work plan that will expand the organization's capacity to use information technology. Throughout the semester, students develop a consulting report. They learn how to use this report to communicate with others and to think through and communicate a strategic technology plan. Students also experience how urban community organizations function, seeing the valuable benefits these organizations provide to society.
Prerequisites: 15111 or 15250

15-392 Special Topic: 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: 15100

15-397 Special Topic: Web Application Development
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 also cover the related topics as necessary so that students may build significant applications. Such topics include: HTTP, HTML, XML, JavaBeans, Design Patterns (Abstract Factories), JSP Libraries (JSTL), Relational Databases (MySQL/JDBC), Security (SSL), Web Services (SOAP/WSDL/UPDDI), the Frameworks (Struts), and AJAX/Server Pages (ASP/ASP.NET). Set software packages will be demonstrated. Students will be required to create and demonstrate their own web applications. They may use the software demonstrated in class or similar software packages with permission of the professor. Grading will be based on these student projects. Notes: Students are required to provide their own computer hardware for this course. Student hardware must run up-to-date versions of (source control, modularity, documentation) are emphasized. The primary focus of the second half. *Two 6 unit listings run only for Mini 3: 46-864/167-660. Tepper Masters students in the Technology Leadership Program register for 46-864. Masters students register from other programs. They wish to take only the non-project part of the course during Mini 3.
Prerequisites: 15212

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 working a small Unix-inspired OS kernel, in C with some x86 assembly language, which runs on a PC (or software simulator 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 such as 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: 15213 or 15395

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 interactions between language design, compiler design, and run-time optimization. Topics covered include syntactic and lexical analysis, handling of user-defined type, and type-checking, context analysis, code generation and optimization, and memory management and run-time organization.
Prerequisites: 15213 or 15312

15-412 Operating System Practicum
Fall: 9,12 units
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, the course may work with an open 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 artifacts about hardware and software, classifying and/or reading large amounts of code written by various people over a long period of time, etc.

Prerequisites: 15410

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 and develop techniques to identify and prevent these 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 these 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: 15211 and 15251

15-415 Database Applications
Fall and Spring: 12 units
This course covers the fundamental topics for Database Management Systems: Database System Architectural Principles (ACID properties; data independence; conceptual, and internal schemas; 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: 15212

15-418 Parallel Computer Architecture and Programming
Spring: 12 units
The fundamental principles and engineering tradeoffs involved in designing modern computer systems are explored. The course develops 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: 15213 or 18347

15-421 Web Commerce, Security and Privacy
Fall: 12 units
Overview: Over the past ten 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 Internet Commerce, including issues of security and privacy. Part I - We will start by trying to understand what eCommerce is, looking at both business-to-consumer and business-to-business usage scenarios. We will examine the differences of electronic commerce, electronic identification of buyers and sellers, to the selection of goods, negotiation, sale, payment, delivery and post-sale activities and examine how new technologies and practices can help add value at each step. In the process, we will look at a variety of technologies such as Web search technologies, personalization, collaborative filtering, data mining, auctions, P2P technologies, Web Services, agent technologies and the Semantic Web. Part II - This section of the course covers Web security issues, including overviews of symmetric and asymmetric key cryptography and PKI. This part of the course also includes an overview of electronic payment solutions and a discussion of Web privacy (e.g. P3P) Part III - This third part of the course is a series of 4 or 5 lectures that look at Mobile Commerce, revisiting many of the issues covered earlier in the course and looking at what happens when latencies exist in the network. This course will draw upon examples primarily from the Internet. Topics to be covered include LAN, wireless, WAP, mobile commerce, payment, authorization, naming, multicasting, switching, internetworking, quality of service, and network security. There will be both written and programming assignments assignments involving the course.

Prerequisites: 15213 or 15395

15-441 Computer Networks
Fall and Spring: 12 units
This is an introductory course about computer networks. The emphasis will be on the basic performance and engineering tradeoffs in the design and implementation of computer networks. Students will 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 LAN, congestion, Internet Service Protocols, IP, TCP, congestion control, naming, multicasting, switching, internetworking, quality of service, and network security. There will be both written and programming assignments assignments involving the design and implementation of a complete protocol stack.

Prerequisites: 15213 or 15395

15-451 Algorithm Design and Analysis
Fall and Spring: 12 units
This course is about the design and analysis of algorithms. We study a variety of algorithms and data structures, 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 protocols.

Prerequisites: 15212 and (15351 or 15354 or 15355 or 21301 or 21373 or 21484)

15-453 Formal Languages and Automata
Spring: 9 units
An introduction to the fundamental ideas and models underlying computing: finite automata, regular expressions, context-free grammars, Turing machines, undecidability, and complexity theory.

Prerequisites: 15212 and (15351 or 15354 or 15355 or 21301 or 21373 or 21484)

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: (15213 and 21241 and 21259) or (15213 and 18202)

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 visualizations of the world. We will examine 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: (15213 and 21241 and 21259) or (15213 and 18202)

15-464 Technical Animation
Fall: 12 units
This course introduces techniques for computer animation such as keyframing, procedural methods, motion capture, and simulation. The course also includes a brief overview of storyboarding, scene composition, lighting, and sound track generation. The second half of the course will explore current research topics in computer animation such as dynamic simulation of flexible and rigid objects, automatically generated control systems, and evolution of behaviors. The course should be appropriate for graduate students in all areas and for advanced undergraduates.

Prerequisites: 15462

15-465 Animation Art and Technology
Spring: 12 units
This class will explore ways in which the production of animation can incorporate enhancements such as motion capture and the modification of algorithms in combination with the objective of artistic expression or content development. Students will work on projects in cross-disciplinary teams. This is a cross-listed class between Art and Computer Science. It will use two different clusters for production work in Maya. The first class will meet in CFA room 303.
Prerequisites: 15462

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, textures/backgrounds and collision detection, and physically-based modeling, game AI, and multi-user games and networking. Although this course has a heavy programming focus, curricular objectives briefly 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.

15-482 Human Language Technologies
Fall: 12 units
During the last decade computers have begun to understand human language. 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 fundamentals of 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, failures, 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: 15212

15-485 Computational Perception and Scene Analysis
Spring: 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 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 observers 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 approach to the course fulfills the goals of scientific research—articulating 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: 15385 or 85370

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 neural 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 neural 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: 15113 and (18202 or 21241)

15-S19 Independent Study in Programming Systems
Fall and Spring: 3-36 units

15-S29 Independent Study in Human-Computer Interaction
Fall and Spring: 3-36 units

15-S39 Independent Study in Computer Science Pedagogy
Fall and Spring: 3-18 units

15-S49 Independent Study in Computer Systems
Fall and Spring: 3-18 units

15-S59 Independent Study in Theoretical Computer Science
Fall and Spring: 3-36 units

15-S69 Independent Study in Graphics
Fall and Spring: 3-36 units

15-S79 Independent Study in Robotics
Fall and Spring: 3-36 units

15-S89 Independent Study in Artificial Intelligence
Fall and Spring: 3-36 units

15-S99 Undergraduate Thesis Research
Fall and Spring: 0-18 units
Advisable only to students registered in the CS Senior Research Thesis Program. More information is available at the CS Undergraduate Office.

15-681 Artificial Intelligence: Machine Learning
Fall: 12 units
Machine Learning is concerned with computer programs that automatically improve their performance through experience (e.g., programs that learn to spot high-risk medical patients, recognize human faces, detect credit card fraud, and drive autonomous robots). This course covers the theory and practical algorithms for machine learning from a variety of perspectives. We cover topics such as datamining, decision tree learning, neural network learning, statistical learning methods, genetic algorithms, Bayesian learning methods, explanation-based learning, and reinforcement learning. The course covers theoretical concepts such as inductive bias, the PAC learning framework, description length principle, and Occam’s Razor. Short programming assignments include hands-on experiments with various learning algorithms. Typical assignments include neural network learning for face recognition, and decision tree learning from databases of credit records.
Prerequisites: 15211

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 related to the design process. Students learn methods of representation, communication, idea generation, and form and practice these methods through a variety of projects.
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.

**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. Project work both theoretical and practical provides the basis for introduction to more complex drawing media. Demonstrations and group and individual critiques reinforce concepts presented in class.

Prerequisites: 51121

**51-132 Introduction to Photographic Design**

Spring: 9 units

Introduction to photography for designers through digital photography. Using a digital camera, students learn how to extend their ‘seeing’? Willing, approaches both in the world and in the 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 a photographic as real as how to make them. In the studio teaching, 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 photographers 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: 51101

**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 and design 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 thoughtful design has enriched 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.

**51-174 History of Objects & Images**

Spring: 9 units

History of Objects and Images The History of Objects and Images serves as an introduction to art and design history. The course exposes students to a diverse, global range of visual and material culture from prehistoric times through the eighteenth-century. It is not intended to give a chronological overview but rather to familiarize students with various ways in which people have designed and made their world. The course draws from many disciplines including anthropology, archaeology, fine and decorative art history, architectural history, and cultural studies. Topics for the course include communication, transportation, privacy, shelter, comfort, typography, art, clothing, furniture, architecture, and landscape.

**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 they are 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 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.

Prerequisites: 51102

**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. Prerequisites: 51201

**51-203 Communication Design Computer Lab**

Fall: 3 units

This new sophomore level Communication Design course introduces students to the rich and diverse process of making images. Communication Design faculty will each work with students on short projects over the course of the semester. Students will make initial projects working with different means and technologies such as mark-making, working with found images and different materials, computer and hand-generated drawing, and the camera.

**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.

Prerequisites: 51102

**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.

Prerequisites: 51211

**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.

Prerequisites: 51201 or 51211

**51-224 Digital Pre-Press Production**

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 output 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.

**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 for reference, acquire an understanding of the design 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 methods 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.
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. Instructer permission required for non CD sophomores.

51-231 Calligraphy I  
All Semesters: 9 units  
Working with pure unadorned Roman letterform, 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 and critiques of writing. Art and hand activities 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. Calligraphic page design. Publications past and present. Calligraphy’s role in design today. The king of 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. Hand letters are introduced, to be decided by student and instructor. Prerequisites: 51231

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. Prerequisites: professional program status Fall: 9.0 units

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 models of complex systems. The skills of freehand drawing, mechanical drawing and three-dimensional models are employed and developed during project sequence. Required of ID students. Prerequisites: 51211

51-243 Prototyping  
Fall: Mini Session - 4.5 units  
A half-semester laboratory mini-course introducing a range of materials, methods, and workshop techniques by which designers prototype their ideas 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.

51-246 Photo Documentation  
Spring: Mini Session - 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.

51-251 Digital Prototyping  
Fall: Mini Session - 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.

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.

51-262 Communication Design Fundamentals  
Spring and Summer: 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.

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.

51-265 Black and White Photography I  
Summer: 9 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 presentations and discussions 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.

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 be more adept at understanding the context of design and designing and exploring the social impact of design. Required of all design sophomores. No prerequisites.

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. Prerequisites: 51202

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. Prérequisits: 51301

51-311 Product Design ID III Fall: 9 units
Course projects are chosen to give students an opportunity to use their creative and technical 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.
Prérequisits: 51212

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.
Prérequisits: 51311

51-315 Digital Imaging Intermittent: 9 units
The objective of this course will be to provide students with a practical, technical and theoretical foundation in digital imaging. The primary software for this course will be Adobe Photoshop, with which students will explore construction, combination, manipulation, input, and output of photographs as a means of image creation. To supplement this technical and theoretical discussion, we will also consider the aesthetic and political implications of the emergence of this and other new electronic imaging technologies.

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 supermarket? A museum? A store? A park? An airport? A parking garage? An athletic field? A hotel lobby? How does the space you are in affect the way you feel? How is the space, and how is it proportioned? What 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? Imagery of a bright orange surface. What if the walls were rough instead of smooth—would they catch the light differently? Does the sunlight come from the space, casting shadows? Or is it 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.

51-318 From Marks to Trademarks Intermittent: Mini Session: 4.5 units
From MARKS TO TRADEMARKS The structure of the class will proceed historically from antiquity to today with mini presentations of mark categories that will provide a grounding for each student who will be particular and category, understanding their historical role and projecting their presence, into contemporary culture. Each student will share their research work with the rest of their peers during each of the class sessions for discussion and feedback. This will help build many connections between subject areas as well as enrich the entire subject of marks. Each student will produce a (written & designed) project, with which they will demonstrate their research. The class will conclude with each student giving a mini presentation of their project. Every student is expected to be a proactive member of the class, contributing to the discussions and content. If time permits, guest experts will be invited to contribute. Goal: To gain an understanding of the significant historical path from the earliest mark making to the role of trademarks in communication design and contemporary society. Class limit: 10

51-321 Photography and Communications Intermittent: 9 units
An advanced photo-imaging course to further develop proficiency in making and understanding photographs in the context of communication design. Photography will be seen as a medium of communication through which personal aesthetic and individual style are expressed. We will work in a variety of photo-image forms, including traditional black and white, altered, and digital. We will also explore different formats for presenting photographs, including book, collage, sequence. In addition, we will examine photography from the nineteenth century to the present to understand how the medium has evolved and how individuals have used photography for personal expression. Extensive shooting and darkroom work, library research. 35mm camera necessary; lab fee.
Prérequisits: 51211 and 51221

51-322 Visualizing the Global Footprint Intermittent: 9 units
Visualizing the Global Footprint The School of Design and the College of Humanities and Social Science, in conjunction with the Steadman Institute for Environmental Education and Research, will work to design a series of interventions to educate college students both nationally and internationally, to better understand their role in preserving the earth’s natural resources. Our goal is to create a set of tools that will allow a better understanding of the factors that influence mankind’s impact on the globe as defined by and demonstrated in the Living Planet Report 2004 (World Wildlife Fund). The project involves helping college students better understand the environmental consequences of various everyday life choices and behaviors. Additionally, the product must be a place where educational modules are made available to help inform the users about behaviors that impact the environment and how one might begin to adopt more positive behaviors without negatively affecting their lifestyles. One of our greatest challenges will be to design something that can be universally understood around the world.
Prérequisits: 51301

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.
Prérequisits: 51122

51-324 Basic Prototyping Methods for CD Spring: Mini Session: 4.5 units
A half-semester laboratory mini-course introducing a range of methods and techniques 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.
Prérequisits: 51201

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.
Prérequisits: 51202

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 to the present. We will discuss theoretical issues, e.g., how cultural context influences the making and understanding of photographs; how photographers use both conscious and unconscious strategies in image-making; how documentary images take different forms-ranging from seemingly literal and objective descriptions, to intensely emotive 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 material 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
Intro to Web Design is an HTML and Web Design fundamentals class, covering topics ranging from the necessary design elements to create a strong site to the coding skills necessary to produce it. Exploring navigational elements and usability along with grids, typography, images, and color through several studio projects will help develop the necessary skills required to design and build useful web sites. No previous HTML coding or design experience is required. Pre-req: Design junior status or 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 books, 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, there is a requirement to use the shop. Extensive shooting and darkroom work, library research. Prerequisite: black and white darkroom 51-221.

51-331 Advanced Calligraphy I

All Semesters: 9 units

Continued study in the discipline of calligraphy. (Meets with Introduction to Calligraphy I.) Two projects will be created. (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: 51232

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: 51331

51-334 Experimental Packaging

Intermittent: 9 units

EXPERIMENTAL PACKAGING This course will explore a range of materials that contain, support and deliver appropriate message about the product. Some materials support the contents better than others. Some packaging is made up of layers of materials, some for protection, some to express the value of the product. Some products are associated with the materials used in their packaging. Some materials are used in the package because they protect the product better than others, while some display it better at the point of sale. Some materials permit the product to be seen by the buyer, while others cloak it in mystery. Some products require closed containers because the contents are liquids or lack a fixed shape or solid form. Many materials have unique textures and cry out to be touched or handled, while some are slick and smooth. Branding and labeling of the packages will be fit the individual packaging concept thus grounding it as a package. Taking Prototyping Methods, (mini 1st half of Spring term on Friday AM; taught by Tom Merriman), or having taken it previously, is a requirement to use the shop. Although some desktop modeling will be used, exploring various materials for packaging can only be accomplished in the shop with the vast array of power and hand tools available. This course is open for a day for Communication Design and Industrial Design students. A 50% mix of both majors is desirable.

51-335 Mapping and Diagramming

Fall: 9 units

This course explores the different ways in which we communicate complex information, through maps and diagrams. Students will design maps and diagrams using subject matter of their choice.

51-336 Web Design Practicum

Intermittent: 9 units

Web Design Practicum All you need to know to set up your web-based portfolio, including basic HTML, image prep, labeling structures, template strategies, direct manipulation and style sheets. Intended for design majors only.

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 twentieth century documentarians while students photographically investigate their own topics. Among the many ethical areas of a documentarian's concern, the course examines (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 and darkroom work, library research. Prerequisite: black and white darkroom 51-221, or by the permission of the instructor.

51-341 How Things are Made

Fall: 9 units

This course introduces students to the alternatives of materials and manufacturing processes that are considered in product design and development. Through the combination of lecture, demonstrations and field trips students learn the advantages and disadvantages of various materials and processes, and how to choose and specify them in a particular product application. Required of ID students.

51-342 How People Work with Things

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 exploring the problem, defining a concept generation using participatory and co-design methods, and user feedback to evaluate emerging design concepts, as they are refined. Course forms include lecture, projects, 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 Product Morphology

Intermittent: 9 units

"Morphology" refers to the systematic study of form; "Product" means that we will be studying the form of products, as compared to buildings or rocks, for example. This course provides ID students an opportunity to develop their form vocabulary and form sophistication beyond the sophomore year. This course will require a lot of drawing, modeling, and other kinds of visual studies, focusing on ways to make a superior product form, issues of form language, visual and tactile usability, expression and emotion, cultural appropriateness. There will be little time put into solving the engineering or marketing aspects of products. Instead, students should be prepared to spend many hours in form variation and revision. Prerequisites: 51243 or 51324

51-344 Advanced Digital Prototyping

Spring: Mini Session - 6 units

This course is an advanced course using SolidWorks computer modeling. It is a prerequisite for Production Prototyping. Prerequisites: 51211

51-346 Production Prototyping

Spring: Mini Session - 6 units

This course is the 2nd half of Advanced Digital Prototyping, using your work in SolidWorks to produce hard models. Prerequisites: 51341

51-349 Visual Notation, Journal

Intermittent: Mini Session - 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 means of field notation, journaling, storyboarding, and "hot-house" conceptualization; 2. gain exposure to advanced rendering techniques such as markers, chalk pastels, and GIMP/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. Prerequisites: 51-121, 51-122

51-351 Drawing, Expression and Communication Intermittent: Mini Session - 4.5 units
Drawing, Expression and Communication 51-351 A2 2nd mini
This course explores the use of drawing as a means of visualizing, communicating and engaging with ideas and ideals 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 on the composition and presentation 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 draftsman 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.

51-353 Writing & Photography: Magazine Writing & Journalism Intermittent: 9 units
Revealing Place: Photographers and Writers Working Together 9 units
Instructors: Jane McCafferty, English Department; Charlee Brodsky, School of Design 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 Learning to Look Intermittent: Mini Session - 4.5 units
Topics courses address important themes in the history, theory, and criticism of design. Offerings vary from year to year. Lectures and discussions. Extensive readings. No prerequisites.

51-374 Understanding Perception through Design Spring: 9 units
51374 Understanding Perception through Design This course emphasizes audience expectations and, also known as schemas, as a major influence on the artifacts we produce. For example, we read many stories in the 19th century as an escape from reality rather than as a home. The manner we use to communicate, either following or deviating from expectations, affects the way people perceive and process information we present. Through lectures, discussions, readings, and projects, we will study the use of schemas in both print and digital mediums, closely examining information structures. We will also explore the hearing of expectations, how they are projected in the 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. Class size: limited 10 people

51-379 Emotion and Reason in Design Intermittent: 9 units
51379 & 51779 Emotion & Reason in Design Emotion plays an important role in all forms of design, yet emotion is difficult to describe and analyze. The goal of this course is to study emotion in a different way. Instead of locating emotion in the responses of an audience, we will focus on locating emotion or emotional expression within the design itself. Assignments will involve extensive reading. This course will be conducted as a research seminar, with each student preparing a paper on a subject of personal interest in design.

51-380 Dignity, Design and Action Intermittent: 9 units
Dignity, Design and Action How would we design to help people realize their dignity and rights as human beings? To answer this question, we will explore what human dignity is and why action is significant to the achievement of this end. Drawing from prominent work in the fields of anthropology, psychology, philosophy, and design studies, the class will develop a definition of human dignity, explore ways it has or has not been designed for in the past, and propose future possibilities with this new theme in mind. Please join us if you are a junior, senior or graduate student, like to speak-up in class, and want to challenge your understanding of design and process. Class size: limited 10 people

51-383 Conceptual Models Intermittent: Mini Session - 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 model to 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.

51-387 Interactive Learning Tools Intermittent: Mini Session - 4.5 units
As we learn to read and write sentences, stories or even poetry we are explicitly taught how to construct an expression. Unfortunately in most schools, we learn very little about the "clothes" words wear. As designers we know that form is content too. We look beyond the letters to the letterforms. The goal of this mini is to develop an interface that enables our target audience to learn how the forms of words reflect the content too and how to use that form to enhance meaning. An interactive learning environment is one that supports structured interaction between communities of learners. In this mini we will conduct exploratory research and use our findings to develop prototypes for a learning environment for writing that includes form as an explicit part of the composition. - The course should only be open to undergrads and grad with experience in design technology or permission of the instructor.

51-396 Redefining the Portfolio Intermittent: Mini Session - 4.5 units
Redefining the Portfolio The portfolio is a document that provides a personal narrative of a student's work, process and approach to solving problems. These artifacts are in effect, an evolving collection of our best work, yet present numerous challenges when trying to craft a cohesive and succinct presentation about our style, approach, and outlook on design and the world. In this course, we will discuss strategies for aligning the content and structure of your printed portfolio to provide a platform from which to present yourself as a designer.

51-399 Junior Independent Study All Semesters: 3-12 units
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 can be created in a variety of advanced topics, both self-initiated and, at times, inspired by clients or organizations, providing real world clients. This project highlights the role that visual interface designers play in the multi-disciplinary development teams. In this mini we will focus on one 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: Product 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 spring 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 coordination of the space. Projects could include signage, exhibit design, navigation and wayfinding, furnishings within a space, or even park design.

51-414 Senior Project 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 teams on projects designed by companies. In addition to the product development project, the course includes lectures on innovation strategy, opportunity identification, designing products, object representation and manufacturability, rules, computer-aided 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 Introduction to Interaction & Visual Interface Design
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 Visual Interface Design
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.

51-425 Letterpress and Bookbinding
Fall and Spring: 3-12 units
This course provides opportunities to work on an antique letterpress and learn the fine art of bookbinding. Emphasis is placed on good craftsmanship, while allowing students to work on individual projects as well as a group project.

51-427 Time Motion and Communication
Fall: 9 units
In the digital medium, we are no longer limited to static forms for expressing information. This digital studio course explores the use of kinetic forms - visual forms expressed over time - to understand their unique qualities in communication design.

51-433 Advanced Interaction & Visual Interface Design
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.

51-441 Product Planning & Development
Fall: Mini Session - 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. This 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
This course highlights the role that visual interface designers play in 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.

51-452 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 research 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. Assignments and a series of 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 aesthetic language of the artifact. Lab fee and material purchases required.

Prerequisites: 51243

51-453 Applied User Research
Mini Session - 4.5 units
This course is an opportunity for students to study how user research applies to the design of specific 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, they 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 through 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, outside readings 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
This mini course explores the various ways that designers, engineers and marketing interact and plan products on a global level. Designers must often plan for products that will be sold in markets around the world. As a result of global markets, design teams must conduct user research on many students in several countries simultaneously. Product programs often require the coordination of designers and other disciplines from around the world. Designers must integrate global manufacturing and
assembly and plan for global distribution of products. Globalization has required designers to think and work in new ways. Case studies discussed in a seminar format and research into successes and failures of global product programs will be the two primary methods used in the class. This course is for upper level design majors, and masters students in design, engineering and business.

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 (1960s – 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. 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: Mini Session - 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 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 create 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, 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 3-12 units Guidelines for independent study in the Design Office. Proposals must be approved by faculty before pre-registration.

Drama

54-101 Acting I Fall: 9 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: 12 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.

54-103 Speech I Fall: 6 units (Speaking Voice) The First Year students are introduced to concepts of vocal support and are encouraged to develop a process which will allow them to communicate on stage with open, free sound. Their regular warm-up sessions demonstrate the possibilities of full-range and strength. The voice work is designed to allow for creative and personal approach to text. (Speech & Phonetics) The speech work introduces students to the phonetic alphabet, isolating each sound and acquainting the students with a symbol for each vowel, diphthong and consonant, a process which will enable them to identify each for particular work to strengthen the production of sounds and/or personal corrective work. The process helps the student actors to eliminate regional characteristics. Both areas of voice and speech approach the application of these beginning techniques to prose and poetic texts.

54-104 Speech I Spring: 6 units (Speaking Voice) The First Year students are introduced to concepts of vocal support and are encouraged to develop a process which will allow them to communicate on stage with open, free sound. Their regular warm-up sessions demonstrate the possibilities of full-range and strength. The voice work is designed to allow for creative and personal approach to text. (Speech & Phonetics) The speech work introduces students to the phonetic alphabet, isolating each sound and acquainting the students with a symbol for each vowel, diphthong and consonant, a process which will enable them to identify each for particular work to strengthen the production of sounds and/or personal corrective work. The process helps the student actors to eliminate regional characteristics. Both areas of voice and speech approach the application of these beginning techniques to prose and poetic texts.

54-105 Voice I Fall: 5 units This course introduces basic concepts and practice related to voice usage for actors. Principles of healthy, expressive and dynamic voice use will be explored and how to maintain healthy voice usage in demanding performance situations. The Linklater work adapted by Feindel and its application to text and acting principles make up the core aspects of the course, including basic principles of the Alexander Technique. Voice and its relation to other areas such as psychology, spirituality, community and science are also introduced.

54-106 Voice I Spring: 6 units Prerequisite, Voice I Fall Semester This is a continuation of Voice 1, fall semester. The course covers the strengthening of resonators, combined with Shakespeare and writing exercises. Students develop a basic understanding of the possibilities of full-range and strength. The voice work is designed to allow for creative and personal approach to text. (Speech & Phonetics) The speech work introduces students to the phonetic alphabet, isolating each sound and acquainting the students with a symbol for each vowel, diphthong and consonant, a process which will enable them to identify each for particular work to strengthen the production of sounds and/or personal corrective work. The process helps the student actors to eliminate regional characteristics. Both areas of voice and speech approach the application of these beginning techniques to prose and poetic texts.

54-107 Movement I Fall: 4 units This first semester of Movement concentrates primarily on developing the students’ awareness of physical messages, how much their movement can add or distract in a scene. First, the look at what they bring to the situation, their personal physical habits and we begin the corrective work to rid them of these unconscious tics and introduce them to balanced alignment. Throughout a series of improvisations, they begin to see that the body can reflect a complex inner life, subtle changes in environment, shifts in status and relationship, history and hidden agendas. By stripping away layers of the unconscious, students learn new physical choices that aid the character and scene. The other components of the first semester address spatial relationships, movement on a stage, rhythm and spontaneity.

54-108 Movement I Spring: 4 units The second semester of Movement deals more specifically with the movement corrective work, incorporates exercises to achieve isolation, control strength, balance and explores specific movement techniques. Non-verbal improvisations lead into animal movement work, to coincide with the animal project in First Year Acting. This is followed with mime techniques, both for the ability to handle imaginary objects and for a physical understanding of what the body does during various activities (analysis of movement), as well as aiding in visualization, concentration, focus and specificity. Pantomime Bianche introduces them to a highly disciplined, purely physical form and
gives students the opportunity to apply techniques in this distinctive style.

54-109 Dramaturgy I
Fall: 9, 15 units
One semester only with crew. Freshman level but open to any student in the university.

54-111 Text
Spring: Mini Session - 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 Introduction to Directing
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
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: 54121

54-123 Dance I
Fall: 5 units
Sec A - Classical technique (Ballet) is used to for proper body alignment, placement, and muscular strength using basic elementary and intermediate vocabulary. Course closed: Only for Music Theatre majors in Drama. Prerequisite: Permission of instructor

54-124 Dance I
Spring: 5 units
Sec A - Classical technique (Ballet) is used to for proper body alignment, placement, and muscular strength using basic elementary and intermediate vocabulary. 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: 6 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
An introduction to the tools of lighting that will serve as the foundation for all lighting design and technical lighting courses. Students are prepared in the skills necessary for crew and safe work practices including: the hang and focus of lighting instruments, basic electricity and wiring, dimmers and the operation of lighting consoles. Students will also learn the roles and responsibilities of each member of the lighting team involved in a production.

54-152 Scenery Stagecraft
Spring: 6 units
This is a hands-on class in basic shop construction techniques. Upon completion of this course, students should be familiar with shop safety procedures and practices, safe and proper tool use, proper use of fasteners, and basic rigging skills, lecture/lab format.

54-153 Costume Stagecraft
Fall: Mini Session - 3 units
This course deals with the costume approach to a production, including such elements as the figure and the actor, how fabric works with the figure, how the figure may be improved or altered and the psychology of costuming. Topics that present more hands-on work include an approach to patterning, the machinery used for costumes and the craft orient elements that might be involved.

54-159 Run Crew
Fall: 4 units
Hands on experience in most aspects of building and running a production.

54-160 Run Crew
Spring: 6 units
Hands on experience in most aspects of building and running a production.

54-161 Production Preparation I
Fall: 6 units
Basic Introduction and practice, through preparation and crew assignments, in building and handling scenery, costumes, props, and lighting.

54-162 Production Preparation I
Spring: 9 units
Basic Introduction and practice, through preparation and crew assignments, in building and handling scenery, costumes, props, and lighting.

54-163 Introduction to Production
Fall: 6 units
The producing of modern theatrical productions involves the participation of professionals in a wide range of disciplines. Introduction to Production provides students with insights and first hand experience participating in the physical production of theatre. The skills learned here provide an invaluable foundation and context for future professional work, of course, useful in their own right. Includes participation in School of Drama productions on shop, install, and run crews.

54-164 Introduction to Production
Spring: 3, 6 units
Participation in School of Drama productions on shop, install, and run crews. Pre-requisites/Co-requisites: 54-163 or instructor's permission
Prerequisites: 54163

54-165 Introduction to Sound Design for Theatre I
Fall: 6 units
Studies in the principles and basic theories of sound design from technical and aesthetic standpoints. Course work includes instruction in the use of simple and sophisticated sound systems and the practical planning of sound plots.

54-166 Introduction to Sound Design for Theatre
Spring: 6 units
Studies in the principles and basic theories of sound design from technical and aesthetic standpoints. Course work includes instruction in the use of simple and sophisticated sound systems and the practical planning of sound plots.

54-169 Studiocraft
Fall: 13 units

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 course 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 course is concurrent with Drafting and Figure Drawing sections. PRE-REQUISITE: Declared Design/PTM focus in the School of Drama FOR: First Year Undergraduate Students

54-177 Foundations of Drama I
Fall: 6 units
In Foundations I: Antiquity, we will examine the prehistoric origins of dramatic art and query its use as a means of bridging the gulf that separates the material world from the cosmic universe of myth, magic, and spirituality. We will examine in broad detail the practice of drama in ancient societies, notably the Indian and Egyptian, before examining the precepts of Attic Tragedy and the Athenian Drama Festival. Along the way, we will closely examine how the politics of the Athenian Golden Age affected its playwriting, with a special emphasis this year on the social-consciousness applications of Old Comedy.
54-178 Foundations of Drama II  
Spring: 6 units  
In Foundations II: Early Modern, we engage the so-called "Dark Ages" and question the extent and causes of the "death" of dramatic art in Europe, as well as its resurrection in the bosom of the medieval Church. We then examine the facts and myths of the Renaissance, and note the transmission of humanist drama following the Fall. At this point, students will be expected to pay particular attention to the Italian Renaissance, the Spanish Golden Age, the English Renaissance, and the Japanese Classical period. 
Prerequisites: 54177

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 -- and to connect each student with the wellspring of his or her own creativity -- 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 reactions to each exercise that is read. The final project for the course will be the completion of the first draft of a one-act play. It is possible that one-act scripts may grow out of assigned exercises.

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 -- and to connect each student with the wellspring of his or her own creativity -- 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 reactions to each exercise that is read. The final project for the course will be the completion of the first draft of a one-act play. It is possible that one-act scripts may grow out of assigned exercises.

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 full-length play, and on finding theatrical conventions which both suit the story and make it live on stage. In order to work with these concepts, students will write a play featuring an historical character -- someone who has done something noteworthy. Therefore, the elements of the story will already be on the record; it will be the student's job to select which aspects of this person's life should be depicted on stage, and to structure these scenes so that, taken together, they create a coherent narrative. A complete first draft of a full-length play based on this historical character is due on the last day of class. 
Prerequisites: 54187

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 full-length play, and on finding theatrical conventions which both suit the story and make it live on stage. In order to work with these concepts, students will write a play featuring an historical character -- someone who has done something noteworthy. Therefore, the elements of the story will already be on the record; it will be the student's job to select which aspects of this person's life should be depicted on stage, and to structure these scenes so that, taken together, they create a coherent narrative. A complete first draft of a full-length play based on this historical character is due on the last day of class. 

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.

54-196 Advanced Screenwriting  
Spring: 9 units  
This course is designed to give writers a variety of tools they can use in rewriting both on a current project and in the future. There will be films to watch and analyze. Either a first draft or and rewritten version of a full length screenplay is to be completed by the end of the semester. By permission only.

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: 54101 and 54102

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: 54201

54-203 Voice and Speech II  
Fall: 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.

54-204 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.

54-207 Movement II  
Fall: 3-4 units  
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: 54107

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, improve their 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 laugh at truth and 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: 54108

54-210 Text Analysis  
Spring: 6 units

54-211 Actor Dance II  
Fall: 3 units  
Fall -- 3 units A class, which uses basic, fundamental vocabulary from Classical technique (Ballet) to train the body in proper
null
Spring: 4.6 units
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: 4 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 on the full spectrum of 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: 4.6 units
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: 4.6 units
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 II: Forms and Formats
Fall: 9 units
Meets with Directing III.

54-248 Dramaturgy II
Spring: 9 units
Meets with Directing III.

54-251 Introduction to Lighting Design
Fall: 6 units
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: 54151

54-252 Introduction to Lighting Design
Spring: 6 units
Students explore the physical properties of light in various design applications and develop a process of storytelling that involves analysis, research, exploration, questioning, problem solving and implementation of a successful design product. Prerequisites: 54251

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.

54-259 Production Preparation II
Fall: 6.9 units
Participation in School of Drama productions, usually on shop fabrication or theatre installation crews. Some participants will fill assistant supervisor positions for other students filling creative or production roles. Prerequisites/Co-requisites: Introduction to Production or instructors permission. Prerequisites: 54163 and 54164

54-262 Production Preparation II
Spring: 9 units
Participation in School of Drama productions, usually on shop fabrication or theatre installation crews. Some participants will fill assistant supervisor positions for other students filling creative or production roles. Prerequisites/Co-requisites: Introduction to Production or instructors permission. Prerequisites: 54163 and 54164

54-263 Introduction to Welding Processes
Fall: 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.

54-264 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
Continuation of 54165; two consecutive semesters. Emphasis on developing a theatrical design process through script analysis and exploration of the creative application of studio techniques. Weekly or biweekly projects and assignments on School of Drama productions.

54-268 Sound Design I
Spring: 9 units
Continuation of 54166; two consecutive semesters. Emphasis on developing a theatrical design process through script analysis and exploration of the creative application of studio techniques. Weekly or biweekly projects and assignments on School of Drama productions.

54-269 Photoshop/Dreamweaver
Spring: 6 units
This course is an introduction to the computer aided drafting program AutoCAD 2004. Principally the course presents how to operate the program in general. However, whenever possible, classroom examples and assignments are tailored to theatre design and production applications. Emphasis will be placed on 2-D drafting, to build the skills that a student will use on production assignments here at the School of Drama. Time permitting, the course will move on to an introduction of 3-D modeling with AutoCAD. Prerequisites/Co-requisites: Media Studio (Drafting) or instructor's permission. Prerequisites: 54171 and 54172

54-270 Computer Applications AutoCAD
Fall: 6 units
An in-depth study of Computer-Aided Design and Drafting for the theatre as well as an examination of applications for modeling, rendering, animation, imaging and simulation. Particular emphasis in the fall is on AutoCAD while the spring portion of the class examines different software packages.

54-271 Standard Scenery Construction
Fall: 6 units
Required for all sophomore Design and PTM students. This class establishes a set of standards for theatrical construction consistent with modern regional and commercial shop standards. Drafting is a pre-requisite, and upon completion of this course, students are qualified to produce shop drawings of standard scenic elements.

54-273 Technical Direction
Fall: 9 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/Co-requisites: Standard Scenic Construction & Production Planning or Instructors Permission
Prerequisites: 54271 and 54279

54-277 Stage Management I
Fall: 6 units
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.

54-278 Stage Management
Spring: 4 units
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.

54-279 Production Planning and Organization
Fall: 9 units
This course presents the processes used by technical managers to plan productions. Emphasis in this presentation is placed on the structure and practice of the regional theatre. Information is presented on the staffing of production departments and the responsibilities of those staff members with regard to production planning. After establishing a basis for discussing planning tasks within the frame of the regional theatre, the class will look at how these tasks transfer and are impacted by factors in other parts of the industry. Instructor’s permission.

54-281 Foundations of Drama III
Fall: 6 units
In Foundations III: Enlightenment, we trace the developments of the drama through French Neo-Classicism, examining the controversy of Ibsen, German Romanticism and Weimar Classicism, and the transformations of American theatre from the colonial period to the end of the 19th century. Touching on the English Restoration, we also look at the rise of non-mainstream theatrical entertainment, such as museum shows, Mardi Gras, minstrelsy, freak shows, and the performances of the Dia de los Muertos.

54-282 Foundations of Drama IV
Spring: 6 units
In Foundations IV: Contemporary, we examine the foundations of Realism with plays by Ibsen and O’Neill, and deeply engage the counter-movement of the European avant-garde of Marinetti and Brecht. Working deeply with Brook’s The Empty Space, we also examine the rise of filmmaking, the impact of the Federal Theatre Project on American drama, and the writings of Williams and Miller. We end the course with a look at the revolutionary theatre of the US and Europe since 1975, and inquire deeply into the current position of theatre artists in the vast stream of theatre history.

54-289 Speech and Theatre Community Outreach
Fall: 9 units
Students will develop a process of teaching theatre to middle school children. Elementary school children will work with drama students from several disciplines in a mentoring relationship and learn that theatre is a collaborative experience. The result will be joint artistic performances at CMU. The Children’s Heritage Theatre will present classic text as well as newly scripted plays based on myths and fairy tales from international cultures.

54-290 Speech and Theatre Community Outreach
Spring: 6 units
All Semesters: 9 units
Students will develop a process of teaching theatre to middle school children. Elementary school children will work with drama students from several disciplines in a mentoring relationship and learn that theatre is a collaborative experience. The result will be joint artistic performances at CMU. The Children’s Heritage Theatre will present classic text as well as newly scripted plays based on myths and fairy tales from international cultures.

54-291 Make-Up
Spring: 2 units
ALL 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 makeup and its 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.

54-292 Speech and Phonetics Instruction and Outreach II
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.

54-293 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 Special Topics in Playwriting
Intermittent: 9 units
This course allows students to expand their knowledge of basic playwriting principles as they refine existing scripts, taking material composed in Advanced Playwriting and working through several new drafts. Students learn how to enrich their characters, amplify dramatic tension and create structures that build toward an explosive climax. Work on student compositions is coupled with in-depth structural analysis of both classical and contemporary plays from the existing repertoire.

54-295 Special Topics in Playwriting
Spring: 6 units
This course allows students to expand their knowledge of basic playwriting principles as they refine existing scripts, taking material composed in Advanced Playwriting and working through several new drafts. Students learn how to enrich their characters, amplify dramatic tension and create structures that build toward an explosive climax. Work on student compositions is coupled with in-depth structural analysis of both classical and contemporary plays from the existing repertoire.

54-300 Advanced Studies in Playwriting
Intermittent: 9 units
This course allows students to expand their knowledge of basic playwriting principles as they refine existing scripts, taking material composed in Advanced Playwriting and working through several new drafts. Students learn how to enrich their characters, amplify dramatic tension and create structures that build toward an explosive climax. Work on student compositions is coupled with in-depth structural analysis of both classical and contemporary plays from the existing repertoire.

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: 54201 and 54202

54-302 Acting III
Spring: 12 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: 54301

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 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
Spring: 6 units
(Voice) The actor continues 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 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 III
Fall: 5 units
This course builds on the previous voice and speech courses in the first and second year of the acting program. The goal is to further build on voice practice in all aspects of performance. The Fitzmaurice work is introduced and students develop both group and personal vocal development. The students continue to develop vocal and individual instruction in integrating voice and Alexander principles with text and performance challenges.

54-306 Voice III
Spring: 3 units
This course builds on Voice 111 Fall semester, which is a prerequisite of the course. Students delve into more personal aspects of voice through original writing projects. Students develop independent research projects to explore Voice and its relation to broader areas such as science and psychology. Along with writing projects, the course includes continued attention to vocal development as it integrates with all aspects of performance.

54-307 Movement III
Fall: 4 units
The third year of Movement can include in-depth studies of various physical theatre styles, the synthesis of movement and text, and the creation of some original movement-theatre work. Physical vocabulary continues to increase.

54-308 Movement III
All Semesters: 4 units
The third year of Movement can include in-depth studies of various physical theatre styles, the synthesis of movement and text, and the creation of some original movement-theatre work. Physical vocabulary continues to increase.

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 senior actors and presented in independent and undergraduate directors. 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 Dramatic Writing, Acting 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 senior actors 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.

54-311 Rehearsal & Performance
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.

54-312 Rehearsal & Performance
Spring: 12 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.

54-313 Junior Auditioning
Fall: 4 units
This is a one-semester elective course for Junior Actors & MTs in the fundamentals of the Audition process. Goals include: to learn the givens of the Audition process including determining the parts of the process over which the actor does & does not have control; to learn how to shape an effective Audition; to learn to present oneself in a professional manner; to learn how to choose Audition pieces that work for the specific individual; to learn to contrast Audition pieces; to learn how to handle cold readings.

54-314 Directing III: Forms and Formats
Fall: 12 units
This is a two-semester course for 3rd-Year Directors & 2nd-Year Actors concerning the application of fundamental staging & work script tools & fundamental acting tools in directing divergent dramatic Forms (Realistic Drama, Shaw Comedy, Farce, Shakespeare, Dialectical Theatre, The Ten-Minute Play) in various theatrical Formats including prosenium, three-quarter, thrust, & arena. Goals include: to encourage understanding & cooperation between disciplines; to develop expertise & confidence in preparation & rehearsal; to learn to play on the team with actors & designers; to develop a directorial vision toward giving the particular play’s Context Illuminating Form. There is a video project at top of second semester, & public performances at end of each semester.

54-315 Directing III: Forms and Formats
Spring: 12 units
This is a two-semester course for 3rd-Year Directors & 2nd-Year Actors concerning the application of fundamental staging & work script tools & fundamental acting tools in directing divergent dramatic Forms (Realistic Drama, Shaw Comedy, Farce, Shakespeare, Dialectical Theatre, The Ten-Minute Play) in various theatrical Formats including prosenium, three-quarter, thrust, & arena. Goals include: to encourage understanding & cooperation between disciplines; to develop expertise & confidence in preparation & rehearsal; to learn to play on the team with actors & designers; to develop a directorial vision toward giving the particular play’s Context Illuminating Form. There is a video project at top of second semester, & public performances at end of each semester.

54-316 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 performance. The fundamentals of the Audition process. Goals include: to learn the givens of the Audition process including determining the parts of the process over which the actor does & does not have control; to learn how to shape an effective Audition; to learn to present oneself in a professional manner; to learn how to choose Audition pieces that work for the specific individual; to learn to contrast Audition pieces; to learn how to handle cold readings.

54-317 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 performance. The fundamentals of the Audition process. Goals include: to learn the givens of the Audition process including determining the parts of the process over which the actor does & does not have control; to learn how to shape an effective Audition; to learn to present oneself in a professional manner; to learn how to choose Audition pieces that work for the specific individual; to learn to contrast Audition pieces; to learn how to handle cold readings.

54-318 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.

54-320 Music Theatre Scenes
Spring: 4 units
Study of the marriage of spoken and sung text- i.e the marriage of drama and music. Class study includes Scenes extracted from the Musical Theatre canon, from a variety of styles and eras. The course explores how the Singing Actor seques from speech to music, thus strengthening the scene through the emotional flight music brings to the script.

54-322 Directing III Seminar
Spring: 4 units
This two-semester class for 3rd-Year Directors is directly related to the work in Directing 3/Acting Lab 2. The Seminar consists of organizational meetings, lectures & discussions relevant to the
current class work -- such as ground planning, rehearsal organization, vision, genre differentiation, new formats, working with actors, etc.

54-323 Dance III  
Fall: 1-3 units  
Fall 1-3 units Sec A – Ballet – 3 units – A class aimed at developing greater technical strength, dexterity and flexibility.  
Prerequisite: 54-224 and permission of instructor Sec B – Jazz – 2 units – A class to expand the versatility to master changes in dynamics, direction and rhythm using a variety of contemporary Jazz styles.  
Prerequisite: 54-224 and permission of instructor  
Sec C – Tap – 2 units – A class to expand vocabulary, precision of sound and tempo changes.  
Prerequisite: 54-224 and permission of instructor.  
Prerequisites: 54223 and 54224

54-324 Dance III  
Spring: 1-3 units  
Spring 1-3 units Sec A – Ballet – 3 units – A class aimed at developing greater technical strength, dexterity and flexibility.  
Prerequisite: 54-323 and permission of instructor Sec B – Jazz – 2 units – A class to expand the versatility to master changes in dynamics, direction and rhythm using a variety of contemporary Jazz styles.  
Prerequisite: 54-323 and permission of instructor  
Sec C – Tap – 2 units – A class to expand vocabulary, precision of sound and tempo changes.  
Prerequisite: 54-323 and permission of instructor.  
Prerequisites: 54323

54-325 Actor Dance III  
Fall: 3 units  
Fall – 3 units A class which uses basic and fundamental contemporary Jazz styles, i.e. Latin, Blues, Lyric, African, to technically train the body using isolations and rhythmic patterns.  
Prerequisite: 54-211 and 54-212 and permission of instructor

54-326 Actor Dance III  
Spring: 3 units  
Spring – 3 units Continue with basic and fundamental contemporary Jazz styles, i.e. Latin, Blues, Lyric, African, to technically train the body using isolations and rhythmic patterns.  
Prerequisite: 54-325 and permission of instructor

54-329 Introduction to Stage Management  
Fall: 6 units  
A course designed to introduce junior actors to the basic fundamentals and techniques of the singing voice. Application of these skills are then applied to singing repertoire that may be suitable for future auditions. A public final project will be presented at the end of the semester. Each participant will present a memorized song, and sing with the entire group.

54-330 Introduction to Stage Management  
Spring: 6 units  
This course is intended to provide students an opening to the knowledge and skills of the professional stage manager. It will also illuminate the qualities of a good stage manager specific to personality and human interaction. Within this course we will examine the role of the stage manager throughout the full scope of creating a production, including preparatory work, rehearsal period, technical rehearsal, performance and closing.

54-331 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 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.

54-332 Scene Design I  
Spring: 6,9 units  
Studies in problems of design and the use of the design imagination through assignments in various styles and periods; practice in the use of research techniques of rendering, and the preparation of designer elevations. Basic design techniques.  
Groundplans, rough models, basic drawing skills. Concentration on the design process and the director-designer relationship.

54-333 Production Management I  
Fall: 6 units

54-334 Production Management I  
Spring: 6 units

54-337 Advanced Scene Painting  
Fall: 4 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: 54237 and 54238

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: 54237 and 54238 and 54337

54-339 Stage Management Seminar  
All Semesters: 3 units

54-340 Stage Management Seminar  
Spring: 3 units

54-341 Costume Design I  
Fall: 9 units  
A two semester course that engages students with Paul Tazewell, Susan Tsu and guest designers. Tazewell teaches second semester which further emphasizes the use of design principles and techniques to communicate and express character, mood, and style in support of the written text: Figure drawing and painting techniques are incorporated with studies on a basic approach to the figure and how it is costumed to suit the production. Emphasis is placed on interpretation, director-designer communication and the design process. Students may participate in Design Workshops such as the annual Dance/Light/Costume production design. PRE-REQUISITES: Drawing For The Theatrical Designer, Figure Drawing, FOR: First year graduate costume majors and upper level undergraduates with declared majors. Non-major Design, PTM and Drama students and all others by Instructor Approval only.  
Prerequisites: 54245 and 54347

54-342 Costume Design I  
Spring: 9 units  
The second semester of a two semester course that engages students with Paul Tazewell, Susan Tsu and guest designers. Tazewell teaches second semester which further emphasizes the use of design principles and techniques to communicate and express character, mood, and style in support of the written text: Figure drawing and painting techniques are incorporated with studies on a basic approach to the figure and how it is costumed to suit the production. Emphasis is placed on interpretation, director-designer communication and the design process. Students may participate in Design Workshops such as the annual television project produced at Pittsburgh’s Public Television station WQED and the collaborative Dance/Light/ 
Costume production design. PRE-REQUISITES: Drawing For The Theatrical Designer, Figure Drawing FOR: First year graduate costume majors and upper level undergraduates with declared majors. Non-major Design, PTM and Drama students and all others by Instructor Approval only.  
Prerequisites: 54246 and 54348

54-343 Costume Construction I  
Fall: 6 units  
FOR: First Year Grads unless otherwise exempted, Sophomore Undergrads 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: 6 units
FOR: First Year Grads unless otherwise exempted, Sophomore Undergrads 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 garment assembly. 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.

54-347 Figure Drawing
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.

54-348 Figure Drawing
Spring: 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.

54-349 Automated Lighting Technology
Fall: 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: Successful completion of Intro to Lighting Permission of Instructor Co-requisites: Lighting Design I Prerequisites: 54351 and 54352

54-350 Pre-visualization Lighting Software
Spring: 6 units
Students become familiar with pre-visualization software programs as a tool for problem solving design issues and communicating design intent. Programs include WYSIWYG and Martin Show Designer. Prerequisites: 54349

54-351 Lighting Design I
Fall: 9 units
The student's ability to analyze and translate information in the script to descriptive stage pictures is developed in a more in-depth process. Verbal, written and visual communication of ideas is emphasized and explored through texts and lab work. Issues of collaboration with the director and other members of the design team are discussed as part of the design process. Prerequisites: 54252

54-352 Lighting Design I
Spring: 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: 54351

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 ideas and concepts for structural design, truss design, tensile systems and structural connections. Prerequisites: 54353

54-357 Directing: Production III
Fall: 10 units
Assignments as stage manager or assistant director for the Studio and Kresge Theatres.

54-358 Directing: Production III
Spring: 10 units
Assignments as stage manager or assistant director for the Rauh Studio and Chosky Theatres.

54-359 Stage Management 2
Fall: 4 units

54-361 Production Preparation III
Fall: 12 units
Participation in School of Drama productions, usually as assistant supervisor positions for other students filling creative or production roles or in the actual supervisory roles. Prerequisites/Co-requisites: 54-259 & 54-262 Prerequisites: 54259 and 54262

54-362 Production Preparation III
Spring: 12 units
Participation in School of Drama productions, usually as assistant supervisor positions for other students filling creative or production roles or in the actual supervisory roles. Prerequisites/Co-requisites: 54-259 & 54-262 Prerequisites: 54259 and 54262

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: 54366 and 54378

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 prerequisite 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: 6 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: 54251 and 54252

54-368 Production Electrics
Spring: 6 units
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 will be prepared for Master Electrician assignments on School of Drama productions as well as similar positions outside of the School. Prerequisites: Successful completion of fall semester of Intro to Lighting Permission of Instructor Co-requisites: Intro to Lighting (if sequence not completed) Prerequisites: 54251

54-371 Directing 3 Seminar
Fall: 4 units
This two-semester class for 3rd-Year Directors is directly related to the work in Directing 3, Act 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
Learn that theatre is a collaborative experience. The result will be students from several disciplines in a mentoring relationship and school children. Elementary school children will work with drama.

### Prerequisites
- 54163 and 54164

### Course Descriptions

#### 54-376 Rigging Seminar
**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. Pre-requisites/Co-requestes: Introduction To Production or instructor’s permission

#### 54-378 Technical Design I
**Spring:** 12 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. Pre-requisites/Co-requestes: Technical Direction or instructor’s permission

#### 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, on paper, in discussion, and in the shop, discussion of any pertinent technical issues for any of the school productions while in development. Pre-requisites/Co-requestes: Technical Direction or instructor’s permission

#### 54-381 History of Drama
**Fall:** Mini Session - 3 units
History of Drama minis. These are eight-week Junior/Senior level dramatic literature courses, meeting twice weekly, based around a single period, author, genre, or "theme". A typical theme might be Drama and Science, Aggressive Comedy; Dialectics and Drama; The Rebel in Drama; Greek drama; Arabic drama; non-realist drama, and so on. The intention is that often very heterogenous plays can be grouped together to reveal both comparisons and contrasts in dramatic methods. At the conclusion of the course students write a paper on its main themes.

#### 54-382 History of Drama II
**Spring:** Mini Session - 3 units
History of Drama minis. These are eight-week Junior/Senior level dramatic literature courses, meeting twice weekly, based around a single period, author, genre, or "theme". A typical theme might be Drama and Science, Aggressive Comedy; Dialectics and Drama; The Rebel in Drama; Greek drama; Arabic drama; non-realist drama, and so on. The intention is that often very heterogenous plays can be grouped together to reveal both comparisons and contrasts in dramatic methods. At the conclusion of the course students write a paper on its main themes.

#### 54-383 Critical Writing
**Fall:** 4 units
A writing intensive course which focuses on developing skills for the analysis and criticism of drama and performance.

#### 54-384 Critical Writing
**Spring:** 4 units
A writing intensive course which focuses on developing skills for the analysis and criticism of drama and performance.

#### 54-387 Dramaturgy: Production III
**Fall:** 10 units
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:** 10 units
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 Speech and Theatre Community Outreach
**Fall:** 9 units
Students will develop a process of teaching theatre to middle school children. Elementary school children will work with drama students from several disciplines in a mentoring relationship and learn that theatre is a collaborative experience. The result will be joint artistic performances at CMU. The Children’s Heritage Theatre will present classic text as well as newly scripted plays based on myths and fairy tales from international cultures.

#### 54-390 Speech and Theatre Community Outreach
**Spring:** 9 units
Students will develop a process of teaching theatre to middle school children. Elementary school children will work with drama students from several disciplines in a mentoring relationship and learn that theatre is a collaborative experience. The result will be joint artistic performances at CMU. The Children’s Heritage Theatre will present classic text as well as newly scripted plays based on myths and fairy tales from international cultures.

#### 54-393 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.

#### 54-394 Speech and Phonetics Instruction and Outreach II
**Spring:** 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 and participate in a presentation for family and friends using the skills they have learned.

#### 54-395 Internship
**Fall:** 6-36 units
**Spring:** 2-36 units

#### 54-401 Camera Lab
**Fall:** 4-6 units
This is a year long course required for senior undergraduate directing and acting majors and second year graduate directors. Thesis projects 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:** 6 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 Voiceover
**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 Graduate Directing
Fall: 6 units
Graduate Directing is a semester long course for first and second year graduate directors and senior actors entitled "Classics in another time and place". It explores the techniques as well as the variety of challenges the director and the actor deal with when they do transplant the original setting of a well known classical play into a radically different time frame or place of action.

54-406 Graduate Directing
Spring: 6 units
Graduate Directing is a semester long course for first and second year graduate directors and senior actors entitled "Classics in another time and place". It explores the techniques as well as the variety of challenges the director and the actor deal with when they do transplant the original setting of a well known classical play into a radically different time frame or place of action.

54-407 Movement IV
Fall: 2-4 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, CIRANO). 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 language 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, designers 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: 54307 and 54308

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
Fall: 4.9 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 and by graduate and undergraduate directors. 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 Dramatic Writing, Acting and Directing Options.

54-410 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 senior actors and by graduate and undergraduate directors. 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 Dramatic Writing, Acting and Directing Options.

54-411 Rehearsal & Performance
Fall: 25 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 Rehearsal & Performance
Spring: 12 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
This is a one-semester elective course for Junior Actors & Mt's in the fundamentals of the Audition process. Goals include: to learn the givens of the Audition process including determining the parts of the process over which the actor does & does not have control; to learn how to shape an effective Audition; to learn to present oneself in a professional manner; to learn how to choose Audition pieces that work for the specific individual; to learn how to contrast Audition pieces; to learn how to handle cold readings. Important: All showings are to be presented as if for an actual Audition -- that is, as if for auditors who do not know you.

54-415 MT Coaching
Fall: 2 units
Each week the students have a private 30 minutes session in which they learn and polish assigned songs. It is important to insure that the audition repertory notebook is complete and diverse. New material is researched and learned. Preparation is made for 16-bar and whole songs for auditions.

54-416 MT Coaching
Spring: 6 units
Each week the students have a private 30 minutes session in which they learn and polish assigned songs. It is important to insure that the audition repertory notebook is complete and diverse. New material is researched and learned. Preparation is made for 16-bar and whole songs for auditions.

54-422 Directing IV
Spring: 4 units
Encounter major 20th century theatrical and dramatic movements. Specific concentration on directorial innovations in the last half of the 20th century.

54-423 Dance IV
Fall: 1-3 units
Fall 1-3 units Sec A – Ballet – 2 units – A class aimed at developing and honing intermediate, advance vocabulary and artistry. Prerequisite: 54-324 and permission of instructor Sec B – Broadway Styles – 2 units – A practical study of American Musical Theatre dance utilizing choreographic elements from the repertoir of master choreographers, Fosse, Robbins, Bennett, DeMille and examines styles from the 20's, 30's 40's, 50's and 60's. Prerequisite: 54-324 and permission of instructor Sec C – Tap – 2 units – A class to challenge the ability to master advanced repertoire at a consistent professional level. Prerequisite: 54-324 and permission of instructor Prerequisites: 54323 and 54324

54-424 Dance IV
Spring: 1-3 units
Spring 1-3 units Sec A – Ballet – 2 units – A class aimed at developing and honing intermediate, advance vocabulary and artistry. Prerequisite: 54-423 and permission of instructor Sec B – Broadway Styles – 2 units – A practical study of American Musical Theatre dance utilizing choreographic elements from the repertoir of master choreographers, Fosse, Robbins, Bennett, DeMille and examines styles from the 20's, 30's 40's, 50's and 60's. Prerequisite: 54-423 and permission of instructor Sec C – Tap – 2 units – A class to challenge the ability to master advanced repertoire at a consistent professional level. Prerequisite: 54-423 and permission of instructor Prerequisites: 54423

54-431 Scene Design II
Fall: 9 units
The first semester of a full-year investigation of the processes, challenges and techniques that support the design development of scenic environments for live-performance and camera-based industries. Assignments of both produced and theoretical projects are evaluated through text analysis and pragmatic problem-solving. Dismissals, industrials formals, advanced design, creative collaboration and communication are explored and engaged. Prerequisite: 54-331 & 54-332 Prerequisites: 54331

54-432 Scene Design II

Spring: 9 units
The second semester of a full-year investigation of the processes, challenges and techniques that support the design development of scenic environments for live-performance and camera-based industries. Assignments of both produced and theoretical projects are evaluated through text analysis and pragmatic problem-solving. Disciplines of conceptualization, collaboration and communication are explored and engaged.
Prerequisite: 54-431

54-433 Producing for TV and Film
Fall and Spring: 9 units
The course will examine the responsibilities of a producer in a variety of production situations: working with a client, a staff producer at a television station, an entrepreneur or an independent producer. Students will be required to produce commercials, corporate material, documentaries and dramatic pieces.

54-437 Acting IV
Fall: 3-4 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: 9 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

54-440 Stage Management Seminar
Spring: 3 units

54-441 Costume Design II
Fall: 9 units
A two-semester course that engages students with Paul Tazewell, Susan Tsu and guest designers. Paul Tazewell teaches first semester which focuses on an exploration of pragmatic solutions in design development. Disciplines of collaboration, conceptualization and communication are the fundamentals of successful professional development are explored, discussed and evaluated within the context of class projects and departmental production assignments. Projects will emphasize problem-solving goals in text analysis, research, the selection of period detail and project organization, as well as graphic skills development and refinement. This upper level course exposes students to a range of genres that includes theatre, film, opera, the annual television projects including the Television Workshop with CMU alumni and the short made for television plays produced at Pittsburgh's Public Television station WQED, as well as the collaborative Dance/Light/Costume production design. PRE-REQUISITES: Costume Design I, Drawing For The Theatrical Designer, Figure Drawing, History of Clothing. FOR: Second year graduate costume majors and upper level undergraduates with declared majors.
Prerequisites: 54245 and 54341 and 54347

54-442 Costume Design II
Spring: 9 units
The second semester of a two-semester course that engages students with Paul Tazewell, Susan Tsu, guest designers and directors. Taught by Tsu, the beginning of the semester culminates the annual collaborative Dance/Light/Costume production design. Fabric identification is studied early in the semester. Created to augment the experience of students who are already designing School of Drama productions, this course is tailored every year to develop students' existing design sensibilities and skills, build their portfolios and deepen the exploration of their individual voices as artists. Students receive career counseling and mentorship on the preparation of their portfolios, resumes and cover letters for professional interviews.
PRE-REQUISITES: Costume Design I, first semester of Costume Design II, Drawing For The Theatrical Designer, Figure Drawing, History of Clothing. FOR: Second year graduate costume majors and upper level undergraduates with declared majors.
Prerequisites: 54246 and 54448

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: 54343 and 54344

54-444 Costume Construction II
Spring: 6 units
FOR: All Costume Majors have priority Advanced problems in costume building and pattern development are individually assigned to strengthen the skills of the student. Projects may be drawn from actual designs for productions if the challenge is suitable for the student's development. This course may be taken for 1 or 2 semesters, starting either Fall or Spring PRE-REQUISITES: Both semesters of Costume Construction I
Prerequisites: 54343 and 54344

54-445 Business Practices for Designers
Fall: Mini Session - 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
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
Spring: 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.

54-451 Lighting Design II
Fall: 9 units
Students explore design in different genres that include opera, dance, large scale live entertainment events, television and architectural lighting. Focus is also given to preparation in the business aspects of developing a professional career.
Prerequisites: 54349 and 54350 and 54352

54-452 Lighting Design II
Spring: 9 units
Students explore design in different genres that include opera, dance, large scale live entertainment events, television and architectural lighting. Focus is also given to preparation in the business aspects of developing a professional career.
Prerequisites: 54451

54-453 Production Management Workshop I
Fall: 3 units
Investigates the organization, planning and interpersonal skills required to successfully manage a live theatrical production. Topics covered include: Budgeting, Scheduling, Communication, Job Descriptions, Reporting and Project Management. Permission of instructor required.

54-456 Production Management Workshop
Spring: 3 units
Investigates the organization, planning and interpersonal skills required to successfully manage a live theatrical production. Topics covered include: Budgeting, Scheduling, Communication, Job Descriptions, Reporting 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

54-461  Production Preparation IV  
Fall: 15 units  
Participation in School of Drama productions, usually in supervisory roles in design or production. Pre-requisites/Co-requisites: 54-361 & 362  
Prerequisites: 54361 and 54362

54-462  Production Preparation IV  
Spring: 15 units  
Participation in School of Drama productions, usually in supervisory roles in design or production. Pre-requisites/Co-requisites: 54-361 & 362  
Prerequisites: 54361 and 54362

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 Design II  
Fall: 9 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: 54378

54-480  Music Reading for Drama Technicians  
Spring: 3 units  
This class gives the basics of music theory, musical terminology and score reading. Students focus on the difference in various musical scores, i.e. piano/vocal, full, hand written scores. Students are guided in classroom listening which a wide variety of music including, opera, musical theatre, ballet, and choral/orchestra works.

54-483  Speech and Theatre Community Outreach  
Fall: 9 units  
Students will develop a process of teaching theatre to middle school children. Elementary school children will work with drama students from several disciplines in a mentoring relationship and learn that theatre is a collaborative experience. The result will be joint artistic performances at CMU. The Children's Heritage Theatre will present classic text as well as newly scripted plays based on myths and fairy tales from international cultures.

54-484  Speech and Theatre Community Outreach  
Spring: 9 units  
Students will develop a process of teaching theatre to middle school children. Elementary school children will work with drama students from several disciplines in a mentoring relationship and learn that theatre is a collaborative experience. The result will be joint artistic performances at CMU. The Children's Heritage Theatre will present classic text as well as newly scripted plays based on myths and fairy tales from international cultures.

54-487  Dramaturgy: Production IV  
Fall: 12 units  
Thesis hours and program assistance in senior year.

54-488  Dramaturgy: Production IV  
Spring: 12 units  
Thesis hours and program assistance in senior year.

54-489  Dramaturgy: Internship  
Fall: 9 units  
Professional internship or acting as production dramaturg for a fully-resourced season shows.

54-490  Dramaturgy: Internship  
Spring: 9 units  
Professional internship or acting as production dramaturg for a fully-resourced season shows.

54-491  Theatre Studies Thesis  
Fall: 9 units

54-492  Theatre Studies Thesis  
Spring: 6-9 units

54-493  Business of Acting  
Fall: 4 units  
The course introduces the (advanced) actor to various aspects of the professional world. Emphasis is placed on the audition and interview process for casting directors, talent agents and personal managers. Each student will present either an individual or small group project chosen from a wide ranging list of topics which include performers unions, various production contracts New York and regional theater season,s professional publications and web sites. Occasional tests are administered on the subject of current Broadway and Off-Broadway seasons.

54-494  Business of Acting  
Spring: 3 units  
The course introduces the (advanced) actor to various aspects of the professional world. Emphasis is placed on the audition and interview process for casting directors, talent agents and personal managers. Each student will present either an individual or small group project chosen from a wide ranging list of topics which include performers unions, various production contracts New York and regional theater season,s professional publications and web sites. Occasional tests are administered on the subject of current Broadway and Off-Broadway seasons.

54-495  Internship  
Fall: 9-36 units  
Assignment to professional theatre organizations designed to meet the professional needs of advanced-standing students. By permission of the Head of the Department.

54-496  Internship  
Spring: 9-36 units  
Assignment to professional theatre organizations designed to meet the professional needs of advanced-standing students. By permission of the Head of the Department.

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 provided for the duration of the year. 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.

54-507  So You Want To Make A Movie  
Fall: 6 units  
This is a two semester course. The goal of the course will be to provide students with the confidence, skill, and experience needed to produce a visually interesting, well-told story. Students must be committed to developing self-discipline and a professional work ethic, in addition to improving techniques and situations that expand their creative vision. Equal emphasis will be placed on the creative and managerial aspects of producing. Students learn to enhance and develop artistic skill and judgment as well as acquire a sound background in business fundamentals essential for successful producing. They will be required to take a story from initial idea, through treatment, to producing a finished script. Using professional and student projects as models, the course develops and advances students' techniques in pre-production, production, and post-production problem-solving. Topics included in discussion will be studio vs location shooting, legal and ethical issues, research, script development, talent selection, details of the pre-production process, and editing. Each student will produce a five minute video during the Fall semester and a long form of not more than thirty minutes in duration during the Spring semester. Presentation materials include an oral pitch, a written treatment, and script. In order to reinforce the
invaluable experience of the collaborative process, students will be encouraged to form production teams. Students will be encouraged to apply for University Grants to cover some cost of production (tape stock, special equipment needs, special post-production effects if required), entry fees to competitions, postage etc.) In addition to scheduled classroom time, a considerable time commitment will be required. The faculty mentor will require one-on-one consultations, supportive discussions and recommendations throughout the production process. Prerequisites: 54433 and 54733 and 54833

54-508 So You Want to Make a Movie
Spring: 9 units
(Will meet Wednesdays 5:30 pm-7:30 pm and as scheduled) The course will be offered in the Fall semester and will be expanded. Using the script developed in the Falls semester, each student will provide a dialogue to the script, and the dialogue will be read within thirty minutes in the course. Prerequisites: 54507

54-517 Director's Colloquium
Fall: 1 units
54-518 Director's Colloquium
Spring: 1 units

Electrical & Computer Engineering

18-100 Introduction to Electrical and Computer Engineering
Fall and Spring: 12 units
This course introduces fundamental topics that are common to a wide variety of electrical engineering devices and systems. The topics include: (1) MATLAB as a robust computational tool, used for design and analysis tasks; (2) computer algebra and symbolic manipulation; (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 ordinary differential equations and particular solutions with polynomial and sinusoidal driving functions described by phasors, (5) Difference Equations, with emphasis upon their relationship to differential equations; (6) Linear Algebra, 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: 21122 or 21118 or 21123

18-220 Fundamentals of Electrical Engineering
Fall and Spring: 12 units
This course introduces fundamental topics that are common to a wide variety of electrical engineering devices and systems. The topics include: (1) MATLAB as a robust computational tool, used for design and analysis tasks; (2) computer algebra and symbolic manipulation; (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 ordinary differential equations and particular solutions with polynomial and sinusoidal driving functions described by phasors, (5) Difference Equations, with emphasis upon their relationship to differential equations; (6) Linear Algebra, 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: 21122 or 21118 or 21123

18-231 Sophomore Projects
Fall: 1-18 units
Experience in planning and conduct of independent engineering research, development or design projects, usually in concert with the research interests and programs of individual faculty members. Prerequisite: sophomore standing in Electrical and Computer Engineering.

18-232 Sophomore Projects
Spring: 3-18 units
Experience in planning and conduct of independent engineering research, development or design projects, usually in concert with the research interests and programs of individual faculty members. Prerequisite: sophomore standing in Electrical and Computer Engineering.

18-240 Fundamentals of Computer Engineering
Fall and Spring: 12 units
This course introduces basic issues in design and verification of modern digital systems. Topics include: Boolean algebra, digital number systems and computer arithmetic, combinational logic design and simplification, sequential logic design and optimization, register-transfer design of digital systems, basic processor organization and instruction set issues, assembly language programming and debugging, and a hardware description language. Emphasis is on the fundamentals: the levels of abstraction and hardware description language methods that allow designers to cope with hugely complex systems, and connections to practical hardware implementation problems. Students will use computer-aided design tools to implement hardware designs in both software and actual hardware implementation laboratories to learn about real digital systems. 3 hrs. lec., 1 hr. rec., 3 hr. lab.
Prerequisites: 18100 Corequisites: 21-202

18-300 Fundamentals of Electromagnetics
All Semesters: 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 theory, Maxwell's equations, 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. Prerequisite: 18-220 or equivalent. Prerequisites: 18220

18-303 Engineering Electromagnetics
Spring: 12 units
This course introduces electromagnetic principles and describes ways in which those principles are applied in engineering devices and systems. Topics include: review of mathematical and physical foundations, Static electric and magnetic fields in free space and in materials, Maxwell's equations in integral and differential forms,
boundary conditions and potential functions, Uniform plane waves in free space and in materials, Transients and sinusoidal steady state on 2-conductor transmission lines, Modes in conducting and dielectric waveguides, Radiation and antennas. 4 hrs. lec. and 1.5 hr. rec. 

Prerequisites: 18220

18-310 Fundamentals of Semiconductor Devices
Spring: 12 units
This course will replace 18311, starting in the Spring 2005 semester. 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 computer simulation of digital and analog circuit performance. 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. Students may not receive credit for both 18-301 and 18-310. 3 hrs. lab. (Note: the prerequisite is typically waived for MSE students who intend to pursue the Electronic Materials Minor).
Prerequisites: 18220

18-316 Introduction to Data Storage Systems Technology
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 rates 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 and simulate analog and digital circuit and magnetic and magneto-resistive devices. 3.0 hrs. lec., 3.0 hrs. lab (meets six times).
Prerequisites: 18220 and 33107

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, bias feedback, non-inverting frequency response and complexity, 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: 18220

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: 18220 and 18240

18-331 Junior Projects
Fall: 1-18 units
Experience in planning and conduct of independent engineering research, development or design projects, usually in concert with the research interests and programs of individual faculty members. Prerequisite: junior standing in Electrical and Computer Engineering

18-332 Junior Projects
Spring: 3-18 units

Experience in planning and conduct of independent engineering research, development or design projects, usually in concert with the research interests and programs of individual faculty members. Prerequisite: junior standing in Electrical and Computer Engineering

18-340 Digital Computation
Spring: 12 units
This course 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) and multiplier designs (sequential, array, Booth, and others) along with various divider circuits. Floating point units are then built upon the concepts introduced in 18-341. Finally, we will explore 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. We will also investigate the relations between the concepts introduced. 3 hrs. lec., 1 hr. rec., 3 hrs. lab.

Prerequisites: 18220

18-341 Logic Design Using Simulation, Synthesis, and Verification Techniques
All Semesters: 12 units
This course will introduce 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 processor and communication system interfacing, asynchronous state machines, discrete-event simulation, fault monitoring, debugging and testbench strategies, and assertion-based verification. Design examples will be drawn from memory systems, bus and communication interfaces, and computer-aided physical design. The course is intended for students who wish to pursue the Embedded Systems Minor.

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 processor and communication system interfacing, asynchronous state machines, discrete-event simulation, fault monitoring, debugging and testbench strategies, and assertion-based verification. Design examples will be drawn from memory systems, bus and communication interfaces, and computer-aided physical design. The course is intended for students who wish to pursue the Embedded Systems Minor.

Prerequisites: 15113 and 18240 and 36217

18-348 Embedded Systems Engineering
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 include: network architecture, 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: 15113 and 18240 and 36217
18-348 Embedded Systems Engineering

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. Topics typically covered include embedded computing platforms (hardware, microcontroller instruction set, software); interacting with the real world (analog I/O, control); system-level engineering (design cycle, architectural patterns); real-time operation (timers, interrupts, concurrency); constraints and optimization (economics, power, size, speed); and a survey of systems that work in the real world (debug, test, robust design, dependability, ethical/societal issues). Weekly hands-on exercises with embedded hardware and software will be used to reinforce core skills. 4 hrs. lec.; lab; Prerequisites: 18-240 and 15-213.

Prerequisites: 15213 and 18240

18-349 Embedded Real-Time Systems

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 real-time embedded systems, along with advanced topics such as real-time resource/device and memory management. Students can expect to learn how to design and build systems with the minimal assurance that an embedded system will perform as expected in a real-world environment. The course will cover a broad range of topics, including but not limited to: behavioral modeling techniques and in later stages using structural modeling techniques. This course is not a how-to handbook and covers the design and analysis tasks. The course covers modeling through the use of a modern hardware description language (Verilog). The language is used to model an IC in the early stages of design, using behavioral modeling techniques and in later stages using structural modeling techniques. This course is not a how-to course on using CAD tools. Rather, it is a study of the algorithms used by CAD tools. The course will cover: modeling of digital systems for simulation and synthesis using Verilog; test generation which is used to determine if a manufactured design is correct; and verification with simulation algorithms, and physical design which is used to map the synthesized logic design onto physical IC area. 4 hrs. lec.

Prerequisites: 15211 and 18240

18-370 Fundamentals of Control

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 control systems; analysis of performance, stability criteria, constraints and optimization (economics, power, size, speed); and a survey of systems that work in the real world (debug, test, robust design, dependability, ethical/societal issues). Weekly hands-on exercises with embedded hardware and software will be used to reinforce core skills. 4 hrs. lec.; 1 hr. rec.

Prerequisites: 18396

18-390 ECE CO-OP

All Semesters: 0-3 units

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 lecture and recitation problems using demonstrations and laboratory assignments which cover such topics as radio transmission and reception, audio/image processing, modern control, and communication 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 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 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: 18202 and 18220

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 for low cost, high performance, high reliability, and low power operation is required. Particular applications which are specifically motivated by current applications in which portable electronics are 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 audio amplifiers, cellular telephones, medical equipment, the Mars rover, etc. Topics covered include embedded architectures (building up to modern 16/32/64-bit embedded processors); interaction with devices (busses, memory architecture, memory management, device drivers); concurrency (software and hardware interrupts, timers); real-time principles (multi-tasking, scheduling, synchronization); implementation trade-offs, programming and code optimization (for performance and memory); embedded software (exception handling, loading, mode-switching, programming embedded systems). Through a series of laboratory exercises with a state-of-the-art embedded development kit, students will acquire skills in the design/implementation/debugging of core embedded real-time functionality. Prerequisites: 18-240, 15-213

Prerequisites: 18240 and 15213

18-360 Introduction to Computer-Aided Digital Design

Spring: 12 units

This course introduces the techniques of modeling digital systems at various levels of abstraction, and computer-aided design algorithms that are applied to these models for design and analysis tasks. The course covers modeling through the use of a modern hardware description language (Verilog). The language is used to model an IC in the early stages of design using behavioral modeling techniques and in later stages using structural modeling techniques. This course is not a how-to course on using CAD tools. Rather, it is a study of the algorithms used by CAD tools. The course will cover: modeling of digital systems for simulation and synthesis using Verilog; test generation which is used to determine if a manufactured design is correct; and verification with simulation algorithms, and physical design which is used to map the synthesized logic design onto physical IC area. 4 hrs. lec.

Prerequisites: 15211 and 18240

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 models, and scientific computing. The first two 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: Math sequence 21-120, 21-122, 21-259, 21-260 or equivalent; 15-100 or equivalent

18-412 Field Effect Devices and Technology

Fall: 12 units

This course develops 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 MOS field effect devices (JFET and MESFETs), thin film field effect transistors (TFTs), and related devices. The course material is supported by motivated 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 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: 33107 and (18310 or 18311)

18-413 Introduction to Computer-Aided Instrumentation and Characterization

Intermittent: 12 units

This course introduces students to the use of Labview, a
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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 cover a systematic approach to the development of instrument control software, including overall planning, partitioning into testable and reusable pieces, implementation of error detection and error handling, and provision of a user-friendly interface. Prerequisites: 18310 or 18311 or 18321

18-415 From Design to the Market for Deep Submicron ICs
Spring: 12 units
The general objective of the 18-415 class is to introduce and analyze all major aspects and tradeoffs which determine the success or failure of the IC product commercial success. This objective will be achieved via playing in the class an "imaginary" fabless IC design house startup 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 available sources of information 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 class objectives. Prerequisites: 18322

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 recording and readback processes including the descriptions of the heads and media. The concepts in magnetic materials and electromagnetics required to understand these devices are also developed. Lectures will be supplemented by six laboratories in which students record, readback, analyze actual signals, and operate magnetic and magnetoresistive devices. 3 hrs. lec., 2 hrs. lab. (meets six times). Prerequisites: 18-300 or 18-310. Prerequisites: 18300 or 18310

18-417 Optical Communications Systems
Fall: 12 units
(Formerly 18-315.) In this course, students will receive an introduction to the basic 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 communication, supplemented by six laboratories in which students record, readback, analyze actual signals, and operate magnetic and magnetoresistive devices. 3 hrs. lec., 2 hrs. lab. (meets six times). Prerequisites: 18-310 or 18-310. Prerequisites: 18-310 or 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 by introducing basic electromagnetic and electromagnetic 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, 2) power electronics for converting between AC and DC portion of an electric energy system, and 3) control of these components for efficiency. The principles underlying the design, operation, and control of these components are introduced using conversion fundamentals and basic electric circuit knowledge. The second part of this course covers 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 electrical energy and its conversion that underlies much of what one does in ECE. Prerequisites: 18220

18-431 Undergraduate Projects - Senior
Fall: 1-18 units
Experience in planning and conduct of independent engineering research, development, or design projects, usually in concert with the research interests and programs of individual faculty members. Prerequisites: senior standing in Electrical and Computer Engineering.

18-432 Senior Projects
Spring: 1-42 units
Experience in planning and conduct of independent engineering research, development, or design projects, usually in concert with the research interests and programs of individual faculty members. Prerequisite: senior standing in Electrical and Computer Engineering.

18-441 Verification of Computer Hardware Systems
Fall: 12 units
This course will present state-of-the-art methodologies and tools for simulation-based and formal verification of complex digital systems. The problem of verification will be introduced and its importance motivated by the current crisis in industry. Various simulation-based techniques will be presented, including white, grey, and black-box testing, random test case generation, and code-coverage metrics. Formal verification techniques will be emphasized, as well. The course covers computer-aided design (CAD) tools and techniques for selecting a verification methodology appropriate for a given application will be described. Student projects will involve the use of commercial tools to test, debug, and verify real designs from industry. Students enrolled in the course must have advanced design experience and therefore prerequisites include one of the following courses: 18-340, 18-347 (or 18-447), 18-348 or 18-349 or 18-360. 3 hrs. lec. Prerequisites: 18340 or 18347 or 18348 or 18349 or 18360 or 18447

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 scalar 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 scalar processor. Learning to design programmable systems requires that you already have the knowledge of building RT systems as taught in the prerequisite 18-315, the knowledge of behavior storage hierarchies (e.g., cache memories) and virtual memory as taught in the prerequisite 15-213, and the knowledge of assembly language programming as taught in the prerequisites. 3 hrs. lec., 3 hrs. lab. Prerequisites: 15213 and 18240

18-450 Digital Wireless Communications
Fall: 12 units
In this course, wireless communication channels will be introduced, and their peculiarities such as fading and inter-symbol interference will be studied. Solutions to combat the problems will be described, covering equalization and detection, coding and diversity ideas. Throughout the course, the emphasis will be on discovering unifying ideas in transmission rather than specifying the details of each application. Illustrative examples will be chosen from existing wireless standards (e.g. W-CDMA). A course with a review of wireless transceiver design and design simulation model, based on MATLAB, will enhance understanding of the underlying theory. Lab demonstrations will be used to show practical applications of the theory. Possible research directions will be pointed out, for students interested. 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 scalar processor. Learning to design programmable systems requires that you already have the knowledge of building RT systems as taught in the prerequisite 18-340, the knowledge of behavior storage hierarchies (e.g., cache memories) and virtual memory as taught in the prerequisite 15-213, and the knowledge of assembly language programming as taught in the prerequisites. 3 hrs. lec., 3 hrs. lab. Prerequisites: 15213 and 18240

18-450 (12 units) In this course, wireless communication channels will be introduced, and their peculiarities such as fading and inter-symbol interference will be studied. Solutions to combat the problems will be described, covering equalization and detection, coding and diversity ideas. Throughout the course, the emphasis will be on discovering unifying ideas in transmission rather than specifying the details of each application. Illustrative examples will be chosen from existing wireless standards (e.g. W-CDMA). A course with a review of wireless transceiver design and design simulation model, based on MATLAB, will enhance understanding of the underlying theory. Lab demonstrations will be used to show practical applications of the theory. Possible research directions will be pointed out, for students interested. 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 scalar processor. Learning to design programmable systems requires that you already have the knowledge of building RT systems as taught in the prerequisite 18-340, the knowledge of behavior storage hierarchies (e.g., cache memories) and virtual memory as taught in the prerequisite 15-213, and the knowledge of assembly language programming as taught in the prerequisites. 3 hrs. lec., 3 hrs. lab. Prerequisites: 15213 and 18240

18-450 (12 units) In this course, wireless communication channels will be introduced, and their peculiarities such as fading and inter-symbol interference will be studied. Solutions to combat the problems will be described, covering equalization and detection, coding and diversity ideas. Throughout the course, the emphasis will be on discovering unifying ideas in transmission rather than specifying the details of each application. Illustrative examples will be chosen from existing wireless standards (e.g. W-CDMA). A course with a review of wireless transceiver design and design simulation model, based on MATLAB, will enhance understanding of the underlying theory. Lab demonstrations will be used to show practical applications of the theory. Possible research directions will be pointed out, for students interested. 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 scalar processor. Learning to design programmable systems requires that you already have the knowledge of building RT systems as taught in the prerequisite 18-340, the knowledge of behavior storage hierarchies (e.g., cache memories) and virtual memory as taught in the prerequisite 15-213, and the knowledge of assembly language programming as taught in the prerequisites. 3 hrs. lec., 3 hrs. lab. Prerequisites: 15213 and 18240
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: 18396

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<td>18-517</td>
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Security is becoming one of the core requirements in the design of critical systems. This course will introduce students to the intro-level fundamental knowledge of computer security and applied cryptography. Students will learn the basic concepts in computer security including software vulnerability analysis and defense, networking and wireless security, and applied cryptography. Students will also learn the fundamental methodology for how to design and analyze security critical systems.

Prerequisites: 15-213

Prerequisites: 21127 and (18345 or 15441 or 15410)

18-491 Digital Signal Processing

This course addresses the mathematics, implementation, design and application of the digital signal processing algorithms widely used in areas such as multimedia telecommunication 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 optimization, and signal spaces. Classroom lectures are supplemented with implementation exercises using MATLAB. Prerequisite(s): 18-396

Prerequisites: 18396

18-496 Bioimaging

The goals of this course are to provide the student with the following: - Ability to use the mathematical techniques such as linear algebra, Fourier theory and sampling in more advanced signal processing settings. - Fundamentals of multiresolution/wavelet techniques. - In-depth coverage of bioimaging applications, such as compression, denoising and others. Upon successful completion of this course, the student will be able to: - Explain the importance and use of signal representations in building more sophisticated signal processing tools, such as wavelets. - Think in basic time-frequency terms. - Describe how Fourier theory fits in a bigger picture of signal representations. - Understand filter blocks, such as a two-channel filter bank. - Characterize the discrete wavelet transform and its variations. - Construct a time-frequency decomposition to fit the signal you are given. - Explain how these tools are used in various applications. - Apply these concepts to solve a practical problem through an independent project.

Prerequisites: 18396

18-517 Data Storage Systems Design Project

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 course will culminate in a demonstration of 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 student projects 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. recitation. Pre-requisites: 18-339 or 18-316 or 18-396 or 18-310 and 18-396 or 18-310 and 18-396 or 18-310 and 18-396.

18-523 Analog Integrated Circuit Design
Fall: 12 units

This course will focus primarily on analog CMOS, but some aspects of BJT design will be discussed. 4 hrs. lecture. Prerequisites: 18321 and 18322.

18-525 Integrated Circuit Design Project
Spring: 12 units

Integrated Circuit Design Project (18-525) is intended to provide the electrical and computer engineering student with IC design experience. It stresses the importance of design documentation. The course will focus on analog CMOS, but some aspects of BJT design will be discussed. 4 hrs. lecture. Prerequisites: 18321 and 18322.

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 involve networking 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: 15213 and (18345 or 18441)

18-545 Advanced Digital Design Project
Spring: 12 units

This is a term-project course oriented towards the development of skills to design large digital systems at a professional level. Typically gained in other Information Technology education courses will be utilized in the design and development of a System-on-a-Chip (SoC) prototype. Project development will utilize a mix of system architecture, design tools, industry-standard design practices, and design verification. The project will result in a prototype which will be built in a lab setting. Prototype development will include some wire-wrap and the use of some state-of the-art design tools. Industry-standard practices and design verification will allow you to enhance your effectiveness in future projects in industry or academia. 2 hours lecture, 24 hours access lab. Prerequisite(s): (18494 or 18340 and 15213) or (18431 and 15212) Substitute 18343 for 18341.

18-549 Embedded Systems Design
Fall: 12 units

This advanced course considers embedded systems with multiple, distributed processing elements connected by a real-time network. These distributed embedded systems are becoming very common in application areas as diverse as transportation, manufacturing, industrial control, and household appliances. The course is divided into three phases: (1) the fundamentals of distributed system architecture and design approaches, (2) real-time embedded networking software, and (3) building and testing a dependable system design. A semester-long course project, such as a detailed distributed implementation of an elevator simulation, is used to test the teamwork in various aspects of the lecture material. While a significant understanding of hardware organization and operation is assumed, the focus of the course is mainly on software, simulation, and embedded network issues. Relevant topics of the Unified Modeling Language (UML) are included, although this is not an in-depth course on that topic. 1 hour of the lecture periods per week is primarily used for discussions, and interactions with classmates the course will include, although this is not an in-depth course on that topic. 1 hour of the lecture periods per week is primarily used for discussions, and interactions with classmates the course will include, although this is not an in-depth course on that topic.

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 detection and signal processing. A significant emphasis is placed upon understanding system behavior and design. Students will be working in small teams to design and build their own digital communications and/or detection and signal processing systems. The course is divided into three phases: (1) the fundamentals of digital communication and detection and signal processing, (2) the application of these concepts to the design of embedded networking software, and (3) building and testing a dependable system design. A semester-long course project, such as a detailed distributed implementation of an elevator simulation, is used to test the teamwork in various aspects of the lecture material. While a significant understanding of hardware organization and operation is assumed, the focus of the course is mainly on software, simulation, and embedded network issues. Relevant aspects of the Unified Modeling Language (UML) are included, although this is not an in-depth course on that topic. 1 hour of the lecture periods per week is primarily used for discussions, and interactions with classmates the course will include, although this is not an in-depth course on that topic.

18-575 Control Systems Design
Intermittent: 12 units

A capstone design elective in Electrical and Computer Engineering integrating the computer-aided analysis and design of feedback control systems from both the classical (transfer function) and modern (state-space) points of view. A significant emphasis is placed upon understanding system behavior and design. Students will be working in small teams to design and build their own digital communications and/or detection and signal processing systems. The course is divided into three phases: (1) the fundamentals of digital communication and detection and signal processing, (2) the application of these concepts to the design of embedded networking software, and (3) building and testing a dependable system design. A semester-long course project, such as a detailed distributed implementation of an elevator simulation, is used to test the teamwork in various aspects of the lecture material. While a significant understanding of hardware organization and operation is assumed, the focus of the course is mainly on software, simulation, and embedded network issues. Relevant aspects of the Unified Modeling Language (UML) are included, although this is not an in-depth course on that topic. 1 hour of the lecture periods per week is primarily used for discussions, and interactions with classmates the course will include, although this is not an in-depth course on that topic.
18-578 Mechanotronic 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 the systems integration in which small teams of students will configure, design, and implement a successions of mechatronic subsystems, leading to a main project. Lectures will complement the laboratory experience with comparative surveys, operational principles, and 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 on 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. Prerequisites: 18348 or 18349 or 18370 or 18470 or 18349 or (18321 and 18396).

18-623 Analog Integrated Circuit Design
Fall: 12 units
Some form of analog circuit design is a critical step in the completion of every modern IC. First and foremost, analog circuits act as the interface between digital systems and the real world. They act to amplify and filter analog signals, and to convert signals from a digital and digital and analog signals. The course will focus primarily on analog CMOS, but some aspects of BJT design will be discussed. 4 hrs. lec. Prerequisites: 18-322 (or equivalent experience with Cadence tools) and 18-321 or equivalent. Prerequisites: 18321 and 18322.

18-630 Introduction to Security and Policy
Fall: 12 units
This course covers the design and analysis of radio-frequency integrated circuits at the transistor level using state of the art CMOS and bipolar technologies. It focuses on system-level trade-offs in transceiver design, practical RF circuit techniques, and modeling for device parameter extraction. For active devices, passive components, and interconnect parasitics are critical for predicting high-frequency analog circuit behavior and will be examined in detail. This course will start with foundational concepts in wireless system design and their impact on design trade-offs in different transceiver architectures. Following that, RF transistor model, passive matching networks will be discussed. Noise analysis, intermodulation, and noise amplifier design are studied next. The effects of nonlinearity are treated along with mixer design techniques. Practical bias circuit for RF design will be illustrated. Then, the importance of phase noise and VCO design will be considered together. This course will conclude with a brief study of frequency synthesizer and power amplifier design. Pre-requisite 18-523 or permission from the instructor. Prerequisites: 18523.

18-724 MEMS Design
Fall: 12 units
This course covers advanced design of integrated MicroElectroMechanical Systems (MEMS) as the basis for futuristic sensors and actuators. The course starts with design of low-level device details and builds to design of "VLSI MEMS." Topics include layout vs. process design; analysis and modeling of micromechanics, thermomechanics, capacitive sensing, and coupled electromechanics; and their test structures and characterization; modulation and switched-capacitor interface circuits; and system design. Homework and projects will make students familiar with MEMS, and analog behavioral modeling with analog hardware description languages; layout generation and synthesis tools; visualization tools; and MEMS fabrication. Assigned readings of recent advances in MEMS design are actively discussed. A final project centers on a complete microsystem design within a post-CMOS micromachined process. Possible systems include sensor/ actuator, ultrasonic, RF, and micropositioning, acoustic, optic or fluidic applications. Prerequisites: 18-614, 18-714; or equivalent by petition of instructor. Prerequisites: 18414 or 18614.

18-730 Introduction to Computer Security
Fall: 12 units
This course provides a principled introduction to techniques for defending against hostile adversaries in modern computer systems and computer networks. Topics covered in the course include: operating system security, network security, including cryptography and cryptographic protocols, firewalls, and network denial-of-service attacks and defenses; user authentication technologies; security for network servers; web security; and security for mobile code technologies, such as Java and Javascript. More advanced topics will additionally be covered as time permits, such as: intrusion detection; techniques to provide privacy in Internet transactions; and techniques for protecting digital content (music, video, software) from unintended use. 3 hrs. lec. Prerequisites: 15-211 and senior standing. Prerequisites: 15211.

18-732 Secure Software Systems
Fall: 12 units
Poor software design and engineering are the root causes of most security vulnerabilities in deployed systems today. Moreover, with code mobility now commonplace--particularly in the context of Web technologies and digital rights management--system designers are increasingly faced with protecting hosts from foreign software and preventing software from foreign hosts running it. This class takes a close look at software as a mechanism for attack, as a tool for protecting resources, and as a resource to be defended. Topics covered include the software design process; choices of programming languages, operating systems, databases and distributed object platforms for building secure systems; common software vulnerabilities, such as buffer overflows and race conditions; auditing software; proving properties of software; software and data watermarking; code obfuscation; tamper resistant software; and the benefits of open and closed source development. Prerequisite: 18-730. Skills needed: operating system security, programming languages: C & Java. Prerequisites: 18730.

18-741 Advanced Computer Architecture
Fall: 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 targets. This course qualitatively and quantitatively examines computer design trade-offs. The topics covered include: advanced processor designs such as superscalar and out-of-order execution, advanced memory systems such as non-blocking caches and multiprotocols.
A large digital integrated circuit (IC) may require 100,000 lines of the course. 4 hrs. lec. Prerequisite: 18-345.

18-764  In Between IC Design and Manufacturing
Fall: 12 units

Essentially, design of integrated circuit (IC) is nothing more than a set of data files. Thus there is no unlimited freedom in exploring IC design space. We know, however, that the reality is different. IC design space is severely restricted. On one hand it is limited by the nature of electronics marketplace and on the other hand it is bounded by "Mother Nature". Market place dictates what kind of design can be sold and with what profit. Mother Nature, i.e. laws of physics, decides what performance is achievable and what kind of circuit can be fabricated with the acceptable cost. The overall objective of this class is to derive the IC design space restrictions from the basic rules concerning both circuit behavior and manufacturing process. Such an objective will be achieved by studying a number of modern IC technologies. These examples will be used to illustrate major reasons limiting efficiency of manufacturing processes. Next concept of manufacturing yield and yield learning process will be discussed. Relation between yield, spectrum of design attributes and limitations of key processing steps will be discussed. Design techniques instrumental in achieving desired levels of manufacturability will be reviewed as well. Finally, discussion in the class will be focused on the variability in IC circuit and system trends. These trends will be examined from the DFM perspective in order to help with the forecasting of future trends of IC industry. Prerequisites: 18-322 or 18-525.
Prerequisites: 18322 or 18525

18-751  Applied Stochastic Processes
Fall: 12 units

During the course, we mainly take a discrete-time point of view, and discuss the continuous-time case when necessary. We introduce the basic concepts of random processes, stochastic processes, and random fields. We then introduce common random processes including the white noise, Gaussian processes, Poisson processes, Markov random fields. We address moment analysis (including Karhunen-Loeve transform), the frequency-domain description, and linear systems applied to stochastic processes. We also present elements of estimation theory and optimal filtering, including Wiener and Kalman filtering. Advanced topics in modern statistical signal processing such as linear prediction, linear models and spectral estimation are discussed. 4 hrs. lec. Prerequisites: 36-217 and 18-396 are required for undergraduates, or permission of the instructor. It is strongly advised that students have a prior Signals and Systems course and a Probability course.
Prerequisites: 18396 and 36217

18-756  Packet Switching and Computer Networks
Fall: 12 units

This course is designed to provide graduate students an understanding of the fundamental concepts in computer networks of the past and the future. In the past, the scarcer and more expensive resource in communication networks has been the bandwidth of transmission facilities. Accordingly, the techniques used for networking and switching have been chosen to optimize the efficient use of this resource. These techniques have differed according to the type of information carried: circuit switching for voice and packet switching for data. It is expected that elements of circuit and packet switching will be used in the integrated networks. This course focuses on packet switching for computer networks and in particular computer networks-over-view; OSI layers, queuing theory; data link protocol; flow control; congestion control; routing; local area networks; transport layer. The current networks and applications will be introduced through the instructor's seminars. The course will cover some of the last weeks of the course. 4 hrs. lec. Prerequisite: 18-345.
Prerequisites: 18345

18-760  VLSI CAD: Logic to Layout
Fall: 12 units

A large digital integrated circuit (IC) may require 100,000 lines of high-level description in a hardware modeling language, which then turns into 1,000,000 logic gates, which ultimately end up as 100 million polygons on the masks that define the IC. This course covers the design, implementation, and use of storage systems, from the characterizations and operation of individual storage devices through the OS, database, and networking approaches involved in tying them together and making them useful to key applications' demands and technology trends. Topics to be covered include: network-attached storage, disk arrays, storage systems, scalable file systems, disk performance enhancement, wide-area data sharing, and storage security. 3 hrs. lec. Prerequisites: 15-410 or 15-412.
Prerequisites: 15410 or 15412

18-747  Advanced Techniques in Microprocessors
Fall: 12 units

This course presents recent commercial and research developments in microprocessors. The course begins with an in-depth treatment of microarchitecture level revision of basic superscalar processor datapath. The course next discusses extensions and variations of the basic superscalar design to address the need for increasing amounts of important issues of power and reliability. Both hardware and software techniques for improving the efficiency of microprocessing will be discussed. Furthermore, the course goes beyond current commercial standard models (Pentium, PowerPC, Itanium, etc.) to the design and development of ideas that are likely to impact microprocessor developments in the next 10 years. 3 hrs. lec. Prerequisite: 18-741 (previously 18-547).
Prerequisites: 18741

18-758  Advanced Digital Signal Processing I
Fall: 12 units

This course addresses the mathematics, applications and implementation of the digital signal processing algorithms widely used in areas such as telecommunications, multimedia data compression, and more recently speech and music processing. Topics include discrete-time signals and systems, discrete-time Fourier transforms and 2D transforms, discrete Fourier transforms, scannable IC designs, and automatic test pattern generation (ATPG) algorithms for combinational and sequential circuits, including the D-algorithm, PODEM, FAN, and the genetic algorithm; testability measures; design-for-testability; scan design; test compression methods; logiclevel diagnosis; built-in self-test (BIST); VLSI testing, and systems. The topics to be covered include modern spectral estimation, linear prediction, short-time analysis, and systems. Classroom discussions are supplemented with implementation exercises using MATLAB. 4 hrs. lec. Prerequisite: 18-396 or equivalent.
Prerequisites: 18591

18-791  Digital Signal Processing I
Fall: 12 units

This course examines in depth the theory and practice of fault analysis, test generation, and design for testability for digital ICs and systems. The topics to be covered include system design, circuit design, test generation, and design for testability for digital ICs and systems. The topics to be covered include system design, circuit design, test generation, and design for testability for digital ICs and systems.
18-795 Advanced Bioimaging
Fall: 12 units
The goal of this course is to expose you to multiresolution signal processing methods and their use in bio(medical) imaging applications as well as to guide you through the steps of a research project. The course is roughly divided into two parts: (1) The first part introduces the necessary mathematical tools with a great emphasis on intuitive understanding of how they operate on real data signals (2) The second part is project-based, where through your own bio(medical) imaging project, you will learn how to choose a research area, formulate a problem, research previous work, propose your own solutions, carry out experiments and interpret results. The focus is on compelling you to become a researcher. To that end, you will write papers in a typically conference format, rehearse your presentations with feedback back from the classmates and other students in the class, as well as present your project as part of the BME Seminar. Upon successful completion of this course, you will be able to: * Examine the importance and use of signal representations in building sophisticated signal processing tools such as wavelets. * Describe how Fourier theory fits in a bigger picture of signal representations. Use basic multirate building blocks, such as a two-channel filter bank and characterize the discrete wavelet transform and its variations. * Construct a time-frequency decomposition to fit the signal you are given. * Apply these concepts to solve a practical problem through your individual project. 2 hrs. lec., 2 hrs. recitation/lab. Prerequisites: 18-491 or 18-791 or instructor's permission.
Prerequisites: 18491 or 18791

18-798 Image and Video Processing
Spring: 12 units
This course studies image processing, image understanding, and video sequence analysis. Image processing deals with deterministic and stochastic image digitization, enhancement, restoration, and reconstruction. This includes image representation, image sampling, image quantization, image transforms (e.g., DFT, DCT, Karhunen-Loeve), stochastic image models (Gauss fields, Markov random fields, AR, ARMA) and hierarchical models, image understanding, multiresolution, edge detection, shape analysis, texture analysis, and recognition. This includes pyramids, wavelets, 2D shape description through contour primitives, and shape analysis (e.g., 'snakes'). Video processing concentrates on motion analysis. This includes the motion estimation methods, e.g., optical flow and block-based methods, and motion segmentation. The course emphasizes experimenting with the application of algorithms to real images and video. Students are encouraged to apply the algorithms presented to problems in a variety of application areas, e.g., synthetic aperture radar images, medical images, entertainment video image, and video compression. 3 hrs. lec. Prerequisites: 18-396 or equivalent, or permission of instructor.
Prerequisites: 18396

18-799 Special Topics in Signal Processing
Intermittent: 12 units
For a complete course description, please refer to the following link: http://www.ece.cmu.edu/users/shared/courses/ grdescript.php?18-7998

18-817 Fundamentals of Semiconductors and Nanostuctures Spring: 12 units
This course is designed to provide students with a foundation of the physics required to understand nanometer-scale structures and to expose them to different aspects of ongoing research in nanoscience and nanotechnology. The course begins with a review of basic concepts in quantum physics (wave-particle duality, Schrodinger's equation, particle-in-a-box, approximation methods in quantum mechanics, etc.) and then continues with a discussion of bulk three-dimensional solids (band structure, density of states, the single-electron effective-mass approximation). Size effects due to nanometer-scale spatial localization are then discussed within a quantum-confinement model in one-, two-, and three- dimensions for electrons. An analogous discussion for photons is also presented. The basic electronic, optical, and electrical properties of the low-dimensional nanostructures are then discussed. A select number of applications in electronics, photonics, biology, chemistry, and bioengineering will then be discussed to illustrate the range of utility of nanostructures. Upon completion of the course, students will have an appreciation and an understanding of some of the fundamental concepts in nanoscience and nanotechnology. The course is suitable for first-year graduate students in engineering and science (but advanced undergraduates with appropriate backgrounds may also take it with permission from the instructor). Pre-requisites: include 09-511, 09-701, 09-702,
73-150 Microeconomics
Fall and Spring: 9 units
A calculus-based introduction to microeconomics, first offered in Spring 07. Topics in partial equilibrium analysis include supply and demand, consumer theory, theory of the firm, profit maximizing behavior, imperfect competition, and efficiency. The course concludes with an introduction to general equilibrium analysis and the welfare laws. (Lecture, 3 hours; Recitation, 1 hour)
Prerequisites: 21120 Corequisites: 21-259, 21-256

73-200 Macroeconomics
Fall and Spring: 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. Beginning in Fall 07, this course will be (Lecture, 3 hours; Recitation, 1 hour).
Prerequisites: (21256 or 21259) and 73150

73-226 Quantitative Economic Analysis
Spring: 9 units
Using and extending upon students' introductory knowledge of probability and economic models, this course introduces students to the tools of economic analysis. Taking the perspective of active economic participants (rather than outside observers), students gain experience with a diversity of analytical techniques—including regression analysis and simulation—in the context of real world data decision problems. Classes consist of a combination of cases, lectures, and interactive discussions. (Lecture, 3 hours)
Prerequisites: 21122 and (73150 or 73200 or 73251) and (21235 or 36217 or 36225 or 36310 or 73207)

73-251 Economic Theory
Fall and Spring: 9 units
This course prepares students for advanced coursework in economics by providing a mathematically intensive overview of economic theory. Students take advantage of their knowledge of multi-dimensional calculus and constrained optimization techniques in order to understand the development and logical consistency of the most commonly employed economic models. Topics include consumer preferences and utility function representations, consumer choice under a budget constraint, substitution and income effects, compensated and uncompensated demands, expected utility theory, risk and insurance, technology and production functions, cost minimization, profit maximizing firms, perfect competition, single-firm markets, the comonetary analysis of markets with few firms, introduction to general equilibrium models and the welfare laws. Course will be replaced by 73-252/253 in Spring 08.
Prerequisites: (21256 or 21259) and 73100

73-252 Advanced Microeconomic Theory
Fall and Summer: Mini Session - 6 units
Mini I and Mini II. 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: (21256 or 21259) and 73150

73-253 Advanced Macroeconomic Theory
Fall and Spring: Mini Session - 6 units
Mini II and Mini IV Fall and Spring, second mini-session: 6 units
This course provides a mathematically intensive overview of advanced applications of microeconomic theory. Topics may include: Solow and neo-classical growth models, the role of money and its effect on the economy, and the overlapping generations model. (Lecture, 3 hours) Course will be first offered in Spring 08.

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: non-linear-least-squares, two-stage estimation, instrumental variables, simultaneous equations, maximum likelihood estimation, and logit/probit models. (Lecture, 3 hours)
Prerequisites: (21122 and (21256 or 21259) and 73226

73-270 Writing for Economists
Fall and Spring: 6 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: 73200 and 76101

73-310 History of Economic Ideas and Analysis
9 units
This course will be organized around the study of several central topics in the development of economics such as: the "invisible hand;" classical analysis of trade, value, and income distribution; the marginalist revolution; general equilibrium theory; classical monetary economics; Keynesian macroeconomics; and recent trends in theory and empirical analysis. Where possible, examination of the contemporary policy issues motivating major analytical developments will be included.
Prerequisites: 73200

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 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: 73150

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 and 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 induced by union contracts and fringe benefits such as health insurance. (Lecture, 3 hours)
Prerequisites: 73150

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 form 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: 73122 and (73251 or 73252)

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 necessary 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: 73150
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: 73200 and (73251 or 73252)

73-357 Regulation: Theory and Policy
Intermittent: 9 units
Fall or Spring 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. Analizing 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: 73251 or 73252

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: environmental externalities and the misallocations of resources, interpreting and understanding consequences, and current government policy to regulate such externalities. The course explores the efficacy/ineffectiveness of markets for non-renewable resources, intended and unintended consequences of regulations and the market, and modern alternative to regulation – such as the creation of new markets and property rights for environmental resources. (Lecture, 3 hours)
Prerequisites: 73150 or 73251

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 individual's life) and the social rate of discount. Applications are considered in detail. (Lecture, 3 hours)
Prerequisites: 73150 and 73226

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: 73251 or 73252

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: 73200 and (73150 or 73251)

73-372 International Money and Finance
Intermittent: 9 units
Fall or Spring This course concerns itself with the determination of real, monetary, and financial aggregates and the policies that influence their determination. It also includes monetary policy and its effects on employment and inflation, the role of the banking system in the transmission of monetary policy, credit market risks as financial intermediaries, and the determination of domestic policies on international trade and financial markets. (Lecture, 3 hours)
Prerequisites: 73150 or 73251 and 73200

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: 73251 or 73252

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: 73226 and (73251 or 73252)

73-395 Independent Study in Economics
Fall or 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: 73150

73-410 The Economics of Business Cycles
Intermittent: 9 units
Fall or Spring This course is concerned with the economic 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 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.
Prerequisites: 73150 or 73251

73-420 Monetary Theory and Policy
Intermittent: 9 units
Fall or Spring 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 the problem is conducted by means of simple 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.
Prerequisites: 73200 and (73251 or 73252)

73-422 Real Estate Economics and Finance
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: 73150 or 73251

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: 73251 or 73252

73-428 Markets for Energy
Intermittent: 9 units
Fall or Spring 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: (73251 or 73252) and 73226

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 economic history. The nature and scope of the project are determined by the student and faculty advisor.

Prerequisites: 73150 and 73200 and (70208 or 73226)

73-495 Advanced Independent Study in Economics

All Semesters: 1-18 units

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: 73251 or 73252

73-474 The Economics of Ideas: Growth, Innovation and Intellectual Property

9 units

Fall or Spring Healthy economies in many ways resemble healthy people – they are alive and vibrant, growing and adjusting in response to changing circumstances – and what fuels economic growth and innovation are ideas. This course explores the role of ideas in the modern economy. Topics include: models of economic growth and its impact on society, innovation and human capital, intellectual property and public policy issues.

Prerequisites: 73251 or 73252
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: 73100

19-424 Energy and the Environment
Intermittent: 9 units
This course will cover 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 nonrenewable fuels for energy generation; energy use for automobiles and other transportation systems; energy use for buildings and industrial processes; and environmental issues such as acid rain; global warming. The emphasis will be on understanding the impacts of energy use and the role of policy in mitigating these impacts.

19-426 Environmental Decision Making
Intermittent: 9 units
This course will cover the role of environmental decision making, including risk perception, risk communication, risk management, and the use of economic tools such as cost-benefit analysis. The course will also examine the ethical and social implications of environmental decisions.

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 advancements on national security and the space policy and arms control issues is proposed. As the exploitation of space continues, the course focuses on specific areas and issues of concern, based on the recent events.

19-440 Combustion and Air Pollution Control
Intermittent: 9 units
Combustion and the control of gaseous and particulate air pollutants in combustion systems. Basic principles of combustion, including thermochanical equilibrium, flame temperature, chemical kinetics, hydrocarbon chemistry, and flame structure. Formation of gaseous and particulate pollutants and the interaction of pollutants in combustion systems. Combustion modifications and postcombustion technologies for pollutant control. Relationship between technology and national, regional, and local planning 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 decade, have seen an unprecedented acceleration of the growth and permeation of technology. The central role of technology and engineering in the modern world will be used to exemplify the responsibility of those who develop and deploy such technologies as well as those who avail of them for various purposes. This course will explore the role of technology in the ethical, social, and economic aspects of modern life.

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: 0-12 units
Students may do undergraduate research as one course for EPP technical elective credit, with an EPP faculty member, or on an approved project with a faculty member from another department. The research credits must be pre-approved by your advisor, and should result in a written product, one copy of which should be sent to EPP.

19-601 Information Warfare
Intermittent: 12 units
Information security is one major concern raised by the increasing use of computers in networks. In this course, we will review, in some technical detail, the nature of the "threats". These include viruses and worms (their history and how they "evolved"), backdoor exploits, Trojan horses, buffer overflows, and the extent to which they imperil the information in computers. Then we will discuss the use and limitations of firewalls in protecting computer networks. We will also discuss intrusion detection and the problems associated with it. We review past and present cyberattacks, like Denial of Service attacks, viruses such as Melissa and I Love You, and assess their implications. We analyze the potential of computing capabilities which may be possible and discuss the extent to which they could be reduced. Finally, we analyze the response to this situation at the national, security and international level.

19-606 Special Topics: Civil Systems Investment Planning and Pricing
Intermittent: 12 units
Economic framework for identifying and analyzing investment and operation options facing agencies and firms, (both in theory and in practice); economic efficiency, utilization, pricing, and investment; and multi-objective evaluation.

19-609 Public Policy and Regulation
Intermittent: 9 units
Regulations are a significant policy tool of government. How society and the economy will react to new regulations can be hard to predict. Unintended side effects sometimes occur resulting in costs exceeding estimates and/or benefits never being realized. This course will review the basics of regulatory policy and use historical examples, to explore the reasons why past regulations have succeeded and failed. The second half of the course will involve 2-3 detailed case studies. Quantitative methods will be used to evaluate several pending regulations for real-world clients from both government and industry perspectives.

Prerequisites: Basic statistics, economics, and quantitative methods

19-644 Medical Devices
Intermittent: 9 units
This course is an introduction to the engineering, clinical, legal and regulatory aspects of medical device performance and failure. Topics covered include phenomenological and mechanistic descriptions of processes such as wear, corrosion fatigue and fretting, in addition to the characterization of bone and other biological materials as it relates to device performance requirements, including biocompatibility. The course also involves case studies of orthopedic fixation devices and prostheses, pacemakers, heart valves and artificial organs. A major portion of the course is a final design project which involves the design of a new medical device or the redesign of an existing device.

English

76-100 Introduction to Reading and Writing
All Semesters: 9 units
76-101 is a reading and writing course for those students who are not native speakers of English. Students who have identified themselves as those who speak English as a second or third language rather than as their primary or only language are eligible to take this class. The course, designed as a prerequisite for 76-101, stresses reading in English for comprehension and application of key concepts for writing summaries and short position papers. Students will be introduced to readers' expectations for Western rhetorical style at the sentence,
paragraph, and whole text levels. Norms for academic English will be explicitly taught within the contexts of these assignments, as well as academic standards for citing. Students who take this course will qualify through a placement test that is administered through the university prior to the fall semester. All sections of 76-100 for the Fall of 2006 will use the reader Now and Then by Judith Stanford.

76-101 Interpretation and Argument
All Semesters; 9 units
**PLEASE NOTE THAT 76-101 SECTIONS W AND X ARE SECTIONS FOR THE QATAR CAMPUS AND WILL NOT BE OFFERED AT THE PITTSBURGH CAMPUS**

This course will give students a comprehensive grounding in communication processes. The course focuses on the ways in which interpretive arguments appear in the processes of communication and social and personal development. In the class, students will develop these skills by reading, understanding, and interpreting the important issues and arguments regarding those issues advanced by a variety of texts, both fiction and non-fiction. They will then be asked to respond to these positions by developing positions of their own, in their writing and in their speaking. The course thus serves as an introduction to the discourse and arguments of the academic community, as well as serving as an introduction to some of the broader issues that the academic community address.

76-144 English Freshman Seminar: The War Against Cliche
Intermittently Offered; 9 units

Topics will vary by semester. Consult the course descriptions provided by the department for current offerings. EXAMPLE: Fall 2006 The War Against Cliche. The war against superficial discourse, the war against superficial discourse, the war against stereotypical "all writing is a campaign against cliche" says Martin Amis in his collection of essays and reviews, The War Against Cliche. He asserts that the writing that battles not just cliches of the pen but cliches of the mind and cliches of the heart. What is the difference between an expression that is universal and one that is cliche? And why does it mean to use fresh language, and still have cliched sentiments? Is there such a thing as a good cliche? Is there such a thing as an utterly original piece of writing? In this course we will explore how overused expressions influence us as critical thinkers and how we can combat/transform/transcend them in our own poems and stories. The materials (poetry, prose and film) for this course will offer "penetrating insights," a "problem" of cliche. "Original in conception," "devoid of sentimentality," "highly informative," "consistently witty," and "rich in color," they will "throw a clear light" on the subject of cliche.

76-206 Introduction to Creative Writing
Fall and Spring; 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 as the 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 public readings are expected.

76-221 Books You Should Have Read By Now: Studies in Classical Literature
Intermittent; 9 units

It may seem more and more difficult to get a good classical, liberal education these days. The demand for mass training force many of us to skim our understanding of major artistic achievements. So, this class is for those people who 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 Dostoevski's The Brothers Karamazov, pointing out that it contains everything we 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, but also as a 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 (Machiavel and the Renaissance, for example). Finally we shall use the ideas the literature is exploring 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 "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 the following texts, and some representative funny movies: Aristophanes, Lysistrata; Shakespeare, As you Like It; Congreve, War of the Worlds; Voltaire, Candide; Oscar Wilde, The Importance of Being Earnest; Samuel Beckett, Endgame; Evelyn Waugh, The Loved One; Joseph Heller, Catch-22; Wylie Sypher, ed., Comedy.

76-238 Introduction to Media Studies
Intermittent; 9 units

The terms mass culture and mass media are historically new, being a little over 100 years old, yet much has been written about them. This class will begin by seeking to understand the words "mass" and "culture." What does the word "mass" mean? What does the word "culture" mean? Beginning with these deceptively basic questions, this course will serve as a theoretical and historical introduction to the study of modern mass communication systems. It will welcome international students with a framework for analyzing the media that surround us. To this end, we will focus primarily on the case of advertising, as it is a body of texts that has exploited all forms of media. Though advertising can be understood as constituting its own medium, it is believed that looking at advertisements that span different types of media will allow us to hone our analytical skills while understanding technical development. Critical developments in the field will begin by introducing some core concepts and debates central to critical analysis of mass media, that focus on questions of type of media production, media distribution, audience, and message(s). This will become the language for our analysis of the historical development of commercial mass media, and give us a vocabulary with which to approach the study of varying forms of mass media. We will examine a variety of historical and present-day mass media to better understand the theories of how media manipulates the masses, others who argue that mass culture manipulates the masses, others who argue that advertisement and consumer culture is the equivalent of "social realism" for capitalist culture, and others still who argue that advertising and mass culture creates its own oppositional subcultures.

76-239 Introduction to Film Studies
Intermittent; 9 units

This course is an introduction to the technology, history, genres, and ideological positions of film as a historically new medium. It aims to teach the student how to analyze and interpret films, including feminist and auteurist. In general, the course will be concerned with the ideologies implicit in the films we see, especially those concerning gender and class. At several points, we will focus specifically on a theory of film criticism, including feminism and auteurism. In general, our approach will be to draw connections between the films and the larger culture.

Prerequisites: 76101

76-241 Introduction to Gender Studies
Intermittent; 9 units

This course, required for a minor in gender studies, will provide students with basic skills in reading about and understanding gender as a fluctuating and problematic cultural construct. The course materials are designed to give students an introduction to some of the various fields that intersect with debates about gender construction, such as sexuality, feminism, race, class, history, medicine, media, and popular culture. We will examine the discourses about gender as they exist in film, advertising, and popular culture. The course, required for a minor in gender studies, will provide students with a framework for analyzing the media that surround us. To this end, we will focus primarily on the case of advertising, as it is a body of texts that has exploited all forms of media. Though advertising can be understood as constituting its own medium, it is believed that looking at advertisements that span different types of media will allow us to hone our analytical skills while understanding technical development. Critical developments in the field will begin by introducing some core concepts and debates central to critical analysis of mass media, that focus on questions of type of media production, media distribution, audience, and message(s). This will become the language for our analysis of the historical development of commercial mass media, and give us a vocabulary with which to approach the study of varying forms of mass media. We will examine a variety of historical and present-day mass media to better understand the theories of how media manipulates the masses, others who argue that mass culture manipulates the masses, others who argue that advertisement and consumer culture is the equivalent of "social realism" for capitalist culture, and others still who argue that advertising and mass culture creates its own oppositional subcultures.

76-244 World English
Intermittent; 9 units

A Limit of 15 students from Pittsburgh. We welcome international students on the Pittsburgh campus to take this course. This course is primarily geared for sophomores. This course will study how so-called Standard English is broadening its definition to accommodate the fact that English is now an international language, the default lingua franca for all educated speakers and writers who share no other language. We shall study the social, economic, and political facts that have caused English to rise to this status. We shall also face many cultural issues raised by these facts. Each week will introduce readings raising new issues and students will be expected to write short weekly position papers relative to these issues. The course will have an
international component, as it will be taken concurrently by CMU students on the Qatar campus, most of whom are not native speakers of English. We will have regular video "town meetings" between students on both campuses.

76-245 Shakespeare: Histories and Tragedies
Fall: 9 units
We will be reading eight plays—three histories from early in Shakespeare’s career and five tragedies from later—and discussing films of some of them. The course will approach these plays from two angles. First, we will try to see them 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 playgoing, and the like. In addition, we will want to see these plays in terms of "what’s in it for us"—how current audiences and readers can enjoy and interpret these plays. We will be considering how close they come to the playwright’s intentions and to the expectations of audiences of the time. We will also consider how well or poorly they speak to us now that those institutions and discourses have been replaced by contemporary ones. Regularly, submit brief responses in class and/or over email from time to time, write two prepared essays, and take a final exam.

76-246 British and American Literature and Culture
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department each semester for current offerings. Example: The British and American Novel: Much has been made of the differences between English and American novelists in their handling of narrative but is it true? In this course, we will examine eight influential novels from the two sides of the Atlantic, four from England and four from the US. We will look at adventure stories like Frankenstein and Huck Finn, at novels about working-class characters from Dickens, Hawthorne, and Stowe, and at courtship novels from Austen, Charlotte Bronte and James. Students are required to attend regularly, participate in discussions, prepare brief commentaries to deliver in class, write two papers, and take a final exam.

76-247 Shakespeare: Comedies and Romances
Spring: 9 units
In this class we examine two genres of Shakespearean drama—comedy and romance—and think about how his work in these two dramatic "kinds" helps us understand the nature of Renaissance drama, in particular the religiously fraught, thriving mercantile culture of London, which supported the institution of theater in the English Renaissance. On the one hand, we will be considering Shakespeare’s ambitions as a writer, in particular the ways in which he adopted these two forms in order to advance his artistic (and financial) interests as a professional playwright for the public theater. On the other, we will be considering how the issues he dealt with in these plays—the nature of romantic love, the duties of children to parents, the construction of view of the world, and notions of romantic communication—in order to understand how these issues translate into contemporary performances (in film) of these plays.

76-260 Survey of Forms: Fiction
Fall and Spring: 9 units
This is an introduction to the reading and writing of fiction offered as the last 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.
Prerequisites: 76101

76-261 Survey of Forms: Creative Nonfiction
All Semesters: 9 units
The National Endowment for the Arts defines "creative nonfiction" as "a 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 and develop pieces of their own creative nonfiction. Prerequisites: 76101

76-265 Survey of Forms: Poetry
Fall and Spring: 9 units
This course is an introduction to the reading and writing of poetry. It is designed as the first in a sequence of courses for creative writing majors. Non-majors wishing experience in the writing of verse, both traditional and free, are welcome. Writing exercises are concerned with the elements of diction, scanion and metrics, as well as imagery. Some classes are devoted to workshop sessions in which poems written by members of the class are discussed. Students are required to submit a final project, which contains exercises and poems written and revised throughout the semester.
Prerequisites: 76101

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. In this course, we will discuss how to write a well-told screen story. Students will also write short papers on assigned viewings.
Prerequisites: 76101

76-270 Writing for the Professions
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.

76-272 Language in Design
Fall: 9 units
Language in Design is a professional communication 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 resumes, grants, 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. Finally, 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 communication situations that you will encounter in your design career. Enrollment is limited to majors in Communication and Industrial Design.

76-294 Interpretive Practices
Fall and Spring: 9 units
This course introduces students to the theories and practices of interpretation. Combining the approach of critical theoretical study with close textual analysis, we will consider how meaning is produced through language and narrative. Theoretical approaches include those that explore the role of the author, those emphasizing the workings of language, such as structuralism and post-structuralism, as well as those that underscore the relationship between texts and contexts, such as feminism, critical race theory, and postcolonial studies. Texts will be drawn from a range of periods, genres and geographical origin and include non-literary as well as literary. See English Department
for detailed descriptions.
Prerequisites: 76101
76-300 Professional Seminar
Fall: 3 units
This once-a-week, 3-unit seminar is designed to give students an overview of the broad range of career options in professional and technical writing, focusing on a range of communications fields — writing for the internet, corporate communications, public relations, journalism, science writing, healthcare communications, freelance writing, and writing for the software industry, for example — come to campus to talk with students and answer their questions. Speakers generally talk informally about what they do, how they got into their fields, how students can get started. At the end of each session, there will be general discussion and an opportunity for students to ask questions and talk individually with speakers. The 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, work on technical writing in a 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, zoos and other groups, software documentation firms and other groups needing technical writers and communication 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 will 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 class 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.
76-301 Internship
Fall and Spring: 1-12 units
Prerequisites: Open to all junior and senior English majors with a 3.0 or above GPA in their major. One prior 200-level or above writing-intensive course (including Survey of Forms) and permission of Internship Coordinator also required. 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, work on technical writing in a 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, zoos and other groups, software documentation firms and other groups needing technical writers and communication 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 will 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 class 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.
76-318 Communicating in the Global Marketplace
Intermittent: 9 units
Prerequisite: 76-270 or 76-271 Many of today's 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 ways 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 have a chance to meet some experienced professionals in this field.
76-319 Environmental Rhetoric
Intermittent: 2 units
Who speaks for Nature? The poet, the hiker, the rancher, the scientist, or the activist? How do these different stances "represent" the meaning of environment in their words and actions? This introduction to ways we talk about the environment and understand our relation to the natural world will trace an American history that has combined mystical celebration with scientific critique, and have students become skilled public debaters. We will read some of the landmark voices in this public discussion, which includes writers such as Henry Thoreau, John Muir, Rachel Carson, Aldo Leopold, Edward Abbey, and will see their influence in popular films and activist groups, from the radical Earth First! to Greenpeace, to the mainstream Sierra Club and Nature Conservancy. We will explore the competing discourses that have emerged in the American debate (the conservationists versus preservationists, the scientific ecologists versus deep ecologists), looking at both their rhetorical strategies and their response to the fundamental environmental question: is nature best understood as a resource, as an object of scientific inquiry, or as spirit? Over the course, students will also create an issue book on an environmental issue of their choice in which they will be able to analyze and compare multiple discourses surrounding that issue (from scientific, political, and activist organizing in media and fiction, to naturalist observation and experiential reflection) with the goal of also making their own contribution.
76-330 Medieval Literature: Women's Lives/Men's Lives
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department each semester for current offerings. EXAMPLE: Women's Lives/Men's Lives. Some contemporary critical arguments about individual agency and contexts in the work of Shakespeare (the invention of the human, as Harold Bloom puts it); are they right? This course will consider records from as early as the 700s and as late as Ben Jonson, utilizing the distinctive ways medieval men and women represented themselves in texts, their sober thoughts and their flights of fancy, to include well known figures like the Roland, Inferno, various Arthurian tales, and writing by women. Students will also choose one twentieth-century fiction based on medieval materials to read and report on. Course requirements include regular attendance and participation in discussions, brief papers and a final exam.
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 natural philosophy and science. How did the complex public debates, ideas, and assumptions about these strange phenomena influence the development of the scientific revolution? With this course, we will explore the ways this changed over time. The 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, work on technical writing in a 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, zoos and other groups, software documentation firms and other groups needing technical writers and communication 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 will 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 class 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.
76-332 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: The Harlem Renaissance. The Harlem Renaissance roughly encompasses the period between the two World Wars. A clash of races, a redefinition of African American identity, and the cultural flowering of the 1920s led to a flourishing of new authors. How did developing global consciousness, and improved education change the composition, structure, and mindset of black Americans? Black cultural production during this period articulated a new form of American modernism, encouraged black political and social consciousness (and thus changed the face of urban and national politics), and spurred lasting debates about the relationship between culture and identity. This course aims to introduce you to major themes and structures of expression in American literature of the Harlem Renaissance. Our primary focus is on fiction. We will also spend time on critical essays, poetry, and people that defined the period to provide historical context and analytical perspectives. This class will perform close readings, paying attention to theme, image, language, and experiential reflection) with the goal of also making their own contribution.
76-334 19th Century Literary and Cultural Studies
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions provided by the Department each semester for current offerings. This course engages the unprecedented changes in the period through major...
and minor cultural works and secondary texts. In particular, we
focus on the “Condition of England Question”—the discourse
surrounding the great social, economic and political upheavals
following the Napoleonic wars and before the halcyon days of mid-
Victorianism. We will explore the set of issues represented by
this complex (and not unchallenged) phrase, from various social
locations. Richard Carlile, Thomas Hodgskin, Thomas Carlyle,
Friedrich Engels, Karl Marx, John Stuart Mill, Benjamin Disraeli,
Charles Dickens, George Eliot, and Matthew Arnold are among
the authors whose works we will examine. We will also read poetry,
including that by Alfred Lord Tennyson, Elizabethan and Robert
Browning, and James Thomson, B.V., and others.

76-335 20th Century Literary and Cultural Studies
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions
provided by the department for current offerings. EXAMPLE Fall
2006: Introduction to Race and Ethnicity. The course examines the
way in which race comes making meaning in American culture through images and narrative. The class focuses most
styles, on race and identities, such as blackness, whiteness, as
important symbols that have tangible social and cultural consequences. We will also address issues of identity more
generally in our theoretical readings and discussions. How do we
know, understand, and live these identities? We will examine
literature and films as a means to approach the question of how
race comes to be understood and conveyed in culture. In what ways
do such texts use race for meaning? Texts include D.W. Griffith’s Birth of a Nation, Toni Morrison’s short-story
Recollect and excerpts from Morrison’s Playing in the Dark,
Willa Cather’s O Pioneers!, Gogol’s Gogolita fiction by Octavia
Butler, and Anne Devere Smith’s Twilight, plus several films.
Thomas Cripps, Slow Fade to Black William Faulkner, Go Down Moses Manthaia Diawara, Black American Cinema bell hooks, Reel
to Real Roberto Bolaño, Reading Urban Uprising Octavia Butler, TBA

76-338 The American Cinema
Intermittent: 9 units
This course will focus at major works of sound-era American
Cinema in the context of the history of the film industry and the
larger society. The course will focus on the following major
transitions in the industry: the production code of 1934; the
consent decree of 1948; the end of the production code in
1954. We will focus at the work of major directors, such as
Hawks, Hitchcock, Coppola, and Polanski, major genres, such
as screwball comedy, women’s pictures, and Westerns, and major
styles, such as American cinema, the major War
Poets, F.Scott Fitzgerald, Robert Graves, Vera Brittain, Evelyn
Waugh.

76-355 The Rhetoric of Making a Difference
Intermittent: 9 units
This course will focus on the rhetoric of making a difference. It is about writing and speaking
wisely and persuasively for change in everyday settings. This
course will focus on the study of rhetoric with practical
experience supporting change making through the methods of a
communication think tank (see www.cmu.edu.thinktank). We begin
with writers out of the American Pragmatist tradition, from
Emerson and Martin Luther King to bell hooks and Cornel West,
who wrestle with the problem of rhetorical strategy. The course
then focus on how everyday people make a difference in local
contexts and compare different approaches, from working on
institutional change, to creating public ideas and transformative
social tools, to intercultural dialogues that amplify marginalized
voices. In your final project (as a “think tank consultant” to a
campus or community group you choose), you will learn how to
institute the problem-solving dialogue, and develop a
briefing book which supports deliberation and change by
documenting public perspectives and options on the issue they are
facing. This portfolio might well also, 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, Evelyn
Waugh.

76-360 Literary Journalism Workshop
Fall: 9 units
PW: 300 level writing course or English Elective EBA: 300 level
Elective ECE CW: can be taken as either an English Elective
or a Work Experience course or a Work Experience course as
credit as a Work Experience course. Professionals who want to
have the course count as a Workshop Requirement must have
earned a grade of “A” or “B” in either 76-260 or 76-265.
Prerequisites: 76-260, 76-265, 76-262, 76-472 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 produce something resembling a book or a collection of
essays.

76-374 American Literary and Cultural Studies: American Fiction
Intermittent: 9 units
Topics will vary by semester. Consult the course descriptions
provided by the Department each semester for current offerings.
EXAMPLE: Fall 2006 American Fiction. American women
American writers. In this course we will focus on the various
titles written by some of the greatest novelists and short story writers of early
20th century. They range from the haunting beauty of the stories of
the Southwest by Willa Cather and John Steinbeck to the
controversial Southern stories of Kate Chopin, and the
inspiring memoir of Eudora Welty. We will also look at the women
where confront urban issues like immigration and labor strife,
including Harriet Arow and Mary Heaton Vorse, in their novels
The Dollmaker and Strike! Throughout the course we will think
about what it means to call something “American literature” and
the categories of “women’s” vs. “woman author.” We will also
consult essays and ideas found in Feminist Theory, using
readings drawn from a popular reader in Feminist Literary Theory.
Prerequisites: 76101
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: 76260 or 76265 or 76270 or 76271 or 76372 or 76375 or 76472

76-363 Reading Contemporary Poetry

Interruption: 9 units

We will explore the multifaceted relationship between modern science and poetry by examining the ways in which poetry has taken on the language and theories of science as well as relating how science has been influenced by poetic thought. The course is designed for English majors who are not necessarily trained in the sciences, as the sciences and original poems aim for an audience of general college-level readers. We will also view—during class time—the entirety of Brian Greene’s The Elegant Universe as a means of spurring students to consider the relationship between both poetry and science. We will employ Greene’s wildly popular, and poetic, video portrayal of the ways in which we experience and make sense of the cosmos in order to augment the poetry and essays assigned during the course—be it at the microscopic level of disease or at the macroscopic level of the discovery of satellites orbiting Jupiter in the seventeenth century. Readings from the anthologies Versus and Universum and about Science and Mathematics will be occasionally included in course handouts. Some of the poetry we will read and discuss includes work by: Alice Thomas Williams; Forrest Gander; Miroslav Holub; Marianne Moore; A. R. Ammons; and Albert Goldbarth...(see English Department for full description)

76-365 Beginning Poetry Workshop

Interruption: 9 units

Prerequisites: A student must receive an A or B in 76-265 Survey of Forms: Poetry class in order to enroll. In 76-365 only with the permission of the 76-365 professor. A student who received a D in the Survey of Forms: Poetry may not take a Poetry workshop. This course is an introduction to writing and thinking about poetry. You are expected to learn the principles and elements of poetry and utilize them in workshop discussions, written analysis, and the composition of your own poems. Class will be constructed around a combination of creative and critical writing connected to readings in The Best American Poetry 2000.

Prerequisites: 76265

76-366 Reading Contemporary Fiction

Interruption: 9 units

This course will focus on reading and analyzing late 20th century and contemporary fiction. Specific works and topics will vary by semester. The goal of the course is to help students develop a deeper understanding and awareness of recent fiction.

Prerequisites: 76-372 Contemporary Journalism

Fall: 9 units

Students will in Contemporary Journalism will learn the rudiments of reporting, interviewing and writing in a journalistic style while participating in discussions and completing assignments on current issues in the news. What makes a story newsworthy? How does a reporter decide which approach to take? What are effective techniques for executing a successful interview? How does a journalist turn pages of scribbled notes into a coherent news story on deadline? Class sessions will examine questions of professional ethics, using real life examples, and deconstruct famous and infamous stories that have gained national attention. The emphasis will be on writing assignments and learning different styles of writing—print and electronic media. But students also will look at how newer mediums, such as blogs, have impacted the newspapering business.

76-373 Topics in Rhetoric: Argument

Fall and Spring: 9 units

This course is designed for both the student interested in developing a more thorough critical apparatus of argumentation and the student interested, for professional or scholarly reasons, to develop more effective arguments. The course presumes that argument is a fundamental form of human communication, and that finding, analyzing, and producing arguments are activities central to our professional and public lives. Students will study argumentation theory, and will test that theory against arguments we find within a public controversy surrounding an important social issue. This theory building should provide us with a framework for evaluating and critiquing the effectiveness of arguments in context. In addition, students will identify and define problems as the initial step toward developing arguments of their own. Students’ assignments will include written analyses of arguments within a controversy and written arguments that clearly define and address problems.

76-375 Magazine Writing

Interruption: 9 units

We’ll read a variety of magazine articles (everything from N.Y. Times magazine section to Utne to Smithsonian to Atlantic Monthly and many more) all of which are aimed at a wide, educated audience. The class will be run as a seminar and workshop: each student will produce their own magazine writing, after reading and analyzing the work of other professionals. Students will choose their own focus and decide on topics that most interest them. Research/interview techniques will be taught. The art and craft of writing (student and professional) will be discussed all term long.

Prerequisites: 76260 or 76270 or 76271 or 76372 or 76472

76-377 Rhetoric of Fiction

Interruption: 9 units

What is the relationship of John Steinbeck’s Of Mice and Men to Booth’s book, The Rhetoric of Fiction, is one of the classic discussions of the ways in which fiction communicates, moves or motivates us. It is a commonplace to assume that literature has a message, but it is still not at all clear just how an imaginative representation of the world does, or can, communicate. Booth had particular difficulty understanding how fiction could communicate a felt sense of life and value when there was doubt about narrative authority, or the “reliability” of the author. So, postmodern fiction (from Joyce on) caused him problems. In an attempt to develop a postmodern rhetoric of fiction we shall be looking at texts that deal 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’). The reading will include the following: Jane Austen, Persuasion; Henry James, The Turn of the Screw; James Joyce, Finnegans Wake; Arthur Miller, Death of a Salesman; and Fedor Dostoevsky Notes From Underground, Gustave Flaubert Madame Bovary; Italo Calvino, If on A Winter Night a Traveller; selections from Wayne Booth, Kenneth Burke, and Mikhail Bakhtin.

76-378 Literacy: Educational Theory and Community Practice

Interruption: 9 units

Literacy has been called the engine of economic development, the road to social advancement, and the prerequisite for critical abstract thought. But what do we mean when we use the discourse of an educated elite or laying down a rap? What is your literacy quotient? 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 a result, we will 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.

76-380 Research for Writers: Finding Information & Studying Your Audience

Interruption: 9 units

Can readers comprehend the document you have worked so hard to produce? Can they follow its directions safely? Are they fearful or confident as they do so? In Research Methods for Writers, you will study and practice methods for providing valid and reliable answers to these types of questions, both in the lab—before a participative learning environment 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.
data. There will generally be two exams and a final. Prerequisites: 76270 or 76271 or 76379.

76-382 Multimedia Authoring I
Intermittent: 9 units
This course will provide an introduction to the technical skills needed for designing On-Line content and Interactive Multimedia. Common multimedia tools for use in creating web-based products will be taught alongside ample opportunity for practice. Students learn authoring tools and multimedia techniques while covering topics including internet-based communication, internet-based visualization, and digital video web-deployment. Principles of design will be discussed and stressed throughout the course. Group design processes and project management issues will also be addressed. This course makes extensive use of web-oriented applications such as Dreamweaver and Flash. Preference will be given to majors in the English Department, Multimedia Production Majors, and IS Majors in the Design and Communication Track. For English majors (EBA, CW, PW, and TWC) who are also in the Multimedia minor, 76-382 may be used to fulfill their core requirements and may NOT use 76-382 as a substitute.

76-383 Multimedia Authoring II
Intermittent: 9 units
Multimedia authoring involves the combination of graphics, sound, text, and movies to create products such as sales presentations, training packages, software programs, and computer-based training materials. You will be using Macromedia Director, the most often used program today for multimedia development and authoring. But production of such degree applications in Macromedia Director often involves much more than we bargained for. Beginning developers are continually asking themselves a variety of questions: Is there an easier way? Is there a more efficient way? How do I handle user interaction, decision-making, and web-interaction issues? And how do I design an interface that works for the user? In this course, we’ll also learn about the relationship of Director’s Lingo scripting and multimedia authoring, and you will work on several smaller projects in preparation for a final class project, due at the end of the semester. This is a course demanding a lot of self-directed study. Students will be encouraged to work diligently on their final project throughout most of the term. For English majors (EBA, CW, PW, and TWC) who are also in the Multimedia minor, 76-383 may NOT be double counted toward both the minor and their English degree requirements. Prerequisites: 15100 or 15111 or 15112 or 15125 or 15127.

76-385 Introduction to Discourse Analysis
3 units
“Discourse” is language in use: people talking or signing or writing. Discourse analysts ask and answer many questions about why people do the things they do with language. They 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. They look at how grammar is influenced by what people need to do with language, and how discourse changes grammar over time. They ask how children learn how to make things happen with talk and writing. They analyze the choices that speakers and writers make and what those choices reveal about how they see themselves and how they relate to others. They study how people define 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 more personal relationships within families and among friends. This course touches on a selection of these topics and gives students practice in paying close attention to the use of language.

76-386 Language & Culture
Intermittent: 9 units
This course seeks to develop an understanding of what language can do socially and communicatively. Language plays a significant and complex role in our lives. We commonly use language to perform actions, to accomplish things like asserting, persuading, telling stories, expressing individual identities and social affiliations by choosing among various ways of talking. Thus, in using language, we also organize ourselves socially. By studying how language is used to organize human life we can understand what ‘culture’ means. In this sense, language and culture are inseparable, and one cannot be studied without the other. This course will engage students with the multiple concepts of linguistic practice to explore the connections between human language and human life through readings, lectures, and discussions.

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 many questions we will focus on 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 written or more oral, gendered in one way or another, and so on? How can such variation be accounted for in theory of language? What kind of “grammar” is involved in knowing how to participate in conversations, and how do conversational styles differ across group to group? What causes misunderstandings and what enables understanding in interaction among people who are different? What are the effects of multilingualism and language contact on speakers? How do speakers select among the range of 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 written and oral language, and students will be encouraged to work diligently on their final assignments, as well as a mid-term exam and a final project.

76-389 Grammar of Standard Written English
Spring: 9 units
This is a course in the grammar that characterizes relatively formal, relatively planned, often written English. As we develop and analyze the complexities of language, we discover the power of language to deceive, control, and manipulate. That power makes it possible for rhetoric to make its mark on the world. Today, many professionals are responsible for the visual design of documents. This course provides students who have already learned the foundations in written communication an opportunity to develop the ability to analyze and create visual-orientated applications. 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 situations. Students in this course will learn the principles of design that are essential to good design. This course will provide an introduction to the technical skills needed for designing On-Line content and Interactive Multimedia. Common multimedia tools for use in creating web-based products will be taught alongside ample opportunity for practice. Students learn authoring tools and multimedia techniques while covering topics including internet-based communication, internet-based visualization, and digital video web-deployment. Principles of design will be discussed and stressed throughout the course. Group design processes and project management issues will also be addressed. This course makes extensive use of web-oriented applications such as Dreamweaver and Flash. Preference will be given to majors in the English Department, Multimedia Production Majors, and IS Majors in the Design and Communication Track. For English majors (EBA, CW, PW, and TWC) who are also in the Multimedia minor, 76-382 may be used to fulfill their core requirements and may NOT use 76-382 as a substitute.

76-391 Document Design
Fall: 12 units
Documents can be designed to have a maximum impact on readers -- whether those readers are professionals (creative, professional or technical writers) or a professional who writes (lawyers, engineers, scientists, business managers--in other words, just about anybody).

76-392 Rhetoric and Public Policy
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 an opportunity to develop the ability to analyze and create visual-orientated applications. 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 situations. Students in this course will learn the principles of design that are essential to good design.
not merely words, but an art, a technique, a process, a mode of invention for the production of public knowledge, public argument, public problem-solving, public action, public response, and public critique. In this course, students read classical and modern theorists in order to understand the role of rhetoric in public decision-making, public argument, and the construction of public knowledge and to rethink rhetoric as a theory of public discourse.

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 and their meanings. 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 investigate the ways in which we ask 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 critically, interpreting texts, conducting interviews and surveys. Students will also learn how to conduct their work in the context of a scholarly conversation, by testing their hypotheses against alternatives and presenting their research to audi ences in the field of their choice. The course requires that students read widely and critically, develop and evaluate research questions, and present their findings in both written and oral forms. The course will be taught using a variety of teaching methods, including lectures, group discussions, and writing assignments. Students will also be required to participate in group projects and to present their findings in a final research paper.

76-395 Science Writing
Spring: 9 units
Today, more than ever, we need illuminating science writing. As the world changes at an ever-accelerating pace, it becomes increasingly difficult for mainstream readers to remain scientifically literate and technologically current. This science writing course looks for students who want to meet that challenge by developing the skills needed to comprehend important scientific subjects, and then clearly and effectively write about them for mainstream readers. Students will write short and medium form science journalism embedded in a culture critical atmosphere. They will develop pieces for a variety of publication styles including newspapers, hard and soft science magazines, as well as general readership publications. The course will feature one-on-one, in-class writing workshops, as well as a final project in which students will apply their new writing skills to a real-world science issue.

76-397 Instructional Text Design
Intermittent: 9 units
This course focuses on the planning, writing, and evaluating of instruction of various kinds. 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 training. In the first part of the course, we will examine the recent history of instructional design and the major current theories. Then we will take a step back and study the concepts of learning upon which these theories are based, with particular implications for instruction. Finally, the course will be taught using a variety of teaching methods, including lectures, group discussions, and writing assignments. Students will also be required to participate in group projects and to present their findings in a final research paper. Prerequisites: 76270 or 76271 or 76372 or 76373

76-400 Process of Reading and Writing
Spring: 9 units
This course is an introduction to the constructive processes behind reading and writing. It asks: what are social and cognitive processes, what are the conscious and unconscious problem-solving strategies we use in a world that is complex and ambiguous? In the course, students will learn to read and write in a critical, interpretive manner, using strategies such as constructing arguments based on evidence, interpreting texts, and considering the ways in which texts are constructed and interpreted. Students will also learn how to read critically and constructively, interpreting texts in light of recurring questions about the meaning-making reader and the ways in which texts are constructed. The course will be taught using a variety of teaching methods, including lectures, group discussions, and writing assignments. Students will also be required to participate in group projects and to present their findings in a final research paper. Prerequisites: 76270 or 76271 or 76372 or 76373

76-431 Advanced Seminar in British Literary and Cultural Studies: The Long 18th Century
Intermittent: 9 units
This course is an introduction to the constructive processes behind reading and writing. It asks: what are social and cognitive processes, what are the conscious and unconscious problem-solving strategies we use in a world that is complex and ambiguous? In the course, students will learn to read and write in a critical, interpretive manner, using strategies such as constructing arguments based on evidence, interpreting texts, and considering the ways in which texts are constructed and interpreted. Students will also learn how to read critically and constructively, interpreting texts in light of recurring questions about the meaning-making reader and the ways in which texts are constructed. The course will be taught using a variety of teaching methods, including lectures, group discussions, and writing assignments. Students will also be required to participate in group projects and to present their findings in a final research paper. Prerequisites: 76270 or 76271 or 76372 or 76373
important role in what we call “the modern.” “Reason,” “enlightenment,” “the public sphere,” “the rights-bearing individual,” indeed, modern imperialism and the nation-state, while not originating during this time, took on characteristics forms that are recognizable as “modern” from our historical perspective. This course focuses on how present-day historians and literary scholars construct the years between 1660 and 1790: what cultural events punctuate historical narratives of this time period? What writers and texts are important to those events? The heart of this course is a wide sampling of imaginative literary texts—fiction, poetry, and drama—from the beginning to the end of the long eighteenth century. Obviously, this reading list will have to be highly selective. To keep us aware of and honest about these choices, we will also study histories of the period that have been influential in the field of literary and cultural studies. These texts should help us consider how the stories we tell about the past and the texts we chose to study from that past mutually determine each other. Six kinds of historical narratives have come to dominate current cultural approaches to this period. We can think of these as dominant, or at least important, frameworks for interpreting and defining eighteenth-century studies. We may determine many of the stories we tell about eighteenth-century culture and they lie behind the on-going formation of the canon...(see English Department for full description)

Prerequisites: 76294 Corequisites: 76-394

76-432 Advanced Seminar in African American Studies: Modernism and the Harlem Renaissance
Interventions: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings.  EXAMPLE Fall 2006: Modernism and the Harlem Renaissance. This advanced seminar takes a broad, interdisciplinary approach to studying Harlem Renaissance culture and its significance. The Harlem Renaissance broadly encompasses the period between the two World Wars. Mass migration of African Americans to urban areas north and south, the experience of fighting for the U.S. overseas, a developing global consciousness, and improved education constituted some of the conditions of modernity that changed the composition, structure, and mindset of Black America. Black cultural production during this period articulated a form of American modernism, encouraged black political and social consciousness (and thus changed the face of urban and national politics), and spurred lasting debates about the relationship between culture and identity. It is well known that an explosion of literary production characterized African American culture during this period. Less well known are the roles performance, music, art and public debate played in ushering in new conceptions of community and race. Course materials include written work by Nella Larsen, Alain Locke, Zora Hurston, and Langston Hughes, including works that remain controversial, like Carl Van Vechten's Nigger Heaven. We will also examine artwork, music, and film theatrical production. This class will approach questions of race, migration, creative expression, transculturalism, and identity.

Prerequisites: 76294 Corequisites: 76-394

76-433 British Literary Movement
Interventions: 9 units
Seminars focusing on British literary movements, forms, periods, or authors since 1800. Topics will vary by semester. Consult the course descriptions provided by the department for current offerings.  EXAMPLE: Modernist Poetry, Poetics, and Politics. In this course we will read the poetry and prose of poets in the period. Hugh Kenner dubbed other famous writers, wrote about their structure and distribution.

Prerequisites: 76294 Corequisites: 76-394

76-435 Feminist Cultural Studies
Interventions: 9 units
What is feminist cultural studies? This course will answer this question with practical work as well as with case studies as well as theory. The goal of the course is to develop some models for how to do feminist cultural study; we will pursue this development through an instructor-designed model case study and through the design and study of cases that arise from the students’ interests and intellectual investments: I. Model Case Study. We will work together on studying materials that comprise a particular “case” from early modern English culture: In 1753 Elizabeth Canning, an 18-year-old servant, disappeared from her London home for nearly two months. She returned nearly mad and in an emaciated condition, and told of being kidnapped and held captive in a "wicked" house where a gypsy named Mary Squires attempted to force her into prostitution. When, Canning claimed, she refused, she was held captive in an attic, with very little bread and water, until she managed to escape and walk the ten miles to her mother’s house.  II. Student Projects: Students in the class will design and develop their own projects in feminist cultural studies that will further help us to delineate and understand the methods and objects of study, and to criticise the theoretical and, and theoretical field. These projects may be collaborative or individual. Students will design a case study select materials relevant to the case class reading lead discussions of the case write a paper for feminist research project based on the case materials.

76-438 Advanced Seminar in American Literary and Cultural Studies
Interventions: 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 seminar 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 Popular Suburbs, Paul Nahin, 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: 76238 and 76239 and 76294

76-439 Advanced Seminar in Film and Media Studies: Sound Theory
Interventions: 9 units
Topics will vary by semester. Consult the course descriptions provided by the department for current offerings.  EXAMPLE Fall 2006: Sound Theory. Sound. Noise. Music. What tools do we have to study these ephemeral objects? How do we study something that, as Jane Gaines argues, "exists just as it is going out of existence"? In this course we will look at the oldest—and the most recent—tools that cultural studies has to offer for the study of sound. Books include Jonathan Sterne’s The Audible Past, Walter Ong’s Orality and Literacy, and Murray Mcluhan’s The Gutenberg Galaxy. We will also examine the ways in which Chaucer’s fictions are situated within specific, but universal, timeless fictions containing “God’s plenty” (in which an eye is worth a reason), and look at other representations of medieval English culture as it saw itself and as we see it from a 20th-century vantage point. Regular attendance, participation in classroom discussion, and brief oral presentations from time to time are required. Each of you will be required to take a special interest in one of the Canterbury pilgrims and try to see the unforging sight from that character’s point of view. Writing assignments include two brief papers and one longer one, but no final exam. Graduate students will meet for an extra hour a week to discuss additional readings.

Prerequisites: 76239

76-441 Chaucer
Interventions: 9 units
Geoffrey Chaucer is sometimes thought of as the author of universal, timeless fictions containing “God’s plenty” (in Don Quixote’s famous phrase) that are recognizable as “modern” from our historical perspective. The ways in which Chaucer’s fictions are situated within specific, both complex and fluid, 14th-century political, social, and religious contexts. We will read The Canterbury Tales and Troilus and Criseyde in Middle English (which is not hard to learn, but fun to know), and look at other representations of medieval English culture as it saw itself and as we see it from a 20th-century vantage point. Regular attendance, participation in classroom discussion, and brief oral presentations from time to time are required. Each of you will be required to take a special interest in one of the Canterbury pilgrims and try to see the unforging sight from that character’s point of view. Writing assignments include two brief papers and one longer one, but no final exam. Graduate students will meet for an extra hour a week to discuss additional readings.

Prerequisites: 76294

76-451 Topics in Language Study
Interventions: 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 current offerings.  May be repeated for credit.  EXAMPLE: Patterns of English Usage. Beside the conventional “grammar” of English there lurk an unlimited number of patterns that play an important and largely unrecognized role in organizing our language. In this course we will learn some techniques for recovering these patterns from an elliptical corpus and making generalizations about their structure and distribution.

76-457 Topics in Rhetorical Study
Interventions: 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 current offerings.  May be repeated for credit.  EXAMPLE: Patterns of English Usage. Beside the conventional “grammar” of English there lurk an unlimited number of patterns that play an important and largely unrecognized role in organizing our language. In this course we will learn some techniques for recovering these patterns from an elliptical corpus and making generalizations about their structure and distribution.
Though creative nonfiction is based on actual events, characters and places, writers in this broad, vital genre often borrow techniques from fiction, such as scene, dialogue, distinctive narrative voice, and point of view. Journalists seek the truth by attempting to be objective. Writers of memoir, the essay and literary journalism (three of the many forms that are part of the genre) understand that truth is the very biased, very personal "truth" as experienced by the author. In this workshop, students will read widely within the genre and work on three of their own pieces. By semester's end, they will have produced a portfolio with forty pages of their own work.

76-469 Screenwriting Workshop

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 76-460 professor. A student who received a D or R in 76-269 may not enroll in 76-469. Students will read professional, self-inquiry expressed in disciplined, lively prose. Student essays will be workshopped in class. By the end of the course, a student will have participate in workshops and written 35 pages of essays — of various lengths — and all are to be finished. Rewritings of workshop essays will be called for.

Prerequisites: 76260 or 76265

76-472 Advanced Journalism

Spring: 9 units

Prerequisites: 76-372 or 76-375 or 76-360 or 76-376 or 76-472 or permission of the instructor. This is the second part of a two-course sequence begun in the fall semester. Students will begin to develop their own theories, and eventually, they will will be encouraged to and assisted in finding outlets to publish their assignments. Weekly sessions will focus on the history and evolution of journalism in the 20th century as a way of understanding contemporary practices and trends. In addition, classes will include presentations of student projects; discussion of practical problems in news gathering; analysis of published stories; and visits by professional journalists. While it is recommended that students take 76-472 before enrolling in this course, students with previous or current journalism experience are encouraged to contact the instructor for permission to enroll. This course may be taken more than once for credit.

Prerequisites: 76360 or 76372 or 76375 or 76367 or 76472

76-476 Rhetoric of Science

Intermittent: 9 units

Do scientists ever argue? 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 dig beneath this common stereotype in order to examine more closely the role of argument in science. In order to establish that science is a persuasive enterprise we will be exploring the philosophy, communication conventions, and texts of scientists. Guided by rhetorical concepts, we will consider a number of historical and modern case studies of science and technology. Our efforts will be mainly devoted to understanding and explaining science as a profession with specific norms of interaction, and as a field in which knowledge is produced according to certain norms, conventions, and practices. Rhetoric will allow us to see how scientists use language to represent the world, develop new ideas, and communicate them to each other. By 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 culture. Students will write original papers or research papers that will help them apply and evaluate theories within specific contexts.

This course explores problems and solutions that will apply to marketing and communication in a broad range of business settings, where professional communicators manage relationships with a wide variety of constituencies including customers, investors, news media, agencies, employees, local communities, and local, regional, and national government agencies. This course will help you develop...
the written and oral communication skills to handle the wide variety of tasks demanded of a professional communicator in such settings. You will learn how to plan and develop a coherent approach for all of an organization’s communications as well as effective marketing strategies for achieving business objectives. Topics covered will vary somewhat by semester but generally include corporate branding, messaging, and positioning; crisis communication; public, media, government, and investor relations; internal employee communication; Web publishing and corporate Web sites; annual reports; measurement and evaluation of communications effectiveness; knowledge management; and customer relationship management.

Prerequisites: 70340 or 76270 or 76271 or 76372

76-481 Writing for Multimedia
Fall: 12 units

There is increasing demand for professional/technical writers who understand multimedia and it’s characteristics of design. 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 rhetorical situations. 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 different design theories from historical, theoretical, and technological perspectives. Class discussion and critiquing are an essential part of this course. While students are not expected to become experts in multimedia 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: 76270 or 76271 or 76260 or 76269

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 ways in which 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 about, argue across, and produce and sustain languages and cultures that are incommensurate. 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.

76-485 Going Public: Local Publics, Counterpublics, and the Rhetoric of Deliberation
Intermittent: 9 units

This course starts with the energetic debate around theories of the public sphere that asks: is significant public debate really easily achieved in a media-saturated world of self-interests and corporate control? Is there a public sphere or just a network of "local" plural publics? Is the traditional, rational-universal (and elitist) model of public deliberation in which the best argument wins the best model for a democratic society? Then we take a close look at the rhetoric of individual local publics and counterpublics (from studies of ecorhetoric, grassroots women's of Web and web-based forums, to a Pittsburgh community think tank) where the process of deliberation and change takes many different forms. To support your own inquiry into the meaning making process of a local public, we will work with the observational tools of activity analysis and social/cognitive negotiation analysis.

76-487 Online Information Design
Fall and Spring: 9 units

Students taking On-Line Information Design must register for both 76-487 and 76-488. The only unit is for US students who have already completed 76-382 or 67-272. Only students enrolled in 76-487 may take 76-488. On-Line Information Design.

This course introduces you to issues and practices in the design of on-line information. The course has the following interrelated goals: Introduce you to the major theories, methodologies, and practices of on-line information design; Develop your skills in evaluating on-line information designs; Develop your skills in analyzing and reporting on user needs prior to design, and verifying a given design’s effectiveness through usability testing; Develop the background knowledge you need to succeed in the interdisciplinary world of information design. Topics in inter-class lecture and discussion will include: methods for exploring users’ needs and tasks (interviews, observation, and more); characteristics of effective Web site design (organization, navigational design, link labeling, form and search design, visual design); methods and artifacts of iterative design and evaluation of Web sites; methods and artifacts of professional organization; usability. The course’s primary focus will be on the design of verbal and pictorial information typical of Web sites, though issues in on-line design for other modes, such as sound, and animation, will be touched upon. Special lecture topics may include personalization, Web communities, or on-line help. There is a series of homework assignments in which students analyze and report on user needs, iterative design, and methodology and Web site. There are two in-class exams and a final.

Prerequisites: (76270 or 76271 or 76379 ) and (76480 or 76382 or 51261 or 51262)

76-488 On-Line Information Design Lab
Fall and Spring: 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 Java- scripting. All student 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 more hands-on practice in doing the lab exercises must attend the lab session. Lab sessions take place in a computer lab.

Prerequisites: (76270 or 76271 or 76379 ) and (76480 or 76382 or 76383)

76-491 Software Documentation
Spring: 9 units

This course introduces students to basic practices involved in software documentation for both internal and external audiences. You will learn to understand the purpose of documentation and the need for various documentation formats for internal and external audiences (user guides, online help, marketing collateral). By the end of the course, you will have a grasp of the standard vocabulary and the tasks of software development for creating software documentation alone and as part of a development team. You will better understand the relationship between the software, its objectives and tasks, and the most effective ways to instruct users. You will also gain experience in assembling and writing material used in software releases, including analysis and design documents, and user manuals. Lab assignments will also take into account the requirements of cross-cultural and special needs users. The course requires a series of homework assignments, collaboration, and several smaller team projects. Assigned readings and documentation examples will enhance the projects in generating a bridge between theory and practice. This course will also use and gain experience with current authoring tools. Subtopics include the fundamentals of software design, project and document management, single-sourcing, and responding to change.

76-494 Healthcare Communication
Fall: 9 units

Prerequisites: 76-270 or 76-271 or 76-379 or instructor permission Healthcare Communications is designed for all those with an interest in how medical and health care information is constructed and transferred between medical experts, health care providers, educators, researchers, and patients and family members who are often not experts but need a thorough understanding of the information to make important health care decisions. Throughout the course, we will (1) explore the intersections of current theory and practice in medical communication and (2) explore the role of writing in the transfer and adoption of new therapies and promising medical research. We will also study how new technologies such as the World Wide Web and computer-based training alters the way that information is both constructed and distributed. Last, we will read the Pulitzer Prize winning play Wit by Margaret Edson to discuss the issues related to clinical research and patient care. This course does not provide you with a set of static skills. Rather, you will be expected to put theory to practice. Early in the semester, you will choose a medical area of interest that you will research using sources such as journals, articles, books, web sites and direct contact with appropriate medical, healthcare, and/or research professionals. For your final project, you will write and design one of the following: a journal article, a Web site, a brochure or booklet or a set of training materials. Your final project should fill a specific need in the medical area that you have chosen. In addition to this project, there are a series of short writing assignments.

Prerequisites: 76270 or 76271 or 76379

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 and 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.
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 improve 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 examining primary sources in various publicized sources, microfilm, and archival collections at Carnegie Mellon and the University of Pittsburgh.

79-156 Freshman Seminar: History of Psychoactive Drug Use in America  
Intermittent: 9 units  
This course will examine the use of psychoactive drugs in American history from a cultural and historical perspective, focusing chiefly on alcohol, opiates, marijuana, tobacco, and cocaine. We will explore both cultural patterns of drug use and policies directed at perceived problems associated with such use. Attempts to control use of various drugs, through law and policy and through informal social controls, will be examined. Students will engage a variety of texts, including firsthand testimonies of drug users and perceived problems as described by social reformers and policy makers, will also be read.

79-158 Freshman Seminar: Slavery and Emancipation in the Americas  
Intermittent: 9 units  
The course is an introduction to comparative slavery and emancipation in New World societies. It examines the evolution of the African slave trade and involuntary labor and their impact on the development of North America, South America, and the Caribbean Islands. It explores the distinctiveness of the overall Atlantic system and differences among slave societies. Major themes of the course include: the roles of human agency and resistance; cultural adaptation of bound people; women and families; free people of color; and the relationship between race, class, and gender in systems of forced labor. Students will engage a variety of texts, including first-hand testimonies of slaves, traders, and owners in Africa, Europe, and the Americas.

79-159 Freshman Seminar: Religious Origins of the Culture Wars  
Intermittent: 9 units  
In recent decades Americans have become increasingly aware of a sharp cultural division in our society, sometimes characterized by such dichotomies as “red state/blue state” or “metro vs. retro.” In this freshman seminar we will analyze aspects of American religious history that may shed light on the present polarization over such value-laden issues as sexuality, bioethics, patriotism, warfare and immigration. We will be studying the religious antecedents of both sides in the culture wars. On the conservative side, topics will include fundamentalism, evangelicalism, tridentine Catholicism and Orthodox Judaism. On the liberal side we will examine the effects of modernism upon the mainstream religious bodies, the appearance of “New Age” movements and the growth of secular humanism.

79-161 Freshman Seminar: Hyphenated-Americans & the Stories They Tell  
Intermittent: 9 units  
Robert Coles, author of The Call of Stories, says that we all have accumulated stories in our lives, that each of us has a history of such stories about our lives, and that no one’s stories are quite like anyone else’s. In this course we will read a series of fictional stories written by hyphenated-Americans and analyze their experience through their characters. We will identify the common issues raised across a number of authors and time periods, question why certain issues are raised and others are not, compare these fictional accounts to historians’ representation of the immigrant and hyphenated-American experience, examine whether the issues identified have changed over time, analyze factual accounts, and compare and contrast different ethnic-American authors writing at roughly the same time. We will, through the eyes of fiction writers, try to capture the essence of what it’s like to be a hyphenated-American.

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, African-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 focus on the way 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
societies change, and considering how we, as anthropologists, discuss what the anthropologist's relationship is to the people's ingrained assumptions, while broadening our understanding of the anthropology makes us more aware of our own culturally-might appear equally bizarre to outsiders. In doing so, the same time probing those aspects of our own society which cultures which might, at first glance, seem bizarre to us, while at Cultural anthropologists "make the strange familiar and the

Fall and Spring:  9 units
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 second-semester freshmen, and first- or second-semester sophomores in the College. In general, these courses are designed to give students some real research experience through work on a faculty project or lab in ways that might stimulate and nurture subsequent interest in research participation. Faculty and students devise a personal and regularized meeting and task schedule. Each Research Training course is worth 9 units, which generally means a minimum for students of about 9 work-hours per week. Prerequisites/ restrictions: For H&SS students only; minimum cumulative GPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g. language proficiency) may arise out of the particular demands of the research project in question. By permission of the relevant professor and the Director of Undergraduate Studies.

Fall and Spring:  12 units
Historical Evidence and Interpretation
This is an introductory survey of American history from colonial times to the present. The course focuses on critical analysis instead of the more traditional emphasis on presidents, wars, and memorizing facts or timelines. The major themes 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.

Fall and Spring:  9 units
Development of American Culture
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, seatonality, morality, and religion. Lectures 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.
History and Policy, learn to become critical consumers of historical studies that address issues in public policy, and develop basic skills in the actual practice of policy formation and evaluation. Case analyses may focus on the regulation of markets, urban planning, the environment, public health, education, technology, or other policy domains. Prerequisite: 79-202.

79-209 Theory and Practice in Anthropology
Course Intermittent: 9 units
How has anthropology changed over its relatively short lifetime? This course will examine the major trends and schools of thought in anthropology in the twentieth century, focusing on how theory shapes the questions anthropologists ask as well as their fieldwork methods. Students will learn to "find" theory within ethnographic writing, both by analyzing the work of notables and anthropologists, and by experimenting with various theoretical orientations in their own analysis of ethnographic data. After first examining some of the 19th century influences on the emerging field of social science, we will explore the paths anthropology took in the early and mid-twentieth century, focusing on how culture and social structure were understood and analyzed at this time. Next, we will turn to issues of power, practice, and history, and the influence of new theoretical approaches on anthropological conceptualizations of culture. Finally, we will explore how more recent theoretical developments and cross-cultural comparisons, have shaped contemporary anthropology. The course will emphasize that, though theory has developed in recognizable ways throughout anthropological history, this development has not been linear. To show how older theoretical approaches resurface in more recent anthropological work, readings will pair classic works in the various theoretical schools with more contemporary reworkings of those same theoretical orientations.

79-210 Picturing Others: A Course on Ethnographic Film
Course Intermittent: 9 units
Western society has long been fascinated with the "primitive." From their earliest days, photography and movies have been used to picture these others, seeming to offer a direct account of ways of life, a "truth" that cannot be conveyed in words. In this course we examine ethnographic films as descriptions of unfamiliar (and sometimes familiar) others. We discuss the ways filmmakers interpret and portray material, examine the significance of changing techniques, and confront the problem of point of view. We also examine the use of visual media for social analysis in general. Students make a film or video tape, applying ideas and issues from readings and class discussion. The work with film and video require extra course hours (to be announced in class).

79-214 18th Century European History
Course 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 the "-isms"- European religion 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.

79-218 The Roots of Rock & Roll
Course Intermittent: 9 units
This course spends 8 weeks on early blues and country "roots" music (like Bessie Smith and Woody Guthrie) of the 1920s-1950s before turning, in the last third of the semester, to the 1960s revolutions of Bob Dylan, Jimi Hendrix, Janis Joplin and other rock & roll legends. The format is informal lecture and discussion on Tues/Thurs afternoons -- plus a required film screening and evening Wednesday event. 6:30-9:20pm. Besides reading 3-4 books and many articles, assignments include weekly music listening, four short essays and a longer final paper.

79-219 The Holocaust in Historical Perspective
Course Intermittent: 9 units
Why did Hitler unleash the Holocaust against the Jews? How did he do it, and how did he get away with it? This course explores the attitudes and actions of the perpetrators, the bystanders, and the victims. Moreover it examines 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.

79-220 Early Christianity
Course 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 Judaism and in the Jewish community in 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.

79-221 Christendom Divided: The Protestant and Catholic Reformations, 1450-1650
Course Intermittent: 9 units
At the dawn of the sixteenth century, western Europeans still shared a common religion 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 irrevocably 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. The course will emphasize the Reformations of the sixteenth century, both Protestant and Catholic, examining the causes of the Reformation, the dynamics of religious change, and its significance for western society. Throughout 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.

79-222 Religion in American Society
Course 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 noted 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 does this American religious diversity affect 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.

79-223 Protest and Dissent in American History
Course Intermittent: 9 units
What does it mean to protest in a country that was founded by revolutionaries? Are radicals heroes or traitors? Dissenters like Sacco and Vanzetti, 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 American 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. The course will emphasize the Reformations of the sixteenth century, both Protestant and Catholic, examining the causes of the Reformation, the dynamics of religious change, and its significance for western society. Throughout 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.

79-225 Religions of China
Course 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 and competitive religious beliefs, 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 latter part of the course uses anthropological works to account for the religious practices currently flourishing in both Taiwan and Mainland China.

79-230 Technology in American Society
Course Intermittent: 9 units
This course introduces students to the history of technology in the United States and examines the ways that American society both shaped and was shaped by technological change. The course's readings, films, and lectures give voice to both technological progress and those who found both such change and its prophets less than desirable. The course aims to raise fundamental questions about technology, society, culture, and power and their interaction across time and space.

79-231 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.

79-233 The United States and the Middle East since 1945
Intermittent: 9 units
Since the end of WWII, the United States has been repeatedly involved in Middle Eastern affairs. This course examines US interests and outcomes in the region from 1945 to the present. Issues covered include the Cold War in the Middle East arena; oil politics; US as Arab-Israeli peacemaker; US and Iran; US and Iran; Middle East terrorism; and case studies concerning US relations with key Middle Eastern countries.

79-234 Body Politics: Women and Health in America
Intermittent: 9 units
Women's bodies have been the sites of long-standing, and sometimes destructive, political battles. This critical 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 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 cultural historians have conducted these debates over time, while examining women's organizing around them. Paying attention to the biological, socio-cultural, economic, and political dimensions of these various subjects, this course investigates why medical science and science are not simply objective, but often subjective, being deeply implicated in the politics and history of inequality.

79-236 Eighteenth 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, "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.

79-237 City Histories: Delhi and London
Intermittent: 9 units
The British Empire connected two great cities – London and Delhi – but even before the British came to India, Tudor London and Mughal Delhi presented a dazzling display of urban life and culture to the world. This course looks at the parallel destinies of these metropolises. It proceeds from that early-modern period into the age of Queen Victoria and her Indian Viceroy, down until today's post-colonial era. Finally, it examines some of the ways in which late-modern political events, environmental change and migration have affected these two civic spaces. Art, travel, diaries, poetry, film, music and other documents will supplement the main textbooks. At the end of the course, you are expected to have learnt something about South Asian and British history, about city cultures in 'East' and 'West' and to have reflected about the changing roles for metropolises in a contemporary globalized world.

79-240 Recent U.S. History 1945 - Present
Intermittent: 9 units
This course will explore the social and cultural history of America since World War II. Topics include: the dawn of the nuclear age, the cold war, the beatniks, the Korean and Vietnam wars, the civil rights movement, the women's movement, hippies, the energy crisis of the 1970s, the rise of environmentalism, yuppies and 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.

79-241 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 ante-bellum 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 A 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 urbanization (transportation, water/wastewater, energy and communications), ethnic and racial change and conflict in the city, and political and policy course topics. It takes in the crises of the 1970s, the rise of environmentalism, yuppies, the cold war, the beatniks, the Korean and Vietnam wars, the civil rights movement, and the post-World War II period; and (5) the deindustrialization of Pittsburgh and attempts to adapt to new social-technological realities. The class will follow a seminar-type format; students will be expected to contribute to class discussions and to complete a major research project. The course will also include spring breaks; both visual (photographs, films) and written materials as well as using the Pittsburgh region as a laboratory for tours.

79-244 Pittsburgh and the Transformation of Modern Urban America
Intermittent: Mini Session - 6 units
This course examines Pittsburgh in themes: (1) the development of the Pittsburgh region in the 19th century from a commercial to a leading industrial center; (2) the development of the urban built environment; (3) attempts to cope with the impacts of industrialism on labor, government, and the environment before World War II; (4) the Pittsburgh Renaissances in the post-World War II period; and (5) the deindustrialization of Pittsburgh and attempts to adapt to new social-technological realities. The class will follow a seminar-type format; students will be expected to contribute to class discussions and to complete a major research project. The course will also include spring breaks; both visual (photographs, films) and written materials as well as using the Pittsburgh region as a laboratory for tours.

79-247 East Asians in Film
Intermittent: 9 units
This course is intended as a visual introduction to East Asian societies, as they adapted to the wrenching experiences in the 20th century. Our focus is on love and family life and the representation of both in China and Japan. The topics are seen in relationship to the Cold War, and under pressure of war, urban development, and science. We will explore the major filmmakers, their films, and their influence on the development of Asian cinema. The course will focus on films that have been made in the last 50 years, and will include both visual (photographs, films) and written materials as well as using the Pittsburgh region as a laboratory for tours.

79-248 History and Theory of Property: Land, Bodies, Ideas and Information
Intermittent: 9 units
This course surveys the changing relationship between private property and the public domain from the Roman Empire to the present. This is the first part of the class, we will explore the roots of our present day property regimes: the land enclosure movement in early modern England (the conversion of common lands into private estates); and the development of intellectual property protection in Anglo-American law. We will also examine the social and economic laws of early modern Europe and the antebellum United States, as well as some representative non-Western views of property, including those of Native Americans and the Chinese. In the second part of the course, we will examine how concepts of property have been expanded to include works of art and culture, software code, materials shared on the internet, various forms of information, one's own body, cell lines, and regions of the genome. We will conclude with a discussion of how Western ideas of property are being spread around the world through new trade laws, economic, religious, political, and cultural exchanges. The course will also examine the role of private property in the development of modern society, and the role of property in shaping the legal systems of different cultures.

79-251 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 economics, 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.

79-253 The Development of Caribbean Culture
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 many 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 economic transformations, and the Atlantic economy; the complex 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, rock and role media, 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.

79-254 The Pacific Islands: History and Culture
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 policy. Since colonization by Western empires and the peoples-imperial powers--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 economic transformations, and the Atlantic economy; the complex 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, rock and role media, 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.

79-255 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 Biology and Society: Evolution, Animal Experimentation and Eugenics
Intermittent: 9 units
This course focuses on the relationship between biology and society in Britain, Europe and the United States from the early 19th century to the beginning of WWII. We will examine the ways that biology and society evolved together during this period, and become 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 obtain 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 thought on society. The second part of the course will be devoted to the rise of experimentalism in biology. As part of this unit, we will analyze 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. The course will culminate with an examination of the early history of genetics and its social application in the form of eugenics.

79-257 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.

79-258 Introduction to African History: 18th Century to Neocolonialism
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 languages/ ethnic groups, individuals as historical actors who daily make collective and personal decisions to pass down, innovate, and borrow practices, technology, spiritual ritual, etc., in the face of change. We will consider the place of the state, 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.

79-259 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 problems of categories such as "heathen," 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, theocidy; ethics, eschatology and secular humanism in the modern age.

79-260 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 and colonization of the sixteenth and seventeenth centuries, we will explore the history of the region during the sixteenth and seventeenth centuries as the state of overall society during the sixteenth and seventeenth centuries. Finally, we will cover the history of the Mayan peoples from the sixteenth and seventeenth centuries to the present, including the political, social, and economic history of the region during the sixteenth and seventeenth centuries. We will examine the role of the Maya in the modern world, including their role in the development of modern Mayan societies and their role in the development of modern Mayan societies.
79-267 Pre-Colonial West African History 1100 to 1800 Intermittent: Mini Session - 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 problems, as reflected in the words of the literate (e.g., Confucian, Daoist, Buddhist and Alphabetic) 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, microdwell, new crops, 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 project, growth of rural villages, tourism and environmental policy. We work mostly by discussion, centering on materials read in advance by class members. Mid-term and final exams, and two five-page papers on set topics.

79-278 China's Environment: Past and Present Intermittent: 9 units
This course examines China's changing ecology, and explores whether and how sustainable development has been, is being, and might be pursued by its vast population. Without neglecting current, e.g., Confucian, Daoist, Buddhist and Alphabetic 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, microdwell, new crops, 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 project, growth of rural villages, tourism and environmental policy. We work mostly by discussion, centering on materials read in advance by class members. Mid-term and final exams, and two five-page papers on set topics.

79-280 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 history 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.

79-281 Russian History: From Communism to Capitalism Intermittent: 9 units
This course covers a broad sweep of Russian history from the 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 present attempts to create a market economy. The course provides essential background for anyone interested in understanding the explosive, history-making events in the former Soviet Union.

79-282 The Soviet Union in World War II: Military, Political, and Social History Intermittent: 9 units
This course covers a broad sweep of Soviet history from the invasion of the Soviet Union 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 devastated 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. The course examines why and how the war was fought using film, novels, interviews, and historical sources, this course covers a broad sweep of Russian history from the 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 present attempts to create a market economy. The course provides essential background for anyone interested in understanding the explosive, history-making events in the former Soviet Union.

79-283 East Asia and World War II Intermittent: 9 units
This is a history of the experience of war in East Asia (1931-1945). The course explores the rise of Japan's empire in the context of international security concerns, with a special focus on China and the fateful impact of invasion there. It examines the cultural settings of the Pacific War, the impact of the war on civilians, and the conduct of the war on the battlefield. It concludes with re-examining the continuing debate on the atomic bombing of two Japanese cities. We explore these topic through case studies, beginning with the religious conflicts and settlement between church and state during the French revolution. The course concludes with critical discussions of the rise of the People's Republic of China, the Chinese Communist Party's anti-slavery movement in Britain, Protestant-Catholic rivalries in Germany, the power of the papacy in Italy, and the s Dreyfus case in France. Students will have reading assignments from both primary and secondary sources. Written assignments include several short papers and a final examination.

79-284 African Americans in Pittsburgh Intermittent: Mini Session - 6 units
This course will examine the development of Pittsburgh's African American community from its late 18th century roots 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 divergent 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.

79-288 Bananas, Baseball, and Borders: Latin America and the US from Alamo to Drug Wars
Intermittent: 9 units

Consider this: The U.S. government maintains an economic embargo on Cuba even as Cuban musicians like the Buena Vista Social Club enjoy wild popularity in the United States. Former left-wing guerrillas in El Salvador resent the U.S. government for its past support of military dictators while they anxiously await for money to be sent from their cousins who clean office buildings in Washington DC. North Americans donate money to protect tropical forests while they consume enormous quantities of bananas grown where rainforests once stood. This course will attempt to make sense of the tumultuous and paradoxical relationships between the United States and Latin America from the early 1800s to the present. The course will go beyond state-to-state diplomatic relations in order to explore the economic, social, and cultural interactions of both regions. Readings and other course materials will focus on U.S. encounters with Mexico, Central America, Cuba, and the Andean nations.

79-289 Development of South Asian Culture and Society
Intermittent: 9 units

This course will familiarize students with an overview of South Asian culture and society from a historical standpoint. It provides a broad perspective on the present – day countries of India, Pakistan and Bangladesh, and also the South Asian diaspora across the contemporary world. While it does not require any prior background in Asian history, it demands a willingness to read and encounter a variety of historical and cultural materials from the region. Audio-visual materials and literature extracts will be extensively used to supplement and enrich the readings.

79-290 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 the 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.

79-294 The Making of the African Diaspora in the New World
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 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 Africans and African survivals, African reemergences, Creole languages, and religion.

79-295 Germany and World War II
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 early life plans, and the military/technological strategy of the War on Thursday evenings (along with students enrolled in The Soviet Union and the Second World War).
This course provides a broad introduction to anthropological perspectives on European cultures in order to address some of the most important issues that arise in the study of complex societies. Among the topics that will be considered are the origins, history, and future of European cultural traditions; the shifting meanings that have been assigned to the concept of "Europe"; the variety and diversity of European experience; and the role of local, national, and international forces in shaping social life. Special attention will be given to the relations between Eastern and Western Europe, the causes and dynamics of contemporary ethnic conflicts, and the problems involved in creating a liberal and democratic European Union. In addition, we will consider what contribution the study of Europe has to make to the development of anthropology, a social science that has traditionally been oriented to the study of non-western societies.

How do societies remember? Memory is social, rather than simply individual, in scope. It is cultural, rather than purely psychological, in nature. Its significance 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 how memory is constructed, conveyed, and used to produce collective identities, and in recollecting and responding to the violence of slavery, colonialism, and genocide. Finally, we will consider the role of memory in the writing of history by professional historians.

This course examines a number of major policy choices in recruiting American men and women into military service, and the political and cultural controversies that have surrounded those choices, from the late 18th century to today (with the focus on the World War I to the present). The main topics to be covered are: (a) the draft, the all-volunteer military, and the Reserve/National Guard as methods of military recruitment; (b) the transition to liberal democracy in the 1970s, and the rise of popular politics and public opinion as recognized forces in European political life.

This course provides an overview of Spain from 1898 until the present. Drawing on the work of historians, anthropologists, and a wide range of writers and artists, the class will consider: the origins and events of the Spanish Civil War of 1936-1939; the character of the Franco dictatorship; the transformation of rural and urban society and culture that occurred between 1939 and 1975; the transition to liberal democracy in the 1970s and 1980s, and the “Europeanization” of Spain since the 1990s.

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 its causes, and investigate both the beliefs and practices surrounding healing, but also the social position and situation 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.

This course focuses on modern European culture and politics through the lens of the relationship between urban and rural life. Drawing on historical, literary, and anthropological sources, the class will first explore how representations of the city and the countryside have continually shaped and been shaped by Europeans’ understanding of history, geography, society, and the nation-state. After the broad sweep, we will proceed by examining a set of topics that reveal the primary forces that have led to radical changes in both urban and rural life since the 1950s in the countries of western Europe. Among the topics that will be considered are modernization and tourism, the spatial organization of class and ethnic identity, recurrent crises of industry and agriculture, environmental movements, the impact of mass media, the context of democratic politics, and the development policies of the European Union. Throughout the course our main concern will be to understand how these general forces have shaped conflicts over power and values that have transformed the everyday experience and sense of possibilities for the future of ordinary Europeans who live in very different kinds of urban and rural communities.

After 7:22 a.m. on April 15, 1865, Abraham Lincoln “Belonged to the Ages.” In the century since his assassination, Americans have fought bitterly about who he was and what he continues to mean to different segments of the nation. Honest Railsplitter or Slick Lawyer? Great Emancipator or racist opportunist? Savior of the Union or demagogic tyrant? Students analyze Lincoln’s own views along with the ways he has been remembered and used by politicians, protesters, poets, advertisers, and Hollywood filmmakers.

This course provides an overview of Spain from 1898 until the present. Drawing on the work of historians, anthropologists, and a wide range of writers and artists, the class will consider: the origins and events of the Spanish Civil War of 1936-1939; the character of the Franco dictatorship; the transformation of rural and urban society and culture that occurred between 1939 and 1975; the transition to liberal democracy in the 1970s and 1980s, and the “Europeanization” of Spain since the 1990s.

This course provides a broad introduction to anthropological perspectives on European cultures in order to address some of the most important issues that arise in the study of complex societies. Among the topics that will be considered are the origins, history, and future of European cultural traditions; the shifting meanings that have been assigned to the concept of "Europe"; the variety and diversity of European experience; and the role of local, national, class, and national forces in shaping social life. Special attention will be given to the relations between Eastern and Western Europe, the causes and dynamics of contemporary ethnic conflicts, and the problems involved in creating a liberal and democratic European Union. In addition, we will consider what contribution the study of Europe has to make to the development of anthropology, a social science that has traditionally been oriented to the study of non-western societies.

This course examines a number of major policy choices in recruiting American men and women into military service, and the political and cultural controversies that have surrounded those choices, from the late 18th century to today (with the focus on the World War I to the present). The main topics to be covered are: (a) the draft, the all-volunteer military, and the Reserve/National Guard as methods of military recruitment; (b) the transition to liberal democracy in the 1970s, and the rise of popular politics and public opinion as recognized forces in European political life.

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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 were in their sex war, our course will consider both 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.

79-324 Modern Painting Intermittent: 9 units
Examines the birth of modern painting in its historical context. Through understanding the major styles and successive movements in the development of modern art, students explore the many relationships of artist and artwork with parallel works in other media such as literature, music and film, and with parallel trends in intellectual and social history.

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 anthropological explanations will be attempted. Major religions will be brought to discussion in one or several of their artistic manifestations.

79-329 Sex, Population, Birth Control Intermittent: 9 units
This course will explore efforts to control reproduction in the United States in the 19th, 20th, and 21st centuries. Topics include: the changing status of birth control and abortion in the context of law, medicine, and public policy; the relationship between women's rights and reproductive rights; the eugenics movement and involuntary sterilization laws; the relationship between birth control and population control; the development and impact of new contraceptive technologies; infertility and the development and use of new reproductive technologies; changes in sexual attitudes and practices; and the impact of AIDS and other sexually transmitted diseases on sex and birth control.

79-330 The American Presidency Intermittent: 9 units
The presidential election campaign offers a context for raising some important questions about the American Presidency as it has evolved over its two centuries of existence. Among them are: Has this kind of leader functioned in the kind of society the United States has become? What political and social roles have Presidents played? How much power, and what kind of power, have they had, and how did they get it, use it, and perhaps lose it? In producing Presidential effectiveness, how crucial have individual character and personality been?

79-331 Crime and Punishment in American Society Intermittent: 9 units
Crime and punishment are among the most important issues in contemporary America. This course offers an introduction to the historical study of crime in the United States and highlights both changes in criminal behavior and the different ways that Americans have sought to deter, punish, and rehabilitate. Primary topics include historical patterns of violence, the role and organization of the police, and the evolution of punishment in theory and practice. This course also emphasizes differences in crime and punishment by race, gender, and age.

79-332 Juvenile Delinquency: Images, Realities and Shaping of Public Policy, 1800-1960 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. 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 "delinquents" and how their behaviors changed over time; and 3) images of "delinquents" as portrayed in film, social science scholarship, government reports, and newspapers. The course will be run in a discussion format. It will meet twice a week, with a lengthy evening session devoted mainly to viewing and discussing films from the 1930s to 1960 (e.g., "Angels with Dirty Faces," "Blackboard Jungle"). Readings will be drawn from historical, sociological, psychological, literary, and journalistic accounts of juvenile delinquency.

79-333 History of Biomedical Research Interment: 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 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.

79-335 Drug Use and Drug Policy Interment: 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 here are heroin, marijuana, tobacco, and cocaine. We will examine changing theories of addiction, ethnographic studies of drug usage 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.

79-336 Epidemic Disease and Public Health Interment: 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 such as bubonic plague, smallpox, and AIDS. Besides considering the social factors that help determine the epidemiology of a particular outbreak of disease, the course analyzes public and private 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.

79-337 Educational Policy in Historical Perspective Interment: 9 units
Education policy is at the center of efforts to make our workplaces more competitive, our civil order more humane, and our schools more effective. Debates over educational policy have raised the tension between public and private spaces, between centralization and federalism, wealthy communities and poor. The special features of American educational policy and institutions are examined in the light of our historical experience and the institutional patterns and finances of other nations.

79-338 Childhood, Education, and Social Reform in American History Interment: 9 units
In this course, we will examine several themes in the history of American childhood and education in the 17th to 20th centuries, and link them to 1) broad social changes that transformed the experience of childhood and 2) key policy changes that sought to enhance the status and well-being of children. While schooling will be a central focus, we will also study the evolving educational roles of other institutions, e.g., families, churches, workplaces, peer groups. We will also try to shed historical light on several contemporary educational controversies, such as desegregation, bilingual education, homework, sex education, religion in the schools, textbook bias, and school vouchers. Readings will center on scholarly books and articles. Three exams will be required, and students will also be evaluated for the legibility of their work and the quality of their class presentations and discussions.

79-340 A History of Modern Warfare Interment: 9 units
Broadly conceived, this course examines the role of warfare in western society and history from the period of emergence and expansion of western nation states. Central themes include the relationship of war to the state and its financial and managerial resources, to military technology, and to technological change in the means of production. Equally important are military leadership and the will to combat, both military and civilian. After an introduction to warfare from the classical period through the emergence of modern warfare, the course focuses on major global conflicts of the from the Seven Years War through World War Two. Topics include the gradual evolution of European classical ideas about warfare, the relationship of war to the state, the evolution of military technology and its production, and changing concepts of strategy, tactics, and generalship as a result of industrialization and the emergence of global economic empires.

79-392 Science, Technology and Society Interment: 9 units
This seminar investigates the complex relationships among
science, technology and society in the modern world. We will explore how scientific and technical knowledge is produced, the role that this knowledge plays in political and legal decision making in democratic societies, and how science and technology reshape the way we think about ourselves and our world.

Throughout the semester, we will examine several case studies, using methods and theoretical insights from anthropology, history, philosophy, science and technology studies, sociology, and political theory. Topics covered include: biotechnology; environmental risk; censuses; expert testimony in the courtroom; sustainability; and large-scale engineering projects. The ultimate goal of this class is to provide students with the theoretical and methodological tools necessary to analyze complex problems at the intersection of science, technology and society.

79-344 Science, Technology, and the Cold War Intermittent: 9 units
This course focuses on how the Cold War shaped the development of science and technology in the United States and the Soviet Union from its emergence in 1946 to the collapse of the Union in 1991. The course will cover the main topography of Cold War history, it focuses especially attention on the interplay among scientists, engineers, political leaders, and educational and scientific institutions in what one American president termed the "long twilight struggle."

79-345 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: 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.

79-346 International Environmental Law and Policy Intermittent: 9 units
Global environmental problems - climate change, ozone destruction, wildlife extinction and loss of biodiversity, and the contamination of air, land and water - are real and urgent, going to the heart of our life on earth and to the future generations. For the first time, human economic activity, and our ever-increasing population and consumption, threaten to surpass the ecological limits of the world. This course explores the major environmental problems and the international agreements, institutions, mechanisms and policies developed to address them, taking into account the social, economic, political and environmental contexts and overarching issues such as the balance between environmental protection and economic development, and between international regulation and national sovereignty. The relationship between environmental law and international trade, human rights, national security, and international finance and investment, will also be addressed.

79-348 Objects of Value Intermittent: 9 units
Value is a universal human concern, one that is as much spiritual as 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 is not-existant 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 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; and national and global political and economic crisis; and the emergence of new kinds of commodities and money, such as the Euro.

79-350 Theories of International Relations Intermittent: 9 units
This course has three major dimensions. Assumptions and propositions that are leading these arguments of global politics 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 older, 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.

79-351 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.

79-352 The Arab-Israeli Condition: War & Peace Intermittent: 9 units
This course focuses on the Arab-Israeli and Palestinian-Israeli conflicts, beginning with a historical overview and continuing on through current events. Emphasis is on primary source documents which are the milestones by which the direction of the conflicts and attempts to resolve them can be charted. Readings and discussion progress with a dual goal: to understand both the historical origins and the contemporary parameters of the conflicts, and to consider the processes by which the conflicts may be moving toward resolution.

79-354 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 chances for a 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.

79-355 The American Skyscraper: Its History and Development Intermittent: Mini Session - 6 units
Returning to America in 1904, the novelist Henry James complained that "monuments of greed" had taken New York of his youth into "a huge jagged city." During his absence, the skyscraper had been born from a marriage of technology and commercial growth, and was beginning not without opposition to dominate the city's urban skylines. Focusing on such major monuments as Adler and Sullivan's Wainwright Building (1891), William Van Alen's Chrysler Building (1930), and Mies van der Rohe's Seagram Building (1958), this course will explore the development of America's greatest contribution to the Western cityscape from the first "elevator buildings" of the 1870s, through the Art Deco towers of the 1920s and the gleaming glass monoliths that proliferated after World War II, to the Postmodern skyscraper of today.

79-356 Introduction to African History:Earliest Times to the Origins of the Slave Trade 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, "climatology," archaeology, and anthropology to reconstruct dynamic, dynamic, historical processes in Africa before the arrival of Europeans and before the availability of written source materials. When written sources are available, the course will investigate 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.

79-358 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 and norms 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
79-359 History of African-American Families
Intermittent: 9 units
This course traces the development of family life, meanings, values, and institutions from the period of slavery up to recent times. The course is long-standing in its focus on black families in the scholarship across disciplines (i.e., anthropology, sociology, and economics) and in the society at large. Course content include secondary reading materials, literary, and film sources. The course will look at the diversity of black family arrangements and the way these have changed over time and adapted to internal and external challenges and demands. It will also situate the history of black families within a broader cross-cultural context.

79-363 The Rise of Modern Golf, 1860-2005
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 in the U.S., Britain, and Canada between 1860 – when Prestwick Golf Club in Scotland hosted the first (British) Open -- and the present. The course will be run as acollegium, with students exercising considerable leadership responsibility for each class. Discussions will center on a wide variety of historical, sociological, literary, and musical sources, and primary sources, will be designed to illuminate broader themes of class, gender, race, and age in social and cultural history. We will also track the evolution of several notable performances and tournaments and discuss the careers of a number of famous players -- from Old Tom Morris to Michelle Wie. In addition to a mid-term exam and several oral presentations, students will conduct a small-scale research project, based mainly on primary sources. Each student will present his/her research to class in a 10-minute oral presentation and in a 15-page term paper. 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 2006 business plan; or that a mashie niblick is a side dish at KFC, you may want to reconsider.

79-364 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 and 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 effect of "exotic" art on the formation of 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.

79-365 Climate Change, Energy Policy and Environmental Protection
Intermittent: 9 units
Global concerns about climate changes have led to the formation of conventions and panels to discuss the regulation of greenhouse gasses and energy-related carbon emissions. This course will examine climate change policy, both applicable international and national legal and institutional arrangements, and alternative scenarios for energy development and emissions policy. We will draw on primary source materials from the Intergovernmental Panel on Climate Change (IPCC) and other international organizations, governments, and academic and industry groups. During the course of study and in assigned work, students will undertake a mini-research project. The student initiative and participation in each class discussion are essential. Evaluation will be based on several writing assignments (including midterm and final examinations) and oral participation.

79-368 Poverty, Charity, and Welfare
Intermittent: Mini Session - 6 units
This course explores in depth the 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 appreciate the policy initiatives of non-Western societies. 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? Finally, what accounts for the different responses to "welfare states" in the twentieth century? Coursework includes readings from primary and secondary sources, participation in class discussions, in-class test, and a short research paper.

79-369 The World of Andrew Carnegie
Intermittent: Mini Session - 6 units
Carnegie, founder of Carnegie Mellon University, was both shaped by and shaped the world in which he lived. This mini course provides students with an opportunity to explore Carnegie's world through biography. We read the critical biography by Joseph Wall, Andrew Carnegie, as a central text and focus on the following specific themes in Carnegie’s life and times, looking at their typicality or uniqueness to Carnegie’s personal experience: 1. the British industrial revolution and the skilled textile trades; 2. antebellum emigration to the U.S. and the immigrant experience in the Pittsburgh region; 3. industrialization in the United States; 4. the rise of big business in the United States; 5. American labor history; and 6. the development of American philanthropy.

79-374 Women in Modern India
Intermittent: 9 units
Does the image of Indian women as helpless victims of patriarchal domination accurately reflect their lives? Or are they active and even challenging gender, caste, class, and race? What have been the major causes of poverty? How far do the main issues in their lives relate to women from other times and places? One of the main themes underlying the course is the diverse ways in which women have been intimately connected with women's lives and the ideologies of gender. We will read a wide variety of texts: autobiographies, memoirs, pioneering feminist tracts, films and the products of women's "labour," in order to 'recast' Indian women. The course will start with a set of lectures and will then be organized on a discussion basis. Students will be expected to write short papers, participate in quizzes and discussions, and to do a set of class presentations.

79-376 Making of the Modern Family
Intermittent: 9 units
This course examines continuities and changes in the family in western Europe from the medieval period through the late 19th century. Organizing themes include; the impact of the Industrial Revolution on family organization; changes in interpersonal relations within the family over time; and differences among the family patterns of different social classes. The family is also viewed as a unit of socialization and of social control. The approach of the course is interdisciplinary, drawing on the research of historians, anthropologists, and sociologists.

79-377 Memories of a Game: The History of Golf in Biography, Autobiography & Journalism
Intermittent: 9 units
This course will examine the construction of memory and the psychological, literary, and journalistic accounts of juvenile delinquency and the operations of the juvenile justice system. We will also analyze the treatment of delinquents as revealed in original case files of a mid-century juvenile court, and in approximately a half-dozen films produced between the 1950s and 1990s (e.g., "West Side Story" and "Boyz N the Hood"). (We will set a mutually agreeable time to view and discuss these films as it will be possible to view/review them in the Hunt Library.) Finally, we will attempt to arrange one or two class visits to juvenile justice institutions in the Pittsburgh area. The course will be run in a seminar format; student initiative and participation in each class discussion are essential. Evaluation will be based on several writing assignments (including midterm and final examinations) and oral presentations and class participation.
place of sport and sport heroes in modern society by studying representations of the game of golf in biography, autobiography, journalism, and documentary film between the late 1800s and the present. In addition to discussion of required course readings and films, each student will 1) participate in a class research project, tracking the evolution of golf journalism and 2) conduct a critical review of literature dealing with a famous amateur or professional golfer.

79-379 Women in American History Intermittent: 9 units
This course explores the history of women in the United States since the mid-eighteenth century. We will examine the sometimes common, but often divergent, experiences of women as they attempted to negotiate and improve their lives in changing historical circumstances. Our discussions will include the experiences of women of color as well as women from different classes and regions.

79-382 African-American Women in U.S. History Intermittent: 9 units
This is an upper-level undergraduate course that focuses on African-American women's history from the era of slavery to the present. It will address broad themes such as labor, family, community, sexuality, and popular culture. The course will examine the social, political, and economic diversity of the experiences of black women within the broader context of U.S. history. The emphasis will be on enhancing students' thinking skills in the humanities: critical thinking, writing, and oral communication. Course materials include primary and secondary sources, visual images, and films.

79-384 Medicine and Society Intermittent: 9 units
This course focuses on the relationship between medicine and society in the modern world. The emphasis is on understanding medicine and medical care as "a complex social process, embedded in the cultural matrix and laden with values." In particular, readings and classes stress the new perspectives that have reoriented the study of "medical history" in the last decades: the emphasis on the patient rather than the doctor; on the emergence of medicine in broader historical contexts of meaning; the influence of other disciplines, such as anthropology and medical sociology on the history of medicine; the existence of a wide range of practitioners ("fringe," "popular," "quacks," "alternatives"); and, finally, the importance of class, race, and gender as categories of historical analysis and as determinants of medical care.

79-392 Dilemmas and Controversies in Anthropology Intermittent: 9 units
Anthropology is poised at the intersection of art and science. Like scientists, anthropologists collect and analyze data, but it is data gained through relationships -- relationships forged with and by historically situated human beings in all their social and emotional complexity. In this course we will examine the practical and ethical dilemmas anthropologists confront in the field and in their writing. We will also investigate the nature of anthropological knowledge and investigate key controversies that have arisen in the discipline. Students are encouraged to think deeply and analytically about anthropology's strengths and limitations. Classroom debates will be a core component of the course.

79-393 Inward Odyssey Intermittent: 9 units
Inward Odyssey explores world history by examining it through the outward-looking eyes of travel writers, on the assumption that travelers, 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. Our primary goals: 1) to improve student critical reading skills, 2) to train students to historically contextualize documents, 3) to improve student analytical writing skills, and 4) to improve student understanding of our shared global history.

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 cultural institutions 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 studies. However, students will be charged a supplemental fee of a minimum of $30 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 Friday and Saturday afternoons, and to attend musical events on several Monday and Friday evenings.

79-396 Music and Society in 19th/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 the society and how music contributed to the making of political consciousness, especially in the twentieth century. In addition to reading assignments, seminars, and films, students will be charged a supplemental fee of a minimum of $130 to help subsidize the considerable expense of purchasing tickets for concerts and performances. Prerequisite: Availability to attend art exhibits on several Friday and Saturday afternoons, and to attend musical events on several Monday and Friday evenings.

79-397 Religion and Politics in the Middle East Fall: 12 units
This course considers the nexus between government and religion in Islam, Judaism, and Christianity and the historic relationship among the three religions in the Middle East. We will study the influence of religion on both domestic and foreign policy in selected Middle Eastern countries, the role of religion in fueling conflicts, the phenomenon of religious fundamentalism, the consequences for women and the implications for US policy towards the region. No prior background knowledge of religions or Middle East studies is required.

79-400 Advanced Studies in Anthropology and History Fall: 12 units
This course normally focuses on a key topic or theme in a way that enables them to bring the perspectives and methods of both disciplines to bear on a problem that is of special interest to them. Research may be based on deep reading in the literature on a topic, on ethnographic fieldwork, on archival investigation, or on a combination of these methods. By undertaking this work, students will gain a better grasp of how new knowledge is created and of what transdisciplinary approaches have to contribute to understanding the world in which we live. Prerequisites: Permission of the instructor or 79-200, 79-201, and 79-209. Prerequisites: 79200 and 79201 and 79209.

79-404 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. Yet recent extremism 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; the "official" and "official" 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. **Prerequisite:** students electing to take this course will have background knowledge in anthropology.

79-409 History and Policy Project Course Mini Spring: Mini Session - 6 units
Majors in History and Policy are required to take the History and Policy Project Course Mini in the spring semester of their junior year; no other students are eligible for this course. Students read background material relevant to the project to be undertaken in the fall, identify relevant archival materials, and refine the research questions, and make preliminary research plans. Prerequisites: 79-200; 79-202; 79-208
Prerequisites: 79200

79-410 History and Policy Project Course Fall: 12 units
The History and Policy Project Course is required for the History and Policy major and is taken in the fall semester of the senior year. In this capstone course, History and Policy majors carry out a collaborative research project which examines a compelling current policy issue which can be illuminated with historical research and analysis. Based both on archival research and on contemporary policy analysis, the students develop a policy original research report and presentation for a client organization in the community.
Prerequisites: 79200 and 79202 and 79409

79-420 Advanced Studies in Social and Cultural 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: 79200

79-421 Social and Cultural History Research Seminar Intermittent: 9 units
This is a small seminar course focused on advanced readings in social history, particularly from a comparative perspective.

79-440 The Rise of Industrial Research and Development Intermittent: 9 units
The electric light, nylon, the atomic bomb, the transistor and integrated circuits, Post-it notes, Teflon, Game Boys, and Viagra, among a plethora of other "miracle" goods, are products that emerged from organized research and development (R&D) programs. What factors led to the establishment of modern R&D? When and why did industrial R&D laboratories appear in the United States and other industrialized nations? Did their creation change the character of science, technology, and business? How has the institutionalization of R&D affected the work of the individual inventor and scientist? Does big business now dominate R&D in the United States, or does "the little guy" (including "start ups") still play an important role in technological innovation? How has federal R&D policy affected the organization and character of industrial R&D programs since the late nineteenth century? What about the role of universities? How has R&D been "managed?" With the globalization of business in the late twentieth and twenty-first centuries, is industrial R&D also going global, and if so, how are firms managing R&D on a global basis? Why did the last decade of the 20th century see the decline and disappearance of numerous prestigious industrial research organizations? What is the future of industrial R&D in the twenty-first century? These are some of the questions explored in this seminar, largely through critical analysis of case studies. This advanced seminar is open to students from all colleges. It requires an extensive amount of reading and writing, and students must be prepared to participate fully in critical discussion of the readings and issues that surround this subject. Prerequisite: junior or senior standing

79-441 Science, Technology, and Business in U.S. History Intermittent: 9 units
This reading seminar focuses on the history of science, technology, and business in the United States from the American Revolution to the late twentieth century. Although the course follows a rough chronology, it treats in depth several major topics and themes that are well developed in the historical literature.

79-491 Independent Study All Semesters: 3-18 units
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.

79-505 Undergraduate Internship All Semesters: 3-12 units
Interns may be placed in relevant off-campus positions where they are evaluated by both an on-the-job supervisor and a faculty member. Permission of the department's Internship Coordinator is required.

H&SS Interdisciplinary

66-210 Science, Technology and the Environment Intermittent: 9 units
This course begins with the premise that it is essential to understand a few scientific principles and the basic premise and practice of technology for two important objectives: (1) to understand how the environment works, and how science and technology affect it; (2) to insure that science and technology work for (and not against) the natural environment. The aim of this course is to explore the use of science and technology in the context of the earth's natural environment. Specifically, students will learn the basic principles of science and technology that can enable them to understand environmental phenomena, and the effects of human activity on these. These principles are learned through their use in the context of environmental issues. Students also examine values, assumptions, and actions that have guided our actions towards the environment, and the resulting impacts. Most class meetings demand active participation by students in the form of discussions, group projects and some field observations.

66-301 Science and Christianity: A Multidisciplinary Approach Intermittent: 9 units
Christianity and Science is a multidisciplinary lecture/discussion course that is part of the interdepartmental program in religious studies at Carnegie Mellon University. The relationship between Christianity and science is considered in light of the cultural, political, philosophical and theological background of the patristic period (0-600 CE). The nature and history of science is developed using the classic "The Structure of Scientific Revolutions" by Kuhn. The history of the interaction of Christianity and Science is examined using the book, "God and Nature", which is a collection of current scholarship in this area. More specifically, using the book, "In The Beginning" by Blocher. A current treatise on the topic of this course, "Quarks, Chaos and Christianity" by Polkinghorne is also studied in detail.

66-307 Independent Study All Semesters: 6-18 units
This course is intended for students with a special interest in an interdisciplinary area in the humanities and/or social sciences not covered by a normal course. Readings and other works are developed by the student and an individual faculty member. The number of units will be assigned at the time of registration based on the number of hours to be completed (decided in advance with the sponsoring faculty member).

66-320 Internship All Semesters: 3-18 units
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 is designed as a readings course, and the second semester course as the culmination of an original, year-long independent research project. Research 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: 66501

67-100 Information Systems Freshman Workshop Fall: Mini Session - 1 unit
This workshop is a discussion-oriented class that provides
interaction between IS freshman students, their advisor, IS faculty and IS upperclassmen. Being a mini-course that meets in the second half of the fall semester, discussions will include students' progress in their college experience so far, as well as guidance for students in course planning, both for the online registration process for creating their spring semester schedule of classes and for their overall four-year plan.

67-101 Colloquium: Perspectives in Information Systems
Spring: Mini Session - 3 units
This course is an introduction to the Information Systems major and to its potential career directions. Topics covered include overviews of systems design and development, project management, the logic of the IS curriculum, industry trends, and the professional workplace. It includes presentations by IS faculty, students (demonstrating systems projects), and by professionals from Pittsburgh-area firms. As a colloquium, it is a new course and will meet once a week for the first three weeks, and again for the last three weeks. It is for IS freshman students only. This is an elective course and is not required in the IS curriculum.

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 by IS business decisions at various levels. Later we will look at the internal behavior of organizations that use information systems and how they grow and change over time. Business students will receive a course project in which they are called upon to design and implement a small database system. This course is an introduction to relational database management system such as Oracle, DB2 or Microsoft SQL Server. Prerequisites: 67-271 and 67-272. The course is reserved for students who will have junior class standing in Information Systems, Business Administration, and Computer Science, or by permission from the instructor. Fall: Mini Session - 6 units
Spring: Mini Session - 6 units

67-250 The Information Systems Milieux
Spring: 9 units
This course is designed to help students understand the role of information systems in modern society and the means by which these systems are created. We will begin by focusing on the economics of information and how businesses make use of IS in the professional workplace. We will look at the internal behavior of organizations that use information systems and how they grow and change over time. Business students will receive a course project in which they are called upon to design and implement a small database system. This course is an introduction to the COBOL programming language, and the course presents several information systems applications and discusses their solution in COBOL. COBOL is the most widely used language in the business community. 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 systems development is a cross-disciplinary area of study. This course will consider relationships in which 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. Grades will be assigned by weighting assigned and presented mid-term and final examinations. Expected section size is 60.
Prerequisites: 15111 or 15121 or 15200 or 15211

67-272 Application Design and Development
Fall: 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 prototype applications. Students will develop competency with several key technologies used in web development and e-commerce and will learn the principles needed to make effective use of these technologies. To that end, lectures each week will focus on conceptual issues and principles for designing and applying IS technologies. Topics include: user-centered design and development, database design concepts, Structured Query Language, and various supporting web technologies. Lab sessions are conducted each week to give students hands-on experience with these technologies. Learning will be accomplished through assigned readings, lectures, homework assignments and projects. Grades will be assigned by weighting assigned and presented mid-term and final examinations. Expected section size is 60.
Prerequisites: 15111 or 15121 or 15200 or 15211

67-304 Database Design and Implementation
Spring: Mini Session - 6 units
This course introduces the business context and mechanics of outsourcing information technology, focusing on offshore outsourcing. The purpose of the course is to prepare students to understand the issues faced by managers and technologists in today's increasingly fluid global IT services marketplace. By presenting the individual and small group in a "significant" relational database management system such as Oracle, DB2 or Microsoft SQL Server. Prerequisites: 67-271 and 67-272.
Prerequisites: 67271 and 67272

67-325 Special Topics: Global Systems Deliverability Models
Fall: Mini Session - 6 units
This course introduces the business context and mechanics of outsourcing information technology, including offshore outsourcing. The purpose of the course is to prepare students to understand the issues faced by managers and technologists in today's increasingly fluid global IT services marketplace. Students will learn from professional speakers and peers about the business and technology interludes where we will focus for a few lectures on some of the basic technologies fueling the internet age. By the end of this course, students will have a better understanding of the people, process, and technology issues connected with modern information systems. Students should note, however, that despite the existence of technology interludes, this course is not a programming class designed to make them fluent in one specific language or technology. In this class students will be given instruction on HTML, CSS, JavaScript and the basics of relational databases, but this instruction is to introduce students to these technologies and allow them to explore further on their own and in small class assignments. The focus of this course is not to teach technology instruction and completing this course alone is not going to give a student sufficient exposure to these topics to be able claim mastery.

67-271 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 basics of systems development, techniques that systems analysts need to understand and how to document requirements and project plans for complex information systems projects. Since software systems development is a cross-disciplinary area of study. This course will consider relationships in which 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. Grades will be assigned by weighting assigned and presented mid-term and final examinations. Expected section size is 60.
Prerequisites: 15111 or 15121 or 15200 or 15211

67-266 Social Issues in Computing
Spring: Mini Session - 6 units
When people use electronic information systems to conduct social relationships, they are involved with social interactions and relationships that are strongly influenced by the social medium in which they are conducted. Although there is some understanding of these influences, the social context of computing is a relatively new area of study. This course will consider relationships in which electronic media, principally the information networks made possible by computers, provide a significant context for social and political engagement. Concepts will be mastered through a combination of readings, class attendance, homework assignments, and mini-projects. Grades will be assigned by weighting assigned and presented mid-term and final examinations. Expected section size is 60.
Prerequisites: 15111 or 15121 or 15200 or 15211

67-272 Application Design and Development
Fall: 9 units
This course provides students with the concepts and techniques
research case studies and recommend public policy or other constructive social responses to issues arising in a world of pervasive electronic networking. This course is cross-listed with 88-366 (Dept of Social & Decision Sciences) and 05-499 (Human-Computer Interaction). Prerequisite: Junior or senior standing.

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: 67-271 and 67-272. Prerequisites: 67271 and 67272

67-390 Independent Study in Information Systems
All Semesters: 3-18 units
Independent studies are opportunities to engage in research with a faculty member to advance your learning in certain areas of interest. Information Systems students may enroll in independent study for 3, 6, 9, or 12 units of academic credit by obtaining a faculty sponsor who will oversee the academic component of the coursework, monitor progress, and assign a final grade.

67-475 Information Systems Applications
Fall: 12 units
In this course, students design and implement a usable information system for a client. The client may be affiliated with the university, government, business, or non-profit agency. Students will be assigned to teams to work on these projects, and will produce operational, fully documented and tested, computer-based information systems. The projects will be supervised by CMU faculty and, when possible, by project clients. Prerequisite: 67-373. Prerequisites: 66373 or 67373

67-501 Information Systems Honors Thesis I
Fall: 9 units

67-502 Information Systems Senior Honor Thesis II
Spring: 9 units

67-505 Information Systems Internship
Spring: 1-12 units

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 majors and non-majors is 15-211. Prerequisites: 15211

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/bwv.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 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. You will 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, physically based rendering 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 is the body of 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 and 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 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.

05-413 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 will also 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, 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: 12 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 programming 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: 15100 or 15112 or 15127
05-431 Software Architecture for User Interfaces
Fall: 12 units
This course is intended for those with advanced programming skills who want to do serious development of graphical user interfaces. The 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; and 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 artificial intelligence to create computer-based “intelligent tutor” systems which will illustrate the commonality of investigative techniques in these fields. A key emphasis will be on algorithm development and implementation. Because of the complexities involved, a significant portion of the course will be devoted to the development of an intelligent tutoring system. The student will be expected to develop a prototype of an intelligent tutor and demonstrate the prototype’s effectiveness through completed testing.

05-499 Special Topics in HCI
Intermittent: 9-12 units
Computer Supported Collaborative Learning - with Dr. Carolyn Rosé and Dr. Susan Finger: The field of Computer Supported Collaborative Learning has as one of its foundational goals to work toward an understanding of the causal connections between interaction and learning so that we can wield technology in a way that maximizes cognitive and social benefits of online learning. The purpose of this class is to expose students to the foundational theoretical and methodological issues underlying previous work in collaborative learning, to introduce students to the wide range of current approaches to collaborative learning, and to offer students a vision of where the field is going through readings of recent foundational articles as well as hands-on experiences with new technologies. The field of Computer Supported Collaborative Learning is changing. Machine learning and next generation technologies bring the potential to adapt support offered to students to the specific needs that arise during their group interactions. Whereas the state of the art in collaborative learning support is primarily composed of static, one-size-fits-all approaches, the ideal of adaptive collaboration support is now within our grasp. Nevertheless, important research questions must be addressed, both on the technical side of computing and on the design of educational technology that was originally developed for different purposes to this new research area, and on the behavioral side of investigating the effect of alternative strategies and approaches to responding to the events that are detected using that technology.

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 register this course in computer science, as this course is focused on the rules and methods of game design, which remain fairly constant regardless of the technology used to develop the 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 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.

05-540 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 course is intended for those with advanced programming skills 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 and expertise in analytical evaluation, implementation and design, and develop skills working in multidisciplinary teams. Students work with Carnegie Mellon University-based clients or external clients to iteratively design, build and test a software application which people directly use. Prerequisites: 05410 or 05610 Corequisites: 05-631, 05-431

05-589 Independent Study in HCI-UG
All Semesters: 3-24 units
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 form. Students should either have the programming skills or experience in the cognitive psychology of human problem solving. Such models have been used to create educational software that has been demonstrated to dramatically enhance student learning in domains like mathematics and computer programming. In addition to discussion and readings on methods and models of problem solving, learning, and tutor design, the course will have a significant “design by doing” component. Students should have either the programming skills or experience in the cognitive psychology of human problem solving. PREREQUISITES 15-211 or 85-213 or 85-411 or instructor permission. Preferred: 05-410 or a course in AI.

05-600 HCI Pro Seminar
Fall: 6 units
Students will attend the one-hour weekly HCII Seminar Series of talks given by national leaders in the field of Human-Computer Interaction. Graduate students will then meet to discuss these topics in a small-group symposium.

Language Technologies Institute
11-617 Language Technologies for Computer Assisted Language Learning
Spring: 12 units
This course studies the design and implementation of CALL systems that use Language Technologies such as Speech Synthesis and Recognition, Machine Translation, and Information Retrieval. After a short history of CALL/LT, students will learn where language technologies (LT) can be used to aid in language learning. From there, the course will explore the specifics of designing software that must interface with a language technology. For each LT, we will explore: what information does the LT require, what type of output does the LT send to the CALL interface, what are the limits of the LT that the CALL designer must deal with, what are the real time constraints, what type of training does the LT require The goal of the course is to familiarize the student with the existing systems that use LT and assess the potential for CALL/LT software. The limitation imposed by the LT for designing CALL/LT software Grading criteria: several short quizzes term project: production of a small CALL/LT system, verbal presentation and written documentation of design of the software

11-792 Software Engineering for Information Technology
Spring: 12 units
The Software Engineering for IT sequence combines classroom material and assignments in the fundamentals of software engineering (11-791) with a self-paced, faculty-supervised directed project (11-792). The two courses cover all elements of project design, implementation, evaluation, and documentation. For students intending to complete both courses, it is recommended that the project design and proof-of-concept prototype be completed and approved by the faculty advisor before the start of the fall semester. Students may elect to take only 11-791; however, if both parts are taken, they should be taken in proper sequence.

Prerequisites: 11791 or 15393

MCS Interdisciplinary
38-101 Eureka
Fall and Spring: Mini Session - 3 units
Excited about science? Join your peers and faculty to explore science through this interdisciplinary laboratory course designed for first-year students. The course will bridge together laboratory experiences from biology, chemistry, and physics, with mathematics playing a central role in the data analysis of the experimental results. The experiments chosen for this course will illustrate the commonality of investigative techniques in these sciences and will emphasize experimental design and hypothesis.
testing. We will engage in weekly discussions not only on topics related to the laboratory experiments and projects in hand but also on some of the most exciting advances, deeper understanding, and ethical questions in science and mathematics.

38-709 Applied Cell and Molecular Biology
Fall: 12 units
This course will examine applications of modern cell and molecular biology, with emphasis on commercial products and processes. The course will include a basic background in major topics that would be covered in courses on prokaryotic and eukaryotic molecular biology and molecular cell biology. The course is intended for non-specialists who seek an understanding and appreciation of fundamental concepts without the analysis of experimental detail that would support the development of concepts in a course for the specialist. The course will draw on the patent literature as a source of commercial applications of biological discoveries. Examples of the topics that might be included are: diagnostic and therapeutic monoclonal antibodies (e.g., Herceptin), recombinant proteins (e.g., colony stimulating factors, erythropoietin, hormones), antibiotics, subunit molecular vaccines, amino acid fermentations, enzyme based processes for chemical synthesis, gene therapy, stem cells and regenerative medicine, herbicide tolerant plants, microbial diagnostics (e.g., multilocus sequence typing), transgenic animals, DNA fingerprinting.

38-710 Principles of Biotechnology
Spring: 12 units
This course is intended to provide an introduction to a set of core areas currently highlighted in the biotechnology industries. The objective is to provide the appropriate background for management level personnel to optimize their decision-making based on a knowledgeable background in today's technologies. The focus will be on weekly modules of similar technologies with an introduction to technology/science behind the topic area and the applications of the technology in today's industries and markets.

Materials Science & 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 and defining the emerging fields of the future. This course will provide 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 and analyzing 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, sections 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. Amorphous materials and microstructures will be discussed. The importance of the structure factor to the interpretation of diffraction patterns will be discussed. The objective of this course is to develop a basic understanding of the significance of structure to the properties of materials.
Corequisites: 21122

27-202 Defects in Materials
Fall: 9 units
Defects have a fundamental influence on the properties of materials. For example, the strength and deformation of materials, the electrical and optical properties of materials, and the rates of diffusion in solids are all determined by the population of intrinsic and extrinsic defects. This course is an introductory approach 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 and electrical and optical properties will be considered. The properties and characteristics of dislocations and dislocation reactions will also be presented. Dislocations in different crystal systems and the role of dislocations in deformation will be discussed. The crystallography and energetics of planar defects and interfaces will also be described. The course includes both lectures and laboratory exercises.
Prerequisites: 21122 Corequisites: 27-100

27-205 Introduction to Materials Characterization
Spring: 3 units
This 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 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 to perform a hands-on analysis. 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).

27-215 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. The concept of the chemical and physical potential introduced. The second half of the course will focus on chemical reactions, liquid and solid solutions, and 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 analyze these principles to problems related to materials manufacture and processing. Topics will include thermal conductivity, convection, heat transfer equations, fluid mechanics (viscosity, etc., Newton’s 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 the components and the processing of materials.
Prerequisites: 15100 and 27215

27-217 Phase Relations and Diagrams
Spring: 12 units
Prerequisites: 27201 and 27202 and 27215
Corequisites: 09-105

27-299 Professional Development I
Fall: 1 units
This is a course designed to teach engineering business and professional skills to the MSE students. It is attended by sophomores, juniors and seniors and the course is one of the 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 storytelling and assignment. The course is designed to include case studies or typical assignments a materials scientist may encounter during his/her employment.
Prerequisites: 27-301 and 27-302 and 27-303
Corequisites: 09-105

27-301 Microstructure and Properties I
Fall: 9 units
This course is designed to introduce the use of light and electron microscopy and instruments in the analysis of microstructure and properties. The objective is to provide the student with the appropriate background to understand and appreciate fundamental concepts without the analysis of experimental detail that would support the development of concepts in a course for the specialist.
Corequisites: 27-302 and 27-303

27-302 Microstructure and Properties II
Fall: 9 units
This course is designed 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 33107
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 transitions, etc. The course includes both lectures and laboratory exercises.
Prerequisites: 27301 Corequisites: 27-301

27-311 Polymeric Biomaterials
Spring: 9 units
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. Prerequisites: None, but 09-105 Introduction to Modern Chemistry and 42-101 Introduction to Biomedical Engineering will be useful

27-312 Metallic and Ceramic Biomaterials
Fall: 9 units
This 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: 5 units
This course addresses the principles of processing of metals and the relationship between processing and performance. Topics include chemical thermodynamics, reaction kinetics, surfaces, fundamentals of heat treatment, process engineering, powder handling, powder compaction, densification and sintering. These aspects of processing science will be applied to the processing of metals including electrometallurgy, hydrometallurgy, pyrometallurgy, extraction, refining, and specific examples of alloy systems such as the production of steel, aluminum or titanium. The principles and practices of processing will be applied to process optimization. The relationship between processing methods and the environment will be discussed. The impact of the processing history and its 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, surface and colloids dispersions, process engineering, powder handling, powder compaction, shape forming, densification, and sintering. Prerequisites: 27100 and 27202 and 27215 and 27216

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 which 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. (Fall: 9 units)

27-325 Polymer Physics and Morphology
Spring: 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 polymer’s glass transition and the crystallization 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
Fall: 5 units
This course introduces the student to the methodology by which a material can be successfully chosen for a given application from the various classes (metals, ceramics and glasses, electronic materials, polymers and composites). Criteria for selection include processing methods, fabrication of materials systems, costs, specifications and standards, environmental considerations, ethics, and substitutions for strategic materials. Common causes of failure and methods of prevention will be discussed. Each student will have the opportunity for an original paper with specialization in a material class of choice.

27-367 Selection and Performance of Materials
Spring: 6 units
This course involves the application of materials and process selection methodologies used in product design. These methodologies are based upon the integration of function, shape, material, and processes used to select materials and processes for a variety of product applications (electronic, magnetic, mechanical, optical, thermal, etc.) from amongst the entire spectrum of engineering materials (ceramics, glasses, polymers, metals, and composites). Other factors in the selection process include engineering economics, codes and standards, environmental and safety regulations, professional ethics, and life cycle analysis. Common causes of failure and methods of prevention are evaluated as one stepping-stone to a final project: the selection of a material or process for a new product or for an improved existing product. There is extensive use of the Ashby Materials Selection Software throughout the course.
Prerequisites: 27100

27-399 Professional Development II
Fall: 1 units
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 Teamwork, II and III are offered in the same year cycle. The main goal of this course is to provide the student the knowledge, skills, and experience necessary for a successful career in engineering. The primary intent of the course is to provide the student with an understanding of the professional responsibilities and obligations of a practicing engineer. The student will have the opportunity for an original paper with specialization in a material class of choice.

27-401 MSE Capstone Course I
Fall: 12 units
This capstone course introduces the student to the methodology by which a material can be successfully chosen for a given application from the various classes (metals, ceramics and glasses, electronic materials, polymers and composites). Criteria for selection include processing methods, fabrication of materials systems, costs, specifications and standards, environmental considerations, ethics, and substitutions for strategic materials. Common causes of failure and methods of prevention will be discussed, Each student will have the opportunity for an original paper with specialization in a material class of choice. Prerequisites: 27301

27-402 MSE Capstone Course II
Spring: 12 units
This capstone course continues the discussion of materials selection with an emphasis on design of components and systems. As in the companion course, the full range of tools for understanding materials structure, processing and properties are applied to optimizing materials performance in current engineering applications. The paper from the companion course will be expanded into a project. Prerequisites: 27401

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 devices made from these 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: Mini Session - 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
Internment: 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 II will develop an in-depth understanding, based on the modern theories of solids, of the electrical, electronic and thermal properties of metals and semiconductors. Topics include properties and their relationships to 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; magnetic domains; soft and hard magnets; and the applications of hot junctions in the establishment and control of electronic properties of selected meta- and semiconductor-based devices. Examples of commercial products will be introduced to demonstrate the application of the information presented in the text and class presentations. Additional topics will include microelectromechanical systems and nanoelectronics.

27-433 Dielectric, Magnetic, Superconducting Properties of Materials & Related Devices
Internment: 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. Overarching and interrelated topics will include elementary quantum and statistical mechanics, relationships between chemical bonds and energy bands in dielectric and magnetic materials and semiconductors, the roles of phonons and electrons in the thermal conductivity of solids, diffusion and drift of electrons and holes, the importance 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 microelectromechanical systems and nanoelectronics.

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, magnetic anisotropy, and magnetostriiction. This is followed by discussion of extrinsic properties including magnetic hysteresis, frequency dependent magnetic response, and magnetic losses. This will serve as the basis for discussing phase relations and structure/properties relationships in various transition metal magnetic materials classes including iron, cobalt and nickel elemental magnets, iron-silicon, iron-nickel-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 magnetic tape applications will also be covered.

27-454 Supervised Reading
All Semesters 3-12 units
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 units
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, ceramic 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.

27-530 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 design and processing affects the properties that can be obtained by control of microstructure. The first part of the course considers phase stability, phase diagrams and the thermodynamics, mechanics and 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: Mini Session - 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 will be examined. 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 optical properties and liquid crystal displays.

27-551 Properties of Ceramics and Glasses
Spring: 9 units
This course focuses on the diverse properties of ceramics and glasses. It includes discussions of thermal properties, such as heat capacity and thermal expansion; mechanical properties of ceramics and glasses; strength and toughness from a failure standpoint; environmental effects; electrical properties including electronic and ionic conductivity, dielectric properties, piezoelectricity, and ferroelectricity; and optical properties as they pertain to glasses. The course also includes a discussion of selected current applications, such as recent trends in ceramic multi-layer packaging for electronics, advanced structural ceramics for automotive engines, and ceramic materials for phased-array radar systems. Numerical examples are used throughout the course to illustrate the engineering relevance of fundamental phenomena. This class will be co-taught with 27-515. Undergraduates taking the course will have separate homeworks and exams from the graduate students and will graded separately from the graduate students.

27-555 Materials Project I
Fall: 6,9 units
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: 6,9 units
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.

27-565 Nanostructured Materials
Internment: 9 units
Fall even years: 9 units This course is an introduction to nanostructured materials or nanomaterials. Nanomaterials are objects with sizes larger than the atomic or molecular length scale, but smaller than microstructures with at least one dimension in the range of 1-100 nm. The physical and chemical
properties of these materials are often distinctly different from bulk materials. This course introduces the basic thermodynamic concepts related to the phases, chemical activity and synthesis of nanomaterials including metallic, semiconductor, inorganic, liquid crystalline, polymeric and surfactant systems. The characterization of the structure of nanomaterials and their applications are also explored. At the end of the course, students should understand the relationship between the nanoscale structures, properties and performance of nanomaterials.

27-566 Special Topics in MSE
Fall and Spring: 9 units
This course is offered occasionally to present one or more topics, usually of timely or of practical engineering importance. Interested students should check with the Department to determine whether the course is being offered, and to obtain a syllabus if appropriate.

27-582 Phase Transformations in Solids
Spring: 9 units
In this course the fundamental aspects of solid state phase transformations are presented. The nucleation (homogeneous and heterogeneous) and growth of diffusionally 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, monotectic, spinodal decomposition, displacive, etc. are discussed with specific examples from the Materials Science literature.

27-591 Mechanical Behavior of Materials
Spring: 9 units
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 include 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
Spring: 9 units
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 Processes in Materials
Fall: 9 units
This undergraduate course is designed to provide an introduction to electrochemical cells, electrode kinetics will be introduced along with electrochemical techniques such as potentiostatic, galvanostatic and electrochemical impedance spectroscopy. Electrochemical applications that will be discussed include: corrosion, electrochemical processing of materials and electrochemically based devices such as fuel cells, batteries and sensors. Prerequisites: 27215

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

24-201 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 drafting techniques, orthographic drawing; auxiliary and oblique views; sectional drawings; working drawings; blueprint reading; freehand sketching; production standards; methods of isometric and 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. rec., 1 hr. rec./lab.

Prerequisites: (21118 or 21122 or 21123) AND 24101 AND 33106

24-231 Fluid Mechanics
Spring: 10 units

Prerequisites: (21118 or 21122 or 21123) AND 33106

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: (21118 or 21122 or 21123) AND 33106

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: 24261 and 21259 and 33106

24-302 Mechanical Engineering Seminar I
Fall and Spring: 2 units
The purpose of this course is to help 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 participation in class discussions. 1 hr. rec. Prerequisites: Junior standing or permission of instructor

24-311 Numerical Methods
Fall: 9 units
Use of numerical methods for solving engineering problems with the aid of a digital computer. Problems will be drawn from all fields of interest to mechanical engineers. 3 hrs. rec.

Prerequisites: 21259 and 21260

24-321 Thermal Fluids Engineering
Spring: 12 units
Momentum and thermal boundary layer. Flow separation and
control. Introduction to turbulence. Introduction to gas dynamics. Turbomachinery. Measurement and computational techniques. 3 hrs. lec., 3 hrs. rec./lab
Prerequisites: 24221 and 24231 and 24311 and 24322 and 33106

24-322 Heat Transfer
Fall: 10 units
Prerequisites: 21260 and 24221 and 24231

24-332 Thermodynamics II
Intermittent: 12 units
Power cycles, including vapor cycles (Rankine, reheat, regenerative, etc.) and gas cycles (Otto, Brayton, Diesel, etc.). Refrigeration cycles, including heat pumps and gas liquefiers. Thermodynamic relations and equations of state. Mixtures of gases; application to hygrometry and air conditioning. Thermodynamically considered. The basic principles of group criteria, the phase rule, heats of reaction, combustion and dissociation. 3 hrs. rec., 3 hrs. lab.
Prerequisites: 24221 and 24231

24-331 Viscous Flow
Fall: 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: 21259 and 21260 and 24221 and 24231

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 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: 21259 and 21260 and 24231

24-333 Gas Dynamics
Spring: 9 units
Prerequisites: 21259 and 21260

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 manufacuturability. The features of mass and batch production are quantitatively considered. The basic principles of group criteria, the phase rule, heats of reaction, combustion and dissociation. 3 hrs. rec., 3 hrs. lab.
Prerequisites: 21259 and 21260

24-351 Dynamics
Fall: 12 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. 4 hrs. lec.
Prerequisites: 21259 and 24262

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. 4 hrs. lec.
Prerequisites: 21259 and 24262 and 33107

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 the synthesis 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.

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 responses of complex systems and distributed mass systems. Applications include isolation, stability, and balancing. 3 hrs. lec., 1 hr. rec., 2 hrs. lab.
Prerequisites: 21259

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: 21259 and 24262

24-371 Electromechanical Systems
Spring: 10 units
Few engineered systems exist today that are purely mechanical in nature. Many incorporate electrical, electronic, or computer subsystems in the form of sensors, actuators, and controls, and mechanical engineers take advantage of such capabilities. The course begins with a review of circuit analysis techniques. Topics then proceed to passive, active, and digital devices; operational amplifiers; power amplifiers; sensors and signal conditioning; and motors and other actuators. Three laboratory assignments spaced throughout the semester include construction and diagnostics of circuits and electromechanical systems with a view towards sensing, actuation, and integration. 3 hrs. lec., 3 labs per semester.
Prerequisites: 21259 and 24262

24-380 Special Topics in Mechanical Engineering
Intermittent: 9 units
The Special Topics in Mechanical Engineering courses provide students with exposure to a variety of advanced concepts related to Mechanical Engineering and are offered on an "as available" basis. The final digit reflects the primary application area of the material, where 0 is professional; 1 is mathematics; 2 is thermal engineering; 3 is fluid mechanics; 4 is design and manufacturing; 5 is dynamics and controls; and 6 is solid mechanics.
Introduction to engineering design. Lectures describe the typical design cycle and its associated activities. Professional responsibilities of designers are emphasized, including ethical relationships with other professionals and with clients. Regulatory aspects and public responsibility are discussed. A practical design project is done by each student, usually working as a member of a small team, 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: 24262 and 24322 and 24352

24-442 Engineering Design EPP
Fall and Spring: 12 units
A design course similar to 24-441. For Mechanical Engineering students who are taking a double major with Engineering and Public Policy.
Prerequisites: 24231 and 24262 and 24352

24-443 Design for Manufacture
Fall: 9 units
Introduces methods for concurrent design and manufacturing. Course topics will include methods of value engineering, function logic, design review processes, Taguchi design systems, design for manufacturing, design for assembly, process selection, statistical process control, and discussion of such topics as net shape processes, zero quality, just-in-time, FMS and robotics. Emphasis on analytical methods and their application to the design of products and manufacturing processes. Project oriented. 3 hrs. lec.
Prerequisites:

24-451 Feedback Control Systems
Fall: 12 units
Fundamentals of feedback control with emphasis on classical techniques and an introduction to state space methods. Topics include the following: state space 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, Nyquist criterion; design and implementation of proportional, proportional-derivative; proportional-integral-derivative, lead, lag, and lead-lag controllers. Laboratory work will include implementation and evaluation of various controllers on real systems for comparison with analytical models. Use of computer aided analysis and design software. 3 hrs. lec., 3 hrs. lab.
Prerequisites: (15100 or 15111) AND 24352

24-491 Department Research Honors
Fall and Spring: 3-24 units
This course is designed to give students increased exposure to "open-ended" projects 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: 3-24 units
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.

Mathematical Sciences

21-101 Freshman Mathematics Seminar
Fall: Mini Session - 3 units
This course is offered in the second half of the Fall semester for first semester freshmen intending to major 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, exponential numbers, and trigonometric functions and identities. 3 hrs lec., 1 hr rec.
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 an even 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: 21131

21-201 Undergrad Colloquium
Fall and Spring: 1 units
All mathematics majors meet for one hour each week to hear presentations on current research by faculty or students, discussions on current research by faculty or students, special topics in mathematics, 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
All Semesters: 9 units
The techniques of discrete mathematics arise in many applications of mathematics, which is not purely continuous, for example in computer science and other fields of natural sciences. The course is divided into several areas: discrete combinatorics, 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: 21127

21-229 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 transfinitude 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. Prerequisites: 21127

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.

Courses 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: 21132

21-236 Mathematical Studies II
Spring: 20 units
A unified and intensive presentation of algebra, analysis, and
geometry by a team of instructors. 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.

Courses 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 Laplace transforms; partial differential equations;

21-256 Multivariate Analysis and Approximation
All Semesters: 9 units
Taylor's Theorem; geometric sequences and series and their
applications; 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: 21120 or 21121

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; 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: 06262 or 18202 or 21256 or 21341

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: 21120 or 21121

21-260 Differential Equations
All Semesters: 9 units
Ordinary differential equations: first and second order equations,
applications, partial differential equations: partial differential equations; separation of variables, Fourier series;
systems of ordinary differential equations; applications. 3 hrs.
lec., 1 hr. rec.
Prerequisites: 21122 or 21123 or 21132

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. At the heart 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 methods; and its
linear algebra foundations, duality, post-optimality and sensitivity
analysis; the transportation problem; the critical path method;
non-linear programming metulus. 3 hrs. lec., 1 hr. rec.
Prerequisites: (21122 or 21132) and (21241 or 21341)

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. 1.5 hrs. lecture/lab.

21-300 Basic Logic
Fall: 9 units
Propositional and predicate logic: Syntax, proof theory and
theories, and applications of the compactness theorem. 3 hrs.
lec.
Prerequisites: 21127 and (21132 or 21228 or 21373 or
21484)

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 include permutations and
combinations, generating functions, recurrence relations,
principles of inclusion and exclusion, and the Fibonacci sequence
and the harmonic series. Additional topics may include existence
problems, partitions, finite calculus, generating combinatorial
objects, Polya theory, codes, probabilistic methods. 3 hrs. lec
Prerequisites: 21122 and 21127

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: 21122 and 21259

21-341 Linear Algebra
Fall and Spring: 9 units
Fields, vector spaces, subspaces, linear independence, basis and
dimension, matrices and linear equations, linear transformations,
groups, rank and nullity theorem, change of basis, inner product
spaces, eigenvalues and eigenvectors. 3 hours lecture.
Prerequisites: 21127

21-342 Linear Algebra II
Intermittent: 9 units
General spectral theory, invariant subspaces, canonical forms,
diagonalization and multilinear algebra, linear 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: 21341

21-350 History of Mathematics
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: 21259 and 21260
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,
equations on bounded domains, general theory of
eigenfunction expansions, the Fourier integral applied to problems
on unbounded domains, introduction to numerical methods. 3 hrs.
lec.
Prerequisites: 21259 and 21260
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, finite groups;
isomorphism theorems. Rings: Subrings, ideals, quotient rings,
first isomorphism theorem. Polynomial rings. Prime and maximal
ildeals, prime and irreducible elements. PID's and UFD's.
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: (21241 or 21341) and 21127
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 tools. 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: 21373
21-380  Introduction to Mathematical Modeling
Intermittent: 9 units
This course shall examine mathematical models, which may be
used to describe natural phenomena. Examples, which have been
studied include: continuum description of highway traffic, discrete
velocity models of a monotonic gas, chemotactic behavior in
biological systems, European options pricing, and cellular-
dynamics models of biological systems. Examples, which have been
studied include: continuum description of highway traffic, discrete
velocity models of a monotonic gas, chemotactic behavior in
biological systems, European options pricing, and cellular-
dynamics models of biological systems. The course will develop these models and then examine the behavior
of the underlying systems, both analytically and numerically. The
mathematical tools required will be developed in the course.
Prerequisites: 21241 and 21260
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: 21257 or 21292
21-420  Continuous-Time Finance
Spring: 9 units
This course begins with Brownian motion, stochastic
integration, and Itô'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: (21260 or 18202) and 21370 and (36225 or
21325 or 36217)
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
This course provides an introduction to one of the basic topics of
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.
Prerequisites: 21259 and 21260
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: 21122 and 21127
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, Jacobian, chain rule function rule, inverse
Vector integral calculus: double and triple integrals, arclength and
surface area, line integrals, Green's Theorem, surface integrals,
Divergence, Stokes and Gauss theorem. Time permits:
trigonometric series, Fourier series for orthonormal bases,
minimization of square error. 3 hours lecture.
Prerequisites: 21241 and 21259 and 21355
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 applications to power 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
Taylor's theorem. Time permits: trigonometric series, Fourier series for orthonormal bases,
minimization of square error. 3 hours lecture.
Prerequisites: 21241 and 21259 and 21355
21-365  Projects in Applied Mathematics
Fall: 9 units
This course provides students with an opportunity to solve
problems posed by area companies. It is also designed to provide
both practical and theoretical interests. Algebra and geometry 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: 21241 and 21259 and 21355
21-366  Topics in Applied Mathematics
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.
21-369  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: 21259 and 21260
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,
equations on bounded domains, general theory of
eigenfunction expansions, the Fourier integral applied to problems
on unbounded domains, introduction to numerical methods. 3 hrs.
lec.
Prerequisites: 21259 and 21260
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: 21127 and 21241

21-450 Topics in Geometry

Intermediate: 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: 21356 or 21460

21-460 Topology

Intermediate: 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 concepts 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: 21355

21-465 Topology and Geometry

Spring: 9 units


Prerequisites: 21356 and 21373

21-470 Selected Topics in Analysis

Intermediate: 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: (21236) or (21241 and 21355)

21-476 Ordinary Differential Equations

Intermediate: 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: 21241 and 21260

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, 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: 21127

21-590 Curricular Practical Training

All Semesters: 3-12 units

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 supervisor 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: 0-99 units

Individual reading courses or projects in mathematics and its applications. Prerequisites and units to be negotiated with individual instructors.

21-600 Mathematical Logic I

Fall: 12 units

The study of formal logical systems, which model the reasoning of mathematics, scientific disciplines, and everyday discourse. Propositional Calculus and First-order Logic. Syntax, axiomatic treatment, derived rules of inference, proof techniques, computer-assisted formal proofs, normal forms, consistency, independence, semantics, soundness, completeness, Lowenheim-Skolem Theorem, compactness, equality. 3 hrs. lec.

Prerequisites: 21132 or 21228 or 21373 or 21484

21-602 Introduction to Set Theory I

Fall: 12 units

First order definability and the Zermelo-Fraenkel axioms; cardinal arithmetic, ordered sets, well-ordered sets (axiom of choice), transfinite induction, ordinals, well-founded sets, the axiom of regularity, recursion theorem, Delta systems, basic results in partition calculus (e.g., Ramsey’s Theorem and the Erdos-Rado Theorem); small to medium large cardinals. 3 hrs. lec.

Prerequisites: 21355

21-603 Model Theory I

Intermediate: 12 units

Similarity types, structures; downward Lowenheim Skolem theorem; construction of models from constants, Henkin’s omitting types theorem, prime models; elementary chains of models, basic results on countable models including Ryll-Nardzewski’s theorem; indiscernible sequences, Ehrenfeucht-Mostowski models; introduction to stability, rank functions, primary models, and a proof of Morley’s categoricity theorem; basic facts about infinitary languages, computation of Hant-Morley numbers.

21-610 Algebra I

Spring: 12 units

The structure of finitely generated abelian groups, the Sylow theorems, nilpotent and solvable groups, simplicity of alternating and projective special linear groups, free groups, the Nielsen-Schreier theorem, the filter of closed unbounded sets (Fodor, Ulm and Solovay’s theorems), Delta systems, basic results on countable models including Ryll-Nardzewski’s theorem; indiscernible sequences, Ehrenfeucht-Mostowski models; introduction to stability, rank functions, primary models, and a proof of Morley’s categoricity theorem; basic facts about infinitary languages, computation of Hant-Morley numbers.

21-620 Real Analysis

Fall: Mini Session - 6 units

A review of one-dimensional, undergraduate analysis, including a rigorous treatment of the following topics in the context of real numbers: sequences, compactness, continuity, differentiation, Riemann integration. (Mini-course. Normally combined with 21-621.) 3 hrs. lec.

21-621 Introduction to Lebesgue Integration

Fall: Mini Session - 6 units

Construction of Lebesgue measure and the Lebesgue integral on the real line. Fatou’s Lemma, the monotone convergence theorem; small to medium large cardinals; applications to partition calculus (e.g., Ramsey’s Theorem and the Erdos-Rado Theorem); small to medium large cardinals. 3 hrs. lec.

21-630 Introduction to Numerical Analysis I

Spring: 12 units

Finite precision arithmetic, interpolation, spline approximation, systems of equations, optimization in finite dimensional spaces. 3 hrs. lec.

21-651 General Topology

Fall: 12 units


21-660 Introduction to Numerical Analysis I

Spring: 12 units

Finite precision arithmetic, interpolation, spline approximation, numerical integration, numerical solution of linear and nonlinear systems of equations, optimization in finite dimensional spaces. 3 hrs. lec.

21-700 Mathematical Logic II

Spring: 12 units

Higher-order logic (type theory). Syntax, Lambda-notation, Axioms of Description and Choice, computer-assisted formal proofs, semantics, soundness, standard and non-standard models, completeness, compactness, formalization of mathematics, definability of natural numbers, representability of recursive functions, Church’s Thesis. Godel’s Incompleteness
464 Course Descriptions

Theorems, undecidability, undefinability. Prerequisites: 21300 or 21600

Military Science-ROTC

30-101 Introduction to Military Leadership
Fall: 5 units
In this course, students will be introduced to the fundamentals of Army leadership 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.

30-301 Basic Leader Planning and Combat Operations
Fall: 5 units
This course offers an in-depth analysis and focused practical application of planning and maneuver 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 regimen, 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 and/or general interest 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 an LIEutenant in the Army. This course covers personal and performance counseling, evaluation of subordinate leaders and team-building skills as well as military justice and discipline. Students bring to bear all of the skills and knowledge that they have accrued over the prior semesters in the Department of Military Science. Each student must participate in physical training, field training exercises and is expected to wear the Army uniform, which will be provided. Prerequisites: Class is open only to contracted students.

Modern Languages

82-101 Elementary French I
Fall and Spring: 12 units
This course is for students who have never studied French. The emphasis is on all four skills (listening, speaking, reading, writing) and on cultural information as it is presented in the text and through homework assignments. Regular participation in class is mandatory (four in-class hours per week). In addition, this course requires that students spend at least 150 minutes per week practicing the language with books, audio materials, CDs, the Modern Language Resource Center (MLRC) using different multimedia tools (audio CD, video, CD ROM, ML server, Internet) 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. Prerequisite: None. 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.

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. The emphasis is on all four skills (listening, speaking, reading, writing) and on cultural information as it is presented in the text 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 French before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160. ***There is a REQUIRED 450 materials fee for the course. This fee must be paid no later than the end of the add/drop period. Prerequisite: 82-101 or placement test for previous instruction in French. Prerequisites: 82101 or 82103

82-103 Elementary French 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. 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. Elementary French 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 should be prepared to participate in such studies in the course of their
classwork. Prerequisites: No previous study required. 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 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.

82-104 Elementary French I Online Spring: 12 units A continuation of 82-103, Elementary French I Online. There is a required weekly class meeting for training and for group activities, plus individual weekly meetings with a tutor or the Instructor for course of study and practice. See website for more detailed description of requirements and class structure before enrolling. Elementary French 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 course will include students who have studied such students' learning process. Prerequisites: French 82-101, 82-103 or permission of the Instructor. 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: 82101 or 82103

82-106 Intensive French Language and Culture: Elementary Level All Semesters: 3-18 units 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: 3-18 units 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 a tutor. Enrollment in the course is limited. Prerequisite: Permission of the Department Head.

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. Prerequisite: German 82-101 or approved equivalent. Prerequisites: 82101 or approved equivalent.

82-122 Elementary German II Fall and Spring: 12 units This course, a 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. 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: 82-121 or approved equivalent. Prerequisites: 82121 or 82122

82-123 Directed Language Study: Elementary German I or II Fall and 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. It is a Chinese language course designed to help beginners develop communicative competence in the four basic skills of listening, speaking, reading and writing. Basic vocabulary and sentence patterns 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 for group activities, and a weekly individual meeting 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 Fall and Spring, and in 82-124 as well. Prerequisites: 82-101 or approved equivalent.

82-126 Intensive German Language and Culture: Elementary Level Intermittent: 6-24 units 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 and background for the Chinese society and multimedia programs. The elementary level is designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study. Prerequisite: None.

82-132 Elementary Chinese II Spring: 12 units This course is the continuation of the elementary Chinese course sequence for beginning students of Mandarin Chinese. Its goal is to continue to train students in the basic skills of listening, speaking, reading and writing for everyday communication. Based on the vocabulary and sentence structures taught in the first semester, students will learn more useful expressions and sentence structures for use in and out of the classroom. 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 approaches of Chinese culture are developed through poetry, reading, group activities, multi-media programs, and research projects throughout the course. 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: 82-131 or approved equivalent. Prerequisite: 82131

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. Basic vocabulary and sentence patterns 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 for group activities, and a weekly individual meeting 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 Fall and Spring, and in 82-124 as well. Prerequisites: 82-101 or approved equivalent.

82-134 Elementary Chinese Online II Spring and Summer: 12 units This course is the continuation of 82-133, Elementary Chinese I Online learning. Students will learn more complex expressions and sentence structures necessary for use in everyday life. Students will 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 for group activities, and weekly 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
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 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 be also 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. Also a study of cultural aspects of Spanish-speaking countries. Prerequisite: None. If a student has studied Spanish before, then s/he must take the placement exam. Instructions for taking the placement exam are in Baker Hall 160.

82-142 Elementary Spanish II
Fall and Spring: 12 units
The second part of a two-semester course sequence (82-141, 82-142). Prerequisite: 82-141, 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: 82141 or 82143

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 taking the placement exam are in Baker Hall 160. NOTE: If 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.

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 add/drop to avoid removal from the class.
Prerequisites: 82141 or 82143

82-146 Intensive Spanish Language and Culture: Elementary Level
All Semesters: 3-18 units
Transfer credit for study abroad in a Spanish-speaking country or other approved program at the Elementary level. Credit determined after consultation with the transfer credit advisor for Spanish.

82-147 Accelerated Elementary Spanish
Intermittent: 12 units
This course is specially designed for students who are not true beginners of Spanish and therefore not appropriately placed in 82-141 but who may lack adequate preparation to enter the second semester of Spanish. Students will engage in a rapid review of first-semester Elementary Spanish materials and then progress to complete the entire elementary level of Spanish (the second semester) in one semester. Upon successful completion, students will be prepared to continue at the intermediate level. The course emphasizes the development of communicative proficiency though oral practice, aural comprehension, reading, writing, and study of cultural aspects of Spanish-speaking countries. Prerequisites: 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 language learning resource center work with audio and video tapes. 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.

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: 82161 or 82163

82-163 Directed Language Study: Elementary Italian I & II
Fall and Spring: 12 units
A self-paced version of 82-161/162, for highly-motivated students, capable of working independently. Weekly practice sessions, 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
A two-semester course sequence (82-171, 82-172) for students with no background in Japanese. The course emphasizes the development of communicative language proficiency: oral practice, aural comprehension, reading, writing, and the study of cultural aspects in 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: 82-171 or approved equivalent.
Prerequisites: 82171

82-176 Intensive Japanese Language and Culture: Elementary Level
Intermittent: 6-24 units
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: Bilingualism Around the World
Intermittent: 9 units
This course will examine social and cognitive effects of knowing two languages, i.e., bilingualism. It will focus on the individual, the education system, and society. We will consider topics such as the measurement and description of bilingualism; the relationship between native language acquisition and second language learning; the affective and cognitive consequences of becoming bilingual; the organization and implementation of programs designed to develop second language proficiency; and the societal repercussions of encouraging or discouraging second language learning or teaching programs. Examples, readings, and assignments will be selected to permit consideration of a broad
range of issues from both so-called monolingual and bilingual countries. 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, students will be expected to produce a paper on the topic of 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 within a wide range 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 and are presented through language use. The topics will include analysis of the relationship between language and thought (the Sapir-Whorf linguistic relativity hypothesis); standard versus vernacular languages, attitudes towards Russian language acquisition as it differs from one speech community to another; bilingualism and multilingualism 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 French literature of the Western European 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 cinema. We will be working on films 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 Aischelle's Orestea and Aristotile's Poetics, the seminar explores the nature of tragedy in ancient Greece as a theatrical experience, and the development of Greek theatre and 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 tragic ideal, showing how the dominant values 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 tracing 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.

82-189 Independent Study in Language and Culture-
Elementary Level
Fall and Spring: 6-12 units
An opportunity for students who wish to complement their course work in the Elementary Level with an independent study course and to pursue further study at this level. 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.

82-191 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 Russian in a wide range 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 and are presented through language use. The topics will include analysis of the relationship between language and thought (the Sapir-Whorf linguistic relativity hypothesis); standard versus vernacular languages, attitudes towards Russian language acquisition as it differs from one speech community to another; bilingualism and multilingualism 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.

82-192 Elementary Russian II
Spring: 12 units
The second part of a two-semester course sequence (82-191, 82-192). Prerequisite: 82-191 or approved equivalent.
Prerequisites: 82191.

82-198 Research Training: Modern Languages
Fall and Spring: 9 units
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 list of participating faculty and the current projects on which they are willing to supervise student interns. The general interests of Modern Languages faculty interns 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 be able to experience language use in a wide variety of 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.

82-201 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 language in culture, with an aim to foster cross-cultural awareness and self-reflection while developing proficiency in French. This course is designed to strengthen listening, speaking, reading and writing, within the context of an evolving French culture. Varying with each semester, the course will use classic French texts as well as songs, excerpts from newspapers, magazines or films. Prerequisite: 82-102/104, placement score, or permission of the instructor.
Prerequisites: 82102 or 82104.

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.
Prerequisite: 82-201, 82-203, placement score, or permission of the instructor.
Prerequisites: 82201 or 82203

82-203 Intermediate German 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. An integrated approach to 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 permission of the Instructor. 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: 82102 or 82104

82-204 Intermediate German 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. 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: 82-202, 82-203, or permission of the Instructor. 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: 82201 or 82203

82-206 Intermediate French Language and Culture: Intermediate Level
Intermittent: 0-18 units
Transfer credit for study abroad in France, a French-speaking country, or otherwise approved program at the Intermediate level. Credit determined after consultation with the transfer credit advisor for French.

82-221 Intermediate German I
Fall and Spring: 9 units
The overall 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. A balance of activities will help the development of all four skills of cultural knowledge, and assessment of progress will occur across skills throughout the semester. This is a content-based course, best titled "De Ausseren in der deutschen Kultur." We will look at various examples of "outsiders" in German-speaking countries, and compare and contrast their home culture with the culture of Germany-speaking countries. We'll be using listening activities for intermediate students and reading children's book written for native speakers. These materials include authentic and up-to-date language and cultural information. You will also complete cultural activities using materials from the web taught in German. Prerequisite: 122 or 123 (part 2) or approved equivalent.
Prerequisites: 82122 or 82123

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 in German-speaking countries; Myths and legends of the German-speaking countries; Modern associations and stereotypes; Immigration/Emigration/Integration. By the end of the course, you should be able to make yourself understood and understand German-speakers with experience dealing with foreigners. Taught in German. Prerequisite 221 or approved equivalent.
Prerequisites: 82221

82-226 Intermediate German Language and Culture: Intermediate Level
Intermittent: 6-24 units
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 daily conversations on various topics related to modern Chinese Society. 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 relate 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: 82-132 or permission of the instructor.
Prerequisites: 82132 or 82135

82-232 Intermediate Chinese II
Spring: 12 units
This is the second semester of Intermediate Chinese, a continuation of the Elementary Chinese course, to further develop students' Chinese. 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. Different aspects of Chinese culture will also be introduced throughout the course through audio and video tapes, lectures and discussions. Prerequisite: 82-231 or permission of the instructor.
Prerequisites: 82231

82-235 Intensive Intermediate Chinese
Intermittent: 12 units
This course is the continuation of Intermediate 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. Different aspects of Chinese culture will also be introduced throughout the course through audio and video tapes, lectures and discussions. Prerequisite: 82-135 or equivalent. Instructor's approval is required to register for this course.

82-236 Intensive Chinese Language and Culture: Intermediate Level
Spring: Variable units
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 the Spanish language and culture by means of grammar review, literary and cultural readings and analysis, 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: 82-142 or approved equivalent.
Prerequisites: 82142 or 82144

82-242 Intermediate Spanish II
Fall and Spring: 9 units
An integrated approach to the study of the Spanish language and culture by means of grammar review, literary and cultural readings and analysis, 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: 82-241 or approved equivalent. Prerequisites: 82241 or 82243

82-243 Intermediate Spanish I Online Fall: 9 units
An integrated approach to the study of the Spanish language and culture by means of grammar review, literary and cultural readings and analysis, 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 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 add/drop to avoid removal from the class. Prerequisite: 82-142, 82-144, 82-147 or permission of the Instructor. Prerequisites: 82142 or 82144

82-244 Intermediate Spanish II Online Spring: 9 units
An integrated approach to the study of the Spanish language and culture by means of grammar review, literary and cultural readings and analysis, 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 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. After a broad 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. In the discussion and exercises in class, students are required to gather and analyze relevant Japanese data, thereby facilitating their understanding of the grammar points in question and developing their analytical skills. This course is taught in English. Prerequisite: None. Prerequisites: 82171 or 82172 or 82271 or 82272

82-278 Japanese Literature in Translation 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 broad 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. In the discussion and exercises in class, students are required to gather and analyze relevant Japanese data, thereby facilitating their understanding of the grammar points in question and developing their analytical skills. This course is taught in English. Prerequisite: None. Prerequisites: 82171 or 82172 or 82271 or 82272

82-280 Learning About Language Learning Fall: 9 units
This course is designed for students majoring in or double majoring in Modern Languages or for students seriously contemplating undertaking the study of a foreign language at a future time. Experienced language learners bring to the tasks of learning a new language all sorts of general knowledge about the ways in which languages work as well as techniques for putting this knowledge to practical use. The objectives of this course are to provide students with a basic introduction to those areas of linguistics and psycholinguistics that will facilitate their language
Intermittent: 9 units
82-281 Tutoring for Community Outreach
Students participate in a community outreach program and work in the Pittsburgh Public Schools with elementary, middle and high school students of ESL, French, German, Japanese, or Spanish. The elementary school experience may involve regular visits, mentoring, and tutoring at Greenfield Elementary School, Lindon School, Liberty School or Frick International Studies Academy. The high school experience invites advanced students, majors, or minors in French, German, Japanese, or Spanish to work with language students at Schenley High School or Taylor Alderdice High School. Activities in the high schools may involve tutoring, may be remedial, or may be for enrichment. At Schenley High, Carnegie Mellon University may aid in student preparation for International Baccalaureate Exams in the Spring. During the early weeks of the semester, students will meet individually with the faculty liaison to arrange their community outreach activities and also as a group to prepare for their experience. Depending on the number of units to be earned, during the course of the semester, students will spend a certain number of hours per week engaged in some of the following activities: reading and preparing for the school visits, keeping a journal of tutoring experiences, writing a paper 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. Grade will be Pass/Fail, based on the student's fulfillment of the plan set at the beginning of the semester. Prerequisites: Permission of the faculty liaison plus completion of an information sheet and clearance forms available in the Department of Modern Languages.

Fall and Spring: 9-18 units
82-289 Independent Study in Language and Culture: Intermediate Level
An opportunity for students who wish to complement their course work at the Intermediate Level and pursue further study at this level. 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.

Fall: 9 units
82-291 Intermediate Russian
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 literature, and as the medium of the Russian language in daily life. Attention is directed toward the dynamic interaction of language and culture in order to foster cross-cultural awareness. Three hours of in-class instruction plus one additional hour of practice per week are required. One to two hours per day outside of these meetings must be devoted to study and homework assignments. Prerequisite: 82-290 or approved equivalent. Prerequisites: 82192

Spring: 9 units
82-292 Intermediate Russian II
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 emphasis on cultural literature, music and self-realization while developing proficiency in Russian. The second part of a two-semester course sequence (82-291, 82-292). Prerequisite: 82-291 or approved equivalent. Prerequisites: 82291

Fall: 9 units
82-293 Introduction to Russian Culture
Russia is one of the oldest European countries and long ago achieved world recognition for its outstanding contributions to Western tradition in the areas of architecture, painting, sculpture, music and literature. This introductory course, based on primary documents, secondary readings, film and music, will help you to understand the distinctive culture of this great nation. Prerequisite: 82-291 or approved equivalent.

Fall: 9 units
82-294 Topics in Russian Language and Culture
Content varies with each offering.

Fall: 9 units
82-296 A Century of Russian Film
This course surveys the dominant works, directors and genres that have defined Russian filmmaking from its birth to the present day. Films are screened during required evening class meetings. Film and assigned readings in film theory and criticism are discussed during additional required class meetings.

Fall and Spring: 3, 6 units
82-299 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" mindsets 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 photography, its digitally aided production, 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 of 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.

Fall: 9 units
82-301 French for Reading Knowledge
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 that will require considerable 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 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.

Fall and Spring: 9 units
82-303 French Culture
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. Prerequisite: Completion of the intermediate level or the equivalent. Prerequisites: 82202 or 82204

Fall and Spring: 9 units
82-304 The Francophone World
This course introduces the student of French to several of the francophone regional cultures outside of France, including North and West Africa, Belgium, Quebec, 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. Prerequisites: 82-303 or permission of the instructor. Prerequisites: 82202 or 82204

Fall: 9 units
82-305 French in its Social Contexts
This course will focus on culture through language variation in spoken and written forms of French. Readings, videos, web use, and in-class conversations expose us to the Francophone world. This introductory course, based on primary documents, secondary readings, film and music, will help you to understand the distinctive culture of this great nation. Prerequisite: 82-291 or approved equivalent.

82-306 Intensive French Language and Culture: Advanced
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. Prerequisite: 82-222 or approved equivalent. Prerequisites: 82222 or 82323 or 82325

82-324 Contemporary Germany, Austria and Switzerland
Spring: 9 units
This course advances proficiency in communicative and grammatical skills in the German language and knowledge of German-speaking cultures through the study of important events, trends, and people of 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. Prerequisite: 82-222 or approved equivalent. Prerequisites: 82222 or 82323 or 82325

82-325 Introduction to German Studies
Fall: 9 units
The Italian literary theorist Franco Moretti has written that "German 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 speak, read, write, and listen to 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 last 250 years 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 read, write, and listen to German. Prerequisite: 82-222 or approved equivalent. Prerequisites: 82222 or 82323 or 82324

82-326 Intensive German Language and Culture: Advanced Level
Intermittent: 6-24 units
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.

82-331 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 to further develop students' language ability to speak, read, write, and listen to Chinese. Emphasis will be given to helping students develop the accuracy and fluency needed for meaningful conversation in a variety of cultural and social situations. Classroom discussions will be an important part of the course followed by the practice of writing of essays on topics related to various social issues in China. Prerequisite: 82-232, 82-235 or approved equivalent. Prerequisites: 82232 or 82235

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. Students will also read and analyze short articles of 300-500 Chinese characters on various topics discussed in class. Prerequisite: 82-331 or approved equivalent. Prerequisites: 82331

82-333 Introduction to Chinese Language and Culture
Fall: 9.12 units
This course will introduce the students to the Chinese language and culture from a historical as well as contemporary point of view. It is intended to help students develop awareness of and sensitivity to Chinese culture and society and to gain a better understanding of Chinese ways of thinking. Students will be exposed to different aspects of Chinese culture and their relationship with the language. Class activities will include lectures by the Instructor and guest speakers, seminars, movies, videos and other multimedia materials. Hands-on experience will also be a part of the course. This course is conducted in English with no knowledge of Chinese language required. Those who take this course toward Chinese Minors will be assigned extra work in Chinese to fulfill the requirement for the extra 3 units. Prerequisite: 82-232 or 82-235 or approved equivalent for students seeking credit toward the Chinese minor. No prerequisites for non-minors. Prerequisites: 82232 or 82235

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 is also required to students who aim to further improve their speaking in Chinese. Emphasis 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: 82-232, 82-235 or approved equivalent. Prerequisites: 82232 or 82235

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 main goal is to train students the ability to read 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, comprehension and self-expression in contemporary Chinese to fulfill the requirement for the extra 3 units. No prerequisites for non-minors. Prerequisites: 82232 or 82235

82-336 Intensive Chinese Language and Culture: Advanced Level
All Semesters: Variable units
Transfer credit for study abroad in China, a Chinese-speaking country, or other approved program at the Advanced level. Credit determined after consultation with the transfer credit advisor for Chinese. Prerequisite: 82-232 or approved equivalent for students seeking credit toward the Chinese minor. No prerequisites for non-minors.

82-337 Chinese for Oral Communication I
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 develop their speaking skills in Chinese. Emphasis will be given to helping students develop the accuracy and fluency which characterize the speech of native Mandarin speakers. Students will also be introduced to the historical and sociopolitical system of Mandarin Chinese, and work to refine and perfect their speaking skills through special attention to different styles, colloquialisms, and modal variations. 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: 82-232, 82-235 or approved equivalent.

82-338 Chinese for Oral Communication II 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 of the students. Students will practice various conversational tasks, such as giving presentations, participating in discussions and debates, and individualized research. 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 movies, music, and other debatable and interesting issues. Prerequisite: Intermediate level in reading and writing Chinese. Permission of the Instructor. Prerequisites: 82232

82-341 Advanced Spanish Transfer Credit All Semesters: Variable units
This course is designed to take students to advanced courses in Grammar, Composition, Conversation, or other appropriate advanced coursework taken as part of a study abroad program or at another institution. Prerequisites: Completion of the intermediate level, prior permission of the Hispanic Studies major or minor advisor and confirmation of credit upon return. Prerequisites: 82242

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 effectively, and the development of a critical stance to the study of Spanish and Spanish culture. 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: 82242 or 82244

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. 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 effectively, and the development of a critical stance to the study of Spanish and Spanish culture. 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: 82242 or 82244

82-344 U.S. Latinos: 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. A course that would analyze the history of the Hispanic presence in what is today known as the United States, since the period of the Spanish exploration and colonization of North America to the present. We will be examining the writing of native, immigrant and exile Hispanics in the context of the geographical, political and societal borders that exist between U.S. mainstream society (black and white) and other sectors of society. Prerequisite: Completion of the intermediate level or equivalent or permission of the instructor. Prerequisites: 82242 or 82244

82-345 Hispanic Literary and Cultural Studies Intermittent: 9 units
Please visit the Modern Language Office in Baker Hall 160 for the semester specific description of this course. This course is a thematic introduction to the cultural production of the transatlantic, Hispanic world (Spain and the two Americas) through texts, film, music, and other arts. Among the themes that might be considered in the course are: the social, political, and economic forces that have shaped the histories and cultures of the Hispanic world, the forces of Diaspora in the Americas, immigration and exile, the role of race, religion or gender in Hispanic societies, and the role of language and discourse in the Hispanic world. Materials might include but not be limited to poetry, plays, narratives, films, slides, digital images, and recordings. Assignments may include reading, research, writing, single and group presentations, quizzes and exams. This course will prepare specialists and non-specialists in Spanish for advanced study at the 400-level and beyond. Prerequisite: Completion of two 300-level Hispanic Studies courses or permission of the instructor. Prerequisites: 82342 and 82343

82-346 Intensive Spanish Language and Culture: Advanced Level Intermittent: 18,24 units
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 communication, we will begin to 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.

82-371 Advanced Japanese I Fall: 9 units
A two-semester course sequence (82-371, 82-372) for advanced-level students. This course emphasizes the acquisition of effective use of oral and written Japanese through readings, interviews with native speakers, class discussions, oral presentations, and writing assignments. Students should be able to advance not only their Japanese language skills but also their understanding of contemporary Japan. Prerequisite: 82-271/82-272 or approved equivalent. Prerequisites: 82272

82-372 Advanced Japanese II Spring: 9 units
A sequel to Advanced Japanese I (82-371). This course continues to further improve communicative competence in oral and written Japanese for advanced-level students. Through readings, interviews with native speakers, class discussions, oral presentations, and writing assignments, students should be able to advance not only their Japanese language skills but also their understanding of contemporary Japan. Prerequisite: 82-371 or approved equivalent. Prerequisites: 82371

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 the English and aids students in understanding and in assimilating the 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 aspects 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 students' understanding of the grammar points in question and developing their analytical skills. This course is taught in
Japanese. Prerequisite: 82-272 or Permission of the instructor.
Prerequisites: Corequisites: 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 language and concepts in electrical engineering, computer science and computer engineering. In addition, it will enable students to acquire knowledge of some key vocabulary used in the context of 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. 82-272, or permission of the instructor.
Prerequisites: 822771 or 822772

82-376 Intensive Japanese Language and Culture: Advanced Level
Intermittent: Variable units
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.

82-380 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 Introduction to Second Language Acquisition
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 will be examined from four perspectives: 1) linguistic knowledge, 2) as a cognitive skill, 3) as a personality-mediated process, and 4) as a socially mediated process. Factors examined include: cognitive 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 vs. informal 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. Prerequisite: None however 82-280 "Learning about Language Learning" is strongly recommended.

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 diverse role of language such 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 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; sociolinguistic variables in the ethnographic context; 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: 3-12 units
Language credit may be attached to any course, independent study, or project for which a student is studying for a core major or minor, or a student speaks or learns a language as part of an 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 throughout 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 a film festival 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 theoretical perspectives relate to perceptions of L2 fluency. 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.

82-389 Independent Study in Language and Culture-Advanced Level
Fall and Spring: 3-12 units
An opportunity for students who wish to complement their course work at the Advanced Level (in 300-level courses) and pursue further study at this level. 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.

82-391 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 in the Language Learning Resource Center, additional to three class hours per week, is mandatory for the evolution of aural/oral fluency. Written compositions and tutorial homework, assigned and evaluated in Russian, contribute to the development of grammatical accuracy and stylistic appropriateness. All class discussions are conducted in Russian. Prerequisite: 82-292 or approved equivalent. Prerequisites: 82292

82-392 Advanced Russian II
Intermittent: 9 units
The second part of a two-semester course sequence (82Prerequisite: 82-391 or approved equivalent. Prerequisites: 82291

82-396 The Faust Legend at Home and Abroad
Intermittent: 9,12 units
This course introduces students to the basic outlines of the Faust story, and examines its nineteenth- and twentieth-century manifestations in the novels, plays, operas and of Great Britain, Germany, France, Hungary, the Czech Republic, Russia and the United States. 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 extent does it speak? How does it contribute to the reemergence of the legend, this course aims to 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 extent does it speak? How does it contribute to the reemergence of 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 extent does it speak? How does it contribute to the reemergence of 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 extent does it speak? How does it contribute to the reemergence of the
82-397 Russia's Demons
Intermittent: 9-12 units
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 does their power been for creating conditions of their own? This course aims to find out by peering into the netherworlds of European and American authors. Works studied include plays, poems, and writings about avant-garde theater. 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. Three units of additional credit are available for students who wish to do some additional work in French. Total enrollment limited to 25.

82-408 Matisse, Chagall, Picasso & Their Contemporaries: Art & Museums on the Riviera
Intermittent: 9-12 units
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.

Prerequisites: None
*Students of French who want course credit toward the major or minor in French will register for an extra 3 units of coursework in French. In this case, prerequisites are completion of 82-303 or 83-304, or approval of the instructor.

82-422 German Literature of the Early Twentieth Century
Intermittent: 9 units
From its inception in 1871, 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, fell upon the German nation, artists and writers found themselves often the victims of his policies. This course will explore the various ways in which German artists and writers coped with this era, both through artistic production and political activism. The course will focus on those who were primarily involved in the Arts, in particular the theatre and the theatre arts, and will also consider the role of music and the culture of the public sphere in this period.
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: Completion of 82-325 or approved equivalent. Prerequisites: 82325

82-424 The New Germany Intermittent: 9 units This course explores contemporary culture in German speaking Central Europe. Prerequisites: Completion of 82-325 or approved equivalent.

82-425 Topics in German Literature and Culture Intermittent: 9 units Fall 2006 Course title: One plus one equals one? The Road to a Re-united Germany. The course will provide an in-depth study of the BRD and the GDR, from their founding in 1949 until the present day, with particular focus on the "Wende" or turning point periods, and the wars and sorrows of Germany's "fission" versus its "separation". Using literary texts, newspapers, magazines, and other sources in German, students will be required to research topics in papers, short stories, and for class discussion. Taught entirely in German. Prerequisite: 82-325 or permission of major/minor advisor in German. Prerequisites: 82325

82-426 Studies in German Literature Intermittent: 9 units A series of innovative courses exploring German literature and culture through a thematic or conceptual focus. Prerequisite: Completion of 82-325 or approved equivalent. Prerequisites: 82323 or 82324 or 82325

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 arts' response of the German and foreign." Often called "anti-Nazi" or "anti-titansy. Arts explored will include literature, film, music, and the visual arts. We will read from the works of a variety of writers, including Ödön Horvath, Oda 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 The Sisters. Grete Janson'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: Completion of 82-325 or approved equivalent. Prerequisites: 82325

82-428 History of German Film Intermittent: 9 units Throughout the twenty century, the German cinema has consistently been one of the most productive and creative national cinemas in the world. During the first three decades of the twentieth century, some of the great classics of silent cinema were produced in Germany. Many of these films were highly influential throughout the world, particularly in the United States, where some of the great German directors and film stars set in the late 1920s and 1930s, frequently for political reasons. In the late 1960s and 1970s, German directors developed a unique film style based on an attempt to recall the German past and on a critique of Hollywood's domination of the world entertainment industry. The history of German cinema closely reflects the history of the German nation in the twentieth century. This course, taught in German, will cover this entire history, from 1895 to the present, with a particular emphasis on the Weimar period (1919-1933) and the renaissance of "New German Cinema" in the 1970s. Also considered will be the cinema of the Second and Third Empires, the cinema of the German Democratic Republic, and the resurgence of German comedy in the 1990s. Directors studied include Friedrich Murnau, Fritz Lang, Leni Riefenstahl, Rainer Werner Fassbinder, and Wim Wenders. Prerequisite: Completion of 82-325 or approved equivalent. Prerequisites: 82324

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 modern 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 prepared them to function in various ways in the real situation of China in the future. Prerequisite: 82-332 or approved equivalent. Prerequisites: 82332

82-434 Studies in Chinese Traditions Spring: 9 units This course is designed for students who have reached the advanced level of Chinese. It aims to introduce to the students Chinese culture and traditions through the study of the different streams of Chinese culture: ancient classical Chinese, including excerpts from famous novels, essays and classical poems. Students will not only learn the difference between spoken and written styles of Chinese and between modern and classical Chinese but also understand more deeply the history of Chinese traditions and civilization. With this knowledge, combined with their ability to use different styles of Chinese language, students will be prepared to function in a generally effective way in the real situations of China in the future. Prerequisite: 82-332 or approved equivalent. Prerequisites: 82332

82-435 Advanced Reading in Chinese Intermittent: 9 units Prerequisites: 82324

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 undergraduates read and understand sophisticated modern Chinese texts, which make frequent use of Classical allusions and constructs. Prerequisite: 82-332 or approved equivalent. Prerequisites: 82332

82-441 Studies in Peninsular Literature and Culture Intermittent: 9 units Please visit the Modern Language Office in Baker Hall 160 for the semester specific description of this course. A sociocritical approach to the study of Spanish literature. A survey of representative authors considered in the context of the cultural heritage of Spain. Prerequisite: Completion of 82-345 or permission of the instructor. Prerequisites: 82345

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, syntax, and discourse. Students will have the opportunity to write and present a research paper in specific areas of Spanish linguistics according to their interests. Prerequisite: Completion of 82-345, or permission of the instructor. Prerequisites: 80280 or 82343

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 (majors and 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: 82342 or 82343 or 82344 or 82345

82-444 The Structure of Spanish

Intermittent: 9 units

This course intends to assess the processes that contribute towards the unification and fragmentation of Spanish as a single language. Some of the 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 ability to express in academic Spanish through class discussions, presentations and by producing a final research paper. Prerequisites: Completion of 82-345 or permission of the instructor.

Prerequisites: 82342 or 82343 or 82344 or 82345 or 82346

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, transnationalism, bilingualism theory, and rhetorical/translation problems of the material under examination. Also of interest will be an ongoing group 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 the U.S.-originated lifestyle employed by Hispanic-Americans for overcoming, subverting or undermining this situation. Material for the course will include literature, film, essays and music by and about Latinos/Hispanics in the United States. Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisites: 82345

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 de la Barca, 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 assignments will be in Spanish. Prerequisite: Completion of 82-345 or permission of the instructor.

82-450 Advanced Research in Hispanic Language and Culture

Fall and Spring: 9 units

This course offers students the opportunity to conduct in-depth, 400-level study in the following courses: 82-342 Spain: Language and Culture, 82-343 Latin America: Languages and Culture, 82-344 U.S. Latinos: Language and Culture, and 82-345 Introduction to Hispanic Literary and Cultural Studies. Students will meet with the regularly scheduled class to work on additional texts, and produce research assignments as agreed upon by the Instructor and student. Focus is on a deeper understanding of the specialized research of the course topics. Prerequisite: By permission of the instructor only.

82-451 Studies in Latin American Literature and Culture

Intermittent: 9 units

This course is an overview of contemporary Latin American literature and a survey of representative authors considered in the context of the cultural heritage of Latin America. Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisites: 82345

82-452 The Latin American Fin de Siglo: Modernity, Modernismo, and Underdevelopment

Intermittent: 9 units

In this course, we shall use print media, film, music, dance, fashion, diet, art and architecture to study the anthropological and cultural ramifications of politico-economic and socio-cultural events surrounding the turn-of-the-century eras (1880-1920 and 1980 to the present) in Latin America and relate them to the current fin de siglo and millennium. We shall analyze the effects of the increasingly globalized nature of the world economy in order to understand the effects of U.S. and European influence and investment in Latin America and how these two world powers have shaped its cultural production in the early and late 20th century. Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisites: 82301 or 82303 or 82304 or 82324 or 82326 or 82331 or 82332 or 82342 or 82343 or 82344 or 82345 or 82346 or 82372 or 82385 or 82386 or 82392 or 82399

82-453 Voices from Within: The Crisis of Latin American Identity

Intermittent: 9 units

An introduction to the complex fabric of Andean, Southern Cone, Mexico, and Caribbean identities. The course will conduct readings and field projects. Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisites: 82345

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 music. 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 shaping 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: Completion of 82-345 or permission of the instructor.

Prerequisites: 82345

82-455 Topics in Hispanic Studies

Fall: 9 units

Please visit the Modern Language Office in Baker Hall 160 for the semester specific description of this course. A series of inquiries into an aspect of Hispanic literature, such as a literary movement, a genre, a theme or the work of a single author (e.g., Knights, Rogues, Saints/Caballeros, Pícaros, Santos; Latin American Short Story and Essay: Literary Mediations; Portrayals of Family Life in Twentieth-Century Spain; The Other in Latin American Literature and Film). Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisites: 82345

82-456 Topics in Hispanic Studies

Spring: 9 units

Please visit the Modern Language Office in Baker Hall 160 for the semester specific description of this course. A series of inquiries into an aspect of Hispanic literature, such as a literary movement, a genre, a theme or the work of a single author (e.g., Knights, Rogues, Saints/Caballeros, Pícaros, Santos; Latin American Short Story and Essay: Literary Mediations; Portrayals of Family Life in Twentieth-Century Spain; The Other in Latin American Literature and Film). Prerequisite: Completion of 82-345 or permission of the instructor.

Prerequisites: 82345

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, and music. We shall 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 'literatized' 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: Completion of 82-345 or permission of the instructor.
82-474 Topics in Japanese Studies II: Samurai, Kamikaze, Totoro
Intermittent: 9 units
Over the past century, Japanese cultural icons have changed substantially -- from loyal Samurai warriors to stoic Kamikaze pilots and cuddly anime characters. This course examines what such icons represent in the Japanese mind, as well as how they have been used by forward-looking film directors in making their audiences aware of the emerging social changes and the altering values associated with the changing society. By analyzing eight high-influential films in their respective social and historical contexts, students are expected to reconstruct the social messages conveyed by the directors through these icons. Prerequisite: 82-372, or permission of the instructor. Prerequisites: 82471 or 82472 or 82473

82-476 Japanese Discourse Analysis
Fall: 9 units
Through practical language activities, interviews, and field projects, students will acquire Japanese 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. Prerequisites: 82273 and 82372

82-477 Japanese Conversation Analysis
Spring: 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 asformal 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 speakers' perspectives and attitudes. This course is offered in Japanese. Prerequisite: 82-372 or equivalent. Prerequisites: 82372

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 communities and individuals. This class will develop their knowledge and analytical skills of bilingualism through the 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: Variable 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.

82-484 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 procedures and evaluation of 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: 3,6,9 units

82-486 Independent Study in Languages

Intermittent: 9-18 units
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 theoretical perspectives, 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. Prerequisites: 82-382 or permission of the Instructor.

82-489 Service Learning in the Community
Intermittent: 9-18 units
This is a community-based research (CBR) course for 400-level students of Modern Languages who wish to bridge service and student research. The course provides an experiential component for advanced students of Modern Languages. Such a component will allow ML students to use their second language and culture 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 create work for which to 'give back' to the community under the guidance of assignments that will be chosen based upon the language, culture and/or history of a specific community. Some examples of this would be: document a community's history or culture, establish an ongoing link between the university and the community, or identify and solve a community problem. Using both English and their target language, students in this course may participate in historical, ethnographic, and cultural research, ethnographic fieldwork, and problem solving around the question of how best to identify a particular linguistic/cultural community and document, interpret, preserve and disseminate its history and culture. Class activities may include group, pair and independent reading and research; group and pair travel; group, pair and one-on-one interaction with community members; public presentations; photography/filming/scanning; webpage and document design; and different kinds of writing in both English and the target language. Prerequisites: 82-345 or permission of the instructor.

82-491 Literature, Politics and Film in Russia & East Europe Today
Intermittent: 9,12 units
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 cultures since the Renaissance. From the rise 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 discourse of cultural analysis produced by both public commentators and those which formulate them. 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 characterize 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: 9,12 units
Pushkin, Gogol, Lermontov, Turgeniev, Ostrovsky 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 break from Russia's past a vision of her future. Emphasis is placed upon the figurative and narrative layers of language that allow to narrative to function as a guidepost to a collective mission and a map of the individual's location within the projected hierarchical scheme. Important literary and artistic discourses and practices are combined at each class meeting. Written papers, oral presentations, and participation in discussions are required, as are reading assignments of approximately 200 pages per week. The course is offered in English, three hours per week, for 9 units, for which there are no prerequisites. An additional 3 units are awarded for work conducted in Russian during one addition hourly meeting per week, for which 82-292 or permission of the Instructor.
Prerequisites: None. Prerequisites: 82292

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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 literary values 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 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 and fragments by 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. Restricted to language majors who wish to go beyond the regular offerings 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: 3, 6 units
This course provides an 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 intersecting 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 non-academic skills and 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: 3-12 units
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: 3-12 units
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: 1-18 units
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.

82-521 Special Topics: German
Fall: 3-12 units
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: 3-12 units
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. Prerequisites: 82427 or 82428 or 82429 or 82430 or 82431 or 82435 or 82436 or 82437 or 82438

82-541 Special Topics: Spanish
Fall: 3-12 units
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: Spanish
Spring: 3-12 units
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: 9,12 units
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: Variable units
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: 3-12 units
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 Japan 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. Prerequisite: Permission of the Instructor.

82-572 Special Topics: Japanese
Spring: 3-12 units
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 Japan 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. Prerequisite: 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 learning experiences 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.

82-591 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 topic. 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 topic. 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: 3-6 units
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.
Music

57-090 Basic Theory Skills
Fall: Mini Session - 0 units
This course prepares students with little or no theory background to succeed in the sequence of harmony and counterpoint classes (course numbers 151-154). Topics include clefs, scales of all types, intervals, simple chord types, basic notation and terminology, and fundamental concepts of analysis.

57-092 Basic Solfege Skills
Fall: 0 units
This course improves the student’s ability to analyze music aurally and to sing at sight music in traditional meters, major and minor keys, written in treble and bass clefs, and to notate rhythmic and melodic patterns. The “fixed do” system is used. The course begins at a basic level and is designed as a noncredit class to prepare the student for successful participation in future Solfege courses.

57-093 Basic Solfege Skills
Spring: 0 units
Continues 57-092 Basic Solfege Skills.
Prerequisites: 57092

57-101 Introduction to Music Technology
Fall and Spring: Mini Session - 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.

57-111 Dance I
Fall: 3 units
This course is designed for voice majors. Jazz is a dance technique unique to the United States. The warm-up activities prepare the body for the specific demands of jazz movement. The music, while basically jazz, may range from gospel to punk rock. Levels one and two consist of intensive body stretching, body awareness, body discipline, and understanding the use of technique and conditioning.

57-112 Dance II
Spring: 3 units
Continues 57-111 Dance I.
Prerequisites: 57111

57-151 Principles 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: 57152 or 57155

57-152 Harmony I
Fall: 6 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: 6 units
This course is a continuation of the study of common practice harmony, exploring dissonant and chromatic harmony.
Prerequisites: 57152 or 57155

57-154 18th Century Counterpoint
Spring: 6 units
This course deals with all phases of two-part tonal writing and culminates in the study of the Bach Two-Part Inventions. The course serves to combine everything the student has learned about counterpoint and harmony.

57-164 Eurhythmics IV
Fall: 3 units
Continues 57-163 Eurhythmics III. Eurhythmics IV focuses on changing metric units within a composition, polymeter, and asymmetric rhythmic augmentation and diminution based on Messiaen techniques.
Prerequisites: 57163

57-173 Survey of Western Music History
Fall: 9 units
This course surveys the origins, history, and development of the art music of European civilization from the time of Pope Gregory I to the present. The course is organized around certain recurrent themes, such as the chronic conflict between words and music, classicism and romanticism, and randomness and predictability. Reading assignments and listening to music are equally important for class sessions, but reading and thinking ability are emphasized on tests and exams.

57-181 Solfege I
Fall: 3 units
This course improves the student’s ability to analyze music aurally and to sing at sight music 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: 57181

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: 57182

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: 57183

57-185 Advanced Solfege I
Fall: 3 units
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: 57185

57-189 Repertoire and Listening for Musicians I
Fall: 1-3 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
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. Proficiency requirement for freshman music majors. Other students admitted with instructor's permission. Repertoire and Listening for Musicians I is not a prerequisite.

57-191 Keyboard Studies I
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.

57-192 Keyboard Studies II
Fall and Spring: 3 units
Continues 57-191 Keyboard Studies I. Prerequisites: 57191

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 improvisation on 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: 57193

57-202 Opera History
Spring: 9 units
This course surveys the origins, history, and development of opera from the time of the Florentine Camerata to the present. The course is organized around the changing relationships between music and drama from the 16th to the 20th Century, using the stage representation of certain standard operatic character types over the past four hundred years as a point of departure. Reading assignments and listening to music are equally important for class sessions.

57-203 Medieval, Renaissance, and Baroque Music History
Spring: 9 units
This course is organized around developments in music, which resulted in the "classical style," from Gregorian chant to the Rococo idiom of the 18th Century. Major emphases of the course are the persistent conflict of words versus notes, the relation of the artist to the rest of society, and music as a mirror of changing world-views across the centuries. Reading assignments and listening to music are equally important for class sessions.

57-204 18th and 19th Century Music History
Fall: 9 units
This course deals with the flowering and subsequent elaboration of the great quasi-Newtonian musical system known as "functional harmony," "tonality," "common practice," or simply the "classical style." From Joseph Haydn to Richard Wagner, the course examines the increasing importance of literary factors versus musical structure per se. Reading assignments and listening to music are equally important for class sessions. Prerequisites: 57173

57-205 20th Century Music History
Spring: 9 units
An exploration of 20th Century music arranged by category into three broad groups: concert music, popular music, and world music. In our present era of musical pluralism and technology, styles are exchanged and combined so freely that we owe it to our cultural continuity to look at as many kinds of music as time will permit. Aspects to be discussed are the role of 20th Century music in society, its reception by audiences, its relation to other arts and to political and economic factors, and its theory and pedagogy.

57-207 Secondary Studio
Fall: 3-12 units
Provides the opportunity for students to pursue study in a secondary instrument or area. By special permission only.

57-208 Secondary Studio
Spring: 3-12 units
Provides the opportunity for students to pursue study in a secondary instrument or area. By special permission only.

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? How did different cultures and countries receive their music? What sorts of political ramifications did their music's reception have? Where do their public images and personal lives fit in? 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. No prerequisites required. Open to all undergraduate students.

57-211 Dance III
Fall: 3 units
Continues 57-112 Dance II. Levels three and four emphasize technique. Prerequisites: 57112

57-212 Dance IV
Spring: 3 units
Continues 57-211 Dance III. Prerequisites: 57211

57-213 Dance (Tap) I
Fall: Mini Session - 3 units

57-214 Dance (Tap) II
Spring: 3 units
Prerequisites: 57213

57-215 Dance (Tap) III
Fall: 3 units
Prerequisites: 57214

57-216 Dance (Tap) IV
Spring: 3 units
Prerequisites: 57215

57-217 Dance (Tap) V
Fall: 3 units
Prerequisites: 57216

57-218 Dance (Tap) VI
Spring: 3 units
Prerequisites: 57215

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
Spring: 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
Spring: 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
Spring: 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.

57-225 Contemporary Ensemble
Fall and Spring: 3 units
This ensemble performs the wide range of expressive media that composers have developed in our time. Programs include three categories of works: 1) compositions that can be called Twentieth Century classics because of the historical importance and the aesthetic influence they have had on our musical culture; 2) compositions written by student composers; and 3) compositions written by well-known composers that show new and original artistic points of view. The repertoire ranges from works for chamber ensemble to concert and chamber opera.

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. Both ensembles perform four to six times a year as part of the School of Music's regular concert series, as well as at University and off-campus events. The music for both bands is drawn from all eras of Big Band repertoire with occasional projects in a specific genre. The Jazz Ensembles are carefully coordinated with the Jazz Performance Minor program, the Jazz Vocal Ensemble, and the other major ensembles in order to challenge and prepare students for professional music careers. Admission to both jazz ensembles is by competitive audition and placement is determined by the director. Grading is based on attendance, preparation, and consistent progress.

57-228 Chamber Music
Fall and Spring: 3 units
Through rehearsal, coaching, and performance, ensembles solve problems of intonation, balance, and interpretation. A jury exam is required.

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. A jury exam is required.

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.

57-240 Acting I
Fall: 6 units
The basics of acting will be established throughout the first year following the guidelines described in Audition, by Michael Shurtleff. 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 students to begin to work together as a cast.

57-241 Acting II
Spring: 6 units
Continues 57-240 Acting I. Prerequisites: 57240

57-253 Renaissance Counterpoint
Fall: 6 units
In this course, the student will study how to write vocal counterpoint using the classic "species" approach, based on the style of Renaissance masters Palestrina, Lassus, and Victoria. The latter part of the course will extend the study to instrumental music of the 16th century and explore the development of chromaticism in the avant-garde composers of the time. Daily writing exercises in the first part of the course will lead to a term project producing a performance piece of music. This course is designed for composers, theory minors, early music lovers, and anyone who wants to seriously sharpen their tonal writing skills.
Prerequisites: 57252 or 57155

57-254 Counterpoint in 18th Century Composition
Fall: 6 units
In this course the student will study how to write two-part counterpoint within the harmonic framework of 18th-century instrumental music. The focus of study will be J.S. Bach's inventions, and writing will be directed towards composing several complete inventions in that style. The integration of tonal writing skills in harmony and counterpoint will prepare the student for Fugue (57-265). This course is designed for composers, theory minors, Bach lovers, and anyone who wants to seriously sharpen their tonal writing skills.
Prerequisites: 57153 or 57156

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: 57152 or 57155

57-258 20th Century Techniques
Spring: 6 units
This course is open to all major 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: 57153 or 57156

57-265 Fugue
Spring: 6 units
The course is designed to help the students in two directions: the analysis of works written as fugues - or with that concept in mind (Fugato) - and the composition of fugues. From the very beginning, it intends to show the difference between Fugue as a form - in particular, a Baroque form - and Fugue as a concept - used as such in many distinctive musical languages (Bach, Mozart, Beethoven, Liszt, Bartok, Ives, and Lutoslawski). The course is useful both for performers, providing them the analytical tools needed to understand this kind of work, and for composers, allowing them to use the concept of Fugue within the framework of their own creative needs. By the end of the semester, each student writes a fugue for string quartet.
Prerequisites: 57408

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: 57257

57-272 Orchestration III
Spring: 6 units
Continues 57-271 Orchestration II and combines orchestration and composition.
Prerequisites: 57271

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 style?" and "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: 57273

57-275 Piano Pedagogy III
Fall: 6 units
Continuation of 57-274. Intermediate literature, analysis, teaching, and performance will be covered.
Prerequisites: 57274

57-276 Piano Pedagogy IV
Spring: 6 units
Continuation of 57-275. Early advanced literature, analysis, teaching, and performance will be covered.
Prerequisites: 57275

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 fugues of Bach and continue through the early works of Beethoven. We will then analyze the genres/forms of the Middle Ages and Renaissance and work our way back through the birth of
Opera and the Baroque era.  
Prerequisites: 57173  Corequisites: 57-289

57-289  Repertoire and Listening for Musicians III  
Spring: 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 experiences. The 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.

57-291  Keyboard Studies III  
Fall and Spring: 3 units  
Prerequisites: 57192

57-292  Keyboard Studies IV  
Fall and Spring: 3 units  
Prerequisites: 57291

57-293  Keyboard Studies Test (Degree)  
Fall and Spring: 0 units

57-300  Pipe 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. Pipers receive a half hour individual lesson with Alasdair Gillies weekly. Drummers are taught weekly by Larry Allen.

57-301  Bagpipe Composers  
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: 57307

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 Redmaking  
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 and tying up. This course follows 57-304, Bagpipe Maintenance. Further analysis of chanter and drone reeds will be covered also.  
Prerequisites: 57304

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.

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.

57-309  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.

57-310  Jazz Chamber Music  
Fall and Spring: 3 units  
Continues 57-212 Dance IV. Level five and six stress full body control and dance combinations varying in style, and the art of auditioning is also explored.  
Prerequisites: 57212

57-311  Dance V  
Fall: 3 units  
Continues 57-212 Dance IV. Level five and six stress full body control and dance combinations varying in style, and the art of auditioning is also explored.  
Prerequisites: 57212

57-316  Dance VI  
Spring: 3 units  
Continues 57-315 Dance V.  
Prerequisites: 57315

57-328  Jazz Chamber Music  
Fall and Spring: 3 units  
This course simulates an all-nighter as closely as possible a "session" atmosphere. Each class consists of a five to six song set. Players must be able to read chord changes and basic jazz melodies on sight.  
Prerequisites: 57450

57-331  Principles of Education  
Fall: 9 units  
This course introduces the student to basic issues in education. Content includes views of the academic and social structure of the school and the review and application of widely recognized theories of learning. Special emphasis is placed on the study of pedagogy as a series of options from which the educator constructs learning activities.  
Prerequisites: Corequisites: 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 familiarizes students with basic techniques of arranging for high school choral and instrumental ensembles. Individual instruments and voices are reviewed for their best scoring properties, and a systematic process of score analysis is used to reveal approaches to scoring both traditional and unusual sounds.  
Prerequisites: 57153

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 Kilte Band will be part of the course content.

57-335 Analysis Seminar Intermittent: 6 units
This course is an analytical survey of the music of the 18th, 19th, and 20th Centuries with an emphasis on the music of the 20th Century. Beginning with a demonstration of various analytic techniques, compositions of Beethoven, Strauss, Debussy, Takemitsu, Bartók, Schoenberg, Webern, and Berg will be analyzed and discussed. Participating students should have good knowledge about voice leading and harmonic progression. The course is open to composers, conductors, and performers.
Prerequisites: 57154

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 workshop that focuses on cold readings as well as monologues, 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 down levels. If 'recording' seems like an energy-intensive activity--involving engineers, musicians, producers--"editing and mastering" are the necessary afterhours-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: 57332

57-337 Sound Recording Fall and Spring: Mini Session - 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 the 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 rooms that can accommodate up to 24 people, other gear, and an interesting array of microphones. All recording is direct to hard disk.
Prerequisites: 57337

57-338 Sound Editing and Mastering Fall and Spring: Mini Session - 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 down levels. If 'recording' seems like an energy-intensive activity--involving engineers, musicians, producers--"editing and mastering" are the necessary afterhours-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: 57332

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 will be involved in the development of characters based on research and collaboration. The state of the art recording studio in the School of Music will assist the professor in delivering 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.
Prerequisites: 57101

57-340 Acting IV Spring: 6 units
Continues 57-339 Acting III.
Prerequisites: 57339

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: 57101

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.
Prerequisites: 57101

57-350 Dalcroze Piano Improvisation Fall and Spring: 3-6 units
These courses are required for candidates in the Dalcroze Certification program. They provide the keyboard skills necessary for the teaching of Eurhythmics.
Prerequisites: 57350

57-351 Dalcroze Piano Improvisation Fall and Spring: 3-6 units
Continues 57-350 Dalcroze Piano Improvisation.
Prerequisites: 57351

57-352 Dalcroze Piano Improvisation Fall and Spring: 3-6 units
Continues 57-351 Dalcroze Piano Improvisation.
Prerequisites: 57352

57-355 Secondary Guided Teaching Spring: 3 units
This course develops understanding and application of appropriate and accurate instruction strategies in the secondary school. The student will spend a portion of the course in an assigned public or private secondary school teaching internship. This course is to be taken concurrently with 57-376. It is the last of three field observation experiences required by the Commonwealth of Pennsylvania for certification.
Prerequisites: 57332 and 57336 and 57356 and 57360 and 57361 and 57362 and 57363 and 57375 and 57607
Corequisites: 57-376

57-356 Elementary Guided Teaching Fall: 3 units
The second level of field experience in the public schools, to be taken concurrently with 57-375. This course provides for observation and closely supervised teaching experiences with elementary age children in a school setting.
Corequisites: 57-375

57-357 Radio Play Intermittent: Mini Session - 6 units
In this seven-week course, students learn to use a state of the art recording studio in the production of experimental and traditional radio plays. We will explore the power of sound (voice, music, noise) to communicate, provoke, frighten, suggest, amuse, entertain, inform, and inspire. For inspiration we will listen to historical recordings from the days of classic radio, as well as more contemporary productions by artists from diverse backgrounds. Students will have the opportunity to participate in all roles of production: idea generation, writing, performance, sound design, production, and post-production.

57-358 Career Strategies for Musicians I Spring: Mini Session - 3 units
This first-half mini course is the first of a two-part course designed to help students plan for a career in music. Part I, offered for spring-semester juniors, will provide students with an overview of post-graduation options: graduate school, fellowships, full-time positions, freelancing, and teaching. Students will learn how to plan for and pursue these options and will develop the skills needed for this level of planning and career development. Students will also learn about a variety of resources that will help them more successfully navigate a career in music. Finally, throughout this mini-course, students will begin to build or refine their professional materials including: resume, bio, headshot, presentation skills, and recording.
Prerequisites: 57101

57-359 Career Strategies for Musicians II Spring: Mini Session - 3 units
This second-half mini course (designed for seniors) will help students continue planning for life after undergraduate music studies. Topics covered include: musician as entrepreneur, contracts, unions, health insurance and otherwise compensating for not getting benefits from a full-time employer. This course will also continue the exploration of options including: teaching, freelancing, and other career possibilities. Students will create a conventional resume, learn how to write a cover letter and learn how to understand and prepare for job interviews. Students will also prepare or refine other professional materials including artistic resume and bio. Part I is not a prerequisite for this course.

57-360  Brass Methods
Fall: 3 units
This music education course develops basic brass playing and teaching techniques. Special emphasis is placed on instructional techniques appropriate to elementary and middle school instrumental classes, aural and visual diagnosis of 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 components of the 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, timbales, and all small hand percussion. Students will learn about purchasing appropriate 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. Special emphasis is placed on instructional techniques appropriate to elementary and middle school instrumental classes, aural and visual diagnosis of 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.

57-374  Music in the Urban School
Intermittent: 9 units
This course will involve workshops with nationally known instructors in ethnomusicology, 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. Corequisites: 57-356

57-376  Music in the Secondary School
Spring: 6 units
This course covers a variety of topics related to the development of instructional skills and the management of administrative details in the secondary school music program. Emphasis is placed on the details of classroom and rehearsal planning, student recruitment and first-year teacher concerns such as weekly planning, relations with parents and student discipline. Prerequisites: 57331 Corequisites: 57-355

57-381  Accompanying I
Fall and Spring: 3-9 units
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: 3-9 units
Continues 57-381 Accompanying I. Prerequisites: 57381

57-383  Accompanying III
Fall and Spring: 3-9 units
Continues 57-382 Accompanying II. Prerequisites: 57382

57-384  Accompanying IV
Fall and Spring: 3-9 units
Continues 57-383 Accompanying III. Prerequisites: 57383

57-385  Accompanying V
Fall and Spring: 3-9 units
Continues 57-384 Accompanying IV. Prerequisites: 57384

57-386  Accompanying VI
Fall and Spring: 3 units
Continues 57-385 Accompanying V. Prerequisites: 57385

57-391  Keyboard Studies
Fall and Spring: 3 units
This course develops piano skills necessary for work in the elementary and secondary school music programs. Special emphasis is placed on transposition, score reading, harmonization and sight-reading. This course is required for all music education majors. Prerequisites: 57292

57-392  Keyboard Studies
Fall and Spring: 3 units
Continues 57-391 Keyboard Studies. This course is required for all music education majors. Prerequisites: 57391

57-396  Introduction to Interdisciplinary Studies
Intermittent: 9 units
This course introduces students to what is loosely known in Great Britain and the United States as Cultural Studies. Cultural Studies broaden the normal range of typical academic subjects by including dynamic topics such as cinema, advertising, popular culture in its various manifestations, political and satirical cartoons, gender relations, mass media, fashion, and popular song. Highlights of this course include discussion of The Beatles, Elvis and Rock'n Roll, James Bond movies, the Kronos Quartet, World-Wide Rap Music, and much more.

57-397  European and Cultural Studies
Intermittent: 9 units
This course introduces students to what is loosely known in Great Britain and the United States as Cultural Studies. Cultural Studies broaden the normal range of typical academic subjects by including dynamic topics such as cinema, advertising, popular culture in its various manifestations, political and satirical cartoons, gender relations, mass media, fashion, and popular song. Highlights of this course include discussion of The Beatles, Elvis and Rock'n Roll, James Bond movies, the Kronos Quartet, World-Wide Rap Music, and much more.

57-398  Global Heartbeat
Intermittent: 9 units
This course will introduce students from any discipline to selected works of art, song, and political behaviors of the world. Following the interdisciplinary format of the studio course, topics will include: native concepts about music, instruments, aesthetics, genres, relationship to community religion, institutions, and patronage. Course goals will be to develop skills useful for broad cross-cultural analyses, and to bring questions about music, art, and politics into the domain of the humanities and social sciences. Special effort will be made to secure the participation of native representatives for each of the cultures under observation.

57-399  Music-Cinema-Culture
Intermittent: 9 units
The first 100 years of the 20th Century's only original art form, whose advent has brought about tremendous social and cultural changes. Students view selected films, learning first the basics of film theory, cinema's working structures and the function of music. Ultimately, they are able to analyze, in the form of a written essay, the function and value of the music in a particular film and the impact such music has had on society.
57-404 String Quartet: A Social History
Intermittent: 9 units
The string quartet is at once a medium and a genre, even a form which for more than two hundred years has had a special, unparalleled place in Western music. This course examines the development of the string quartet - from its function as an intimate and conversational social setting for amateurs, to its role as a secret repository of composers’ most daring thoughts. The string quartet repertoire under discussion spans the first attempts at string quartet writing in the 17th Century, to serialism and microtonal disintegration in the 1960s, to contemporary Pop-Rock fusion experiments. This course also deals with the social and personal histories of four individuals who freed themselves from hegemonic orchestral rules in favor of an instrumental democratic microcosm. The program analyzes great music performed by the world’s greatest soloists and orchestras.

57-405 Concerto: Virtuosity and Contrast
Intermittent: 9 units
The Concerto, one of the most popular forms of music, is also a dramatic form, a drama of contrast between the strength of one body of sound and another (volume), between one type of sound and another (tonal distinction), between the individual and the masses, and finally, between the “Solo” virtuoso and the less gifted “Tutti” players. The goal of this course is to examine the greatest concerti written for all instruments; from Vivaldi’s “Concerto for Two Mandolins” to John Adams’s “Grand Pianola Music,” and much more, while dealing with the social and personal histories of unforgettable virtuos and the concerti that became their “Battle Horses.” The program analyzes great concerti performed by the world’s greatest soloists and orchestras.

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: 57153 or 57156

57-409 Puccini’s Operas
Intermittent: 9 units
Standing between the 19th and 20th Centuries, Puccini witnessed extraordinary socio-political and cultural shifts sweeping across Europe. His operas reflect such changes through their gradual stylistic adherence to modernity. From theatrical and literary plots to complex relationships with poets, publishers, impresarios, singers, conductors, and political censors, Puccini’s operas offer excellent grounds for interdisciplinary dialogue and cultural analysis.

57-415 Dance VII
Fall: 3 units
Continues 57-316 Dance VI. Levels seven and eight explore advanced jazz and ballet technique.
Prerequisites: 57316

57-416 Dance VIII
Spring: 3 units
Continues 57-415 Dance VII.
Prerequisites: 57415

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 Choir. Repertory Choir 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.
A highly selective group of mixed voices who perform contemporary jazz and pop vocal arrangements. Open to all CMU students. Audition required.

57-420 Jazz Vocal Ensemble

57-422 Horn Choir
Fall and Spring: 3 units
This course refines skills pertaining to ensemble playing. Students will work in groups of varying size. Material will include major orchestral works, pieces expressly written for horn ensemble, and transcriptions. The course is open to all horn majors; non-majors may be accepted by audition.

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; non-majors may be accepted by audition.

57-428 Theatre Orchestra
Intermittent: 6 units
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. It covers reading, listening to recordings and group survey of repertoire. Reading and writing assignments will serve to establish historical perspective as well as programming considerations.

57-431 Italian Literature and Repertoire
Fall: 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 writing assignments will serve to 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: 57433

57-435 German Literature and Repertoire
Fall: 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 technologies or for works by specific composers. Repertoire will be examined according to vocal requirements, musical style, and programmatic function. The repertoire will consist primarily of works by British and American composers, but works by Russian and Spanish composers will also be included.

**57-437 Literature and Repertoire**  
Fall and Spring: 3 units  
This course deals with literature and repertoire for orchestral instruments. There are multiple sections organized by instrument categories or specific instruments, as follows: Woodwind, Flute, Bass, Trumpet, Trombone, Tuba, Violin, Viola, Cello, Double Bass, Percussion, Harp, Euphonium/Baritone, Saxophone.

**57-438 Multitrack Recording**  
Fall and Spring: Mini Session - 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:** 57337

**57-439 Acting V**  
Fall: 6 units  
The third and final year is designed to launch the student actor into the business of performing. Great emphasis will be placed on the individual's ability to manage their own performance while developing an awareness of what does and does not "work" in front of a paying audience. Beginning with an "autodrama", the students will discover what is stage worthy and how to mold their work into performance shape. This focus will be maintained throughout further character study and an opera scene project, and will culminate in a public performance that is developed primarily by the students themselves.

**Prerequisites:** 57340

**57-440 Acting VI**  
Spring: 6 units  
Continues 57-439 Acting V.

**Prerequisites:** 57439

**57-442 Analytical Techniques**  
Spring: 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. Recommended to be taken after 57-408 Form and Analysis. 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:** 57408

**57-450 Jazz Ear Training**  
Fall: 3 units  
The jazz musician must learn nomenclature found in the many volumes of repertoire in current circulation. To facilitate the interpretation of and improvisation upon jazz pieces of various styles, an examination and explanation of common practice is necessary. Intervals through the 13th, construction and function of 3, 4, and 5-note chords, common scales and chord sequences, rhythms and scales will, through dictation exercises, be made a part of the improviser's language, preparing for the application of these elements in Jazz Improvisation, Jazz Chamber Music, and applied courses offered in the jazz minor curriculum.

**57-451 Jazz Arranging**  
Intermittent: 6 units  
This course provides the opportunity for qualified participants to learn to write and arrange for various configurations of standard jazz instrumentation. Elements, including scoring 3, 4, and 5-note chords, intros and codas, melody settings, solo backgrounds, and techniques of rhythm section writing will be applied to examples of the standard jazz repertoire. The final project will be a written arrangement to be performed by one of the jazz ensembles in the School of Music. A strong background in theory and/or jazz performance and repertoire is recommended.

**Prerequisites:** 57152

**57-452 Jazz Composition**  
Intermittent: 6 units  
This course will analyze standard jazz forms such as blues, ternary (A-B-A), and binary (ABAC), with written assignments using riff to through-composed techniques. Use of odd meters, extended harmony, modal harmony, and slash chords will be examined. Students will write examples using these forms and techniques. Techniques in writing for rhythm section will be shown, in preparation for jazz arranging. Contemporary jazz composers and their practical use will be analyzed and used in assignments leading to a final project to be performed with a jazz combo.

**Prerequisites:** 57152 and 57451

**57-453 Jazz Improvisation**  
Spring: 3 units  
This introductory class explores the many facets of improvised music, with an emphasis on fundamental jazz principles. The course also briefly surveys other improvisational approaches, drawing from a wide variety of sources including twentieth-century classical concepts, blues, Bach, and freely-composed forms. The discipline necessary and essential for this field of study will also be emphasized.

**Prerequisites:** 57450

**57-454 Jazz Transcription and Analysis**  
Intermittent: 6 units  
There are few activities an aspiring jazz musician can engage in that are as beneficial as transcribing the improvisational works and compositions of the jazz masters. Every aspect of the student's musical ability is challenged and enhanced. Aural ability, rhythmic notation skills, harmonic theory and function, technique, phrasing, and musicianship are all vastly improved when the student embarks on the painstaking but rewarding process of transcription. The course establishes a framework of basic techniques that help break down this process into manageable goals while moving through the distinct eras of the jazz continuum.

**Prerequisites:** 57152

**57-457 Jazz History I**  
Fall: 6 units  
This first semester of a two-semester course deals with jazz from its roots through the Bebop Era.

**57-458 Jazz History II**  
Spring: 6 units  
This continuation of Jazz History I (57-457) covers jazz styles and compositions from the Bebop Era to the present. Jazz History I is not a prerequisite.

**57-459 Score Reading/Keyboard Harmony**  
Fall: 6 units  
This course is for pianists, organists, and other musicians with good keyboard skills. It is a completely practical, hands-on learning experience. Students learn by doing and observing other students. All work is done at the keyboard.

**Prerequisites:** 57153 or 57156

**57-460 Score Reading/Keyboard Harmony for Composers and Conductors**  
Spring: 6 units  
This course is for composers, conductors, and other musicians. It is a completely practical, hands-on learning experience. Students learn by doing and observing other students.

**57-462 Community Based Jazz**  
Intermittent: 9 units  
In this class, students will gain skills and information found outside of the classroom setting. Students will continue their study of ear training based on common practice, both current and traditional. For the jazz language to be assimilated in the student's instrumental and vocal vocabulary, skills for hearing and articulating musical ideas will be developed in the CMU classroom. Application of these skills with AAMI students in jam sessions and performances in the Homewood neighborhood of Pittsburgh will create an environment in which students can gain a deeper understanding of the effect jazz has on the community. Through master classes by AAMI faculty and CMU faculty, this course will raise the ability of musicians past the rudiments of jazz improvisation to a level for public performance. Furthermore, the involvement of members of the community will demonstrate the important role music plays in bringing together the greater community. Admission is by audition or instructor permission.

This class incorporates Jazz Ear Training (57-450).
Architectural Historian Diane Shaw, with guest speakers from the Musicologist/Cultural Historian Franco Sciannameo and the ways in which the arts shaped and were influenced by cultural, embracing both avant-garde and conservative movements, the histories of the arts in Europe and America. A period course examines the connections between and the independent developments within the various arts. In contrast to the separate histories of architecture, music, art, and theater traditionally taught, this course takes a multidisciplinary, thematic stance to the histories of the arts in Europe and America. A period course explores the competing aesthetic movements of the period, and the ways in which the arts shaped and were influenced by cultural, social, economic, and political forces. Team taught by Musicologist/Cultural Historian Franco Sciannameo and Architectural Historian Diane Shaw, with guest speakers from the College of Fine Arts and the College of Humanities and Social Sciences.

57-463  Eurhythmics Applications for Non-Majors
Fall and 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.

57-465  Eurhythmics Applications for Performing and Teaching
Fall: 3 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: 57164

57-466  Eurhythmics Applications for Performing and Teaching
Spring: 3 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: 57164

57-467  Production: Skills
Intermittent: 3-6 units

57-468  Production: Skills
Intermittent: 3-6 units

57-469  Production: Workshop
Intermittent: 3-6 units

57-470  Production: Workshop
Intermittent: 3-6 units

57-471  Production: Performance
Fall: 3-6 units

57-472  Production: Performance
Spring: 6 units

57-475  The Symphonies of Mahler
Intermittent: 9 units
The eleven symphonic works of Mahler will be analyzed in relation to their form, melodic and harmonic content, counterpoint, orchestration, program, and emotional content. Further topics of discussion will be Mahler’s use of beauty sentimentality, banality, tragedy, irony, and humor to present the “Whole Truth” in his symphonic writing. The class will be very interactive with each student expected to make an oral presentation and write a research paper on a symphony of their choice. This seminar style class is open to all upper level undergraduate music students.

57-479  Beginning Piano for Children
Fall and Spring: 6 units
This 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: 57429

57-485  1920s and 1930s: Perspectives on Arts
Intermittent: 9 units
Using the period of the 1920s and 1930s as a case study, this course examines the connections between and the independent developments within the various arts. In contrast to the separate histories of architecture, music, art, and theater traditionally taught, this course takes a multidisciplinary, thematic stance to the histories of the arts in Europe and America. A period embracing both avant-garde and conservative movements, the 1920s-1930s was an era of intense debate. This course explores the competing aesthetic movements of the period, and the ways in which the arts shaped and were influenced by cultural, social, economic, and political forces. Team taught by Musicologist/Cultural Historian Franco Sciannameo and Architectural Historian Diane Shaw, with guest speakers from the College of Fine Arts and the College of Humanities and Social Sciences.

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 Börtok, Honegger, Stockhausen, or Boulez. Dictations are three-part contrapuntal and difficult harmonic three and four parts.
Prerequisites: 57186

57-488  Advanced Solfege IV
Spring: 3 units
Continues 57-487 Advanced Solfege III.
Prerequisites: 57487

57-491  Solfege Seminar
All Semesters: 3 units
This course is for undergraduate students who have completed the four-semester sequence of required solfege courses and for graduate students. Solfege concepts are explored in more depth in a laboratory setting in class. This is a mini-course which meets during the first half of the semester.
Prerequisites: 57184 or 57488

57-492  Advanced Solfege Seminar
Fall: Mini Session - 3 units
This course is for undergraduate students who have completed Advanced Solfege IV and for graduate students with similar preparation. It will help the student cope with the melodic, harmonic, and rhythmic problems, presented in dictation, encountered in twentieth century music. This is a mini-course which meets during the second half of the semester.
Prerequisites: 57488

57-500  Major Studio (Voice)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-501  Major Studio (Piano)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-502  Major Studio (Organ)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-503  Major Studio (Harp)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-505  Major Studio (Violin)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-506  Major Studio (Viola)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-507  Major Studio (Cello)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-508  Major Studio (Double Bass)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-509  Studio Major (Guitar)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-510  Major Studio (Flute)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-511  Major Studio (Oboe)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:

57-512  Major Studio (Clarinet)
Fall and Spring: 9-12 units
A one hour private lesson per week for all music majors.
Prerequisites:
57-513  Major Studio (Bassoon)  
Fall and Spring:  9-12 units  
A one hour private lesson per week for all music majors.  
Prerequisites:  

57-514  Major Studio (Saxophone)  
Fall and Spring:  9-12 units  
A one hour private lesson per week for all music majors.  
Prerequisites:  

57-515  Major Studio (Horn)  
Fall and Spring:  9-12 units  
A one hour private lesson per week for all music majors.  
Prerequisites:  

57-516  Major Studio (Trumpet)  
Fall and Spring:  9-12 units  
A one hour private lesson per week for all music majors.  
Prerequisites:  

57-517  Major Studio (Trombone)  
Fall and Spring:  9-12 units  
A one hour private lesson per week for all music majors.  
Prerequisites:  

57-518  Studio Major (Euphonium/Baritone)  
Fall and Spring:  9-12 units  
A one hour private lesson per week for all music majors.  
Prerequisites:  

57-519  Major Studio (Tuba)  
Fall and Spring:  9-12 units  
A one hour private lesson per week for all music majors.  
Prerequisites:  

57-520  Major Studio (Percussion)  
Fall and Spring:  9-12 units  
A one hour private lesson per week for all music majors.  
Prerequisites:  

57-521  Major Studio (Composition)  
Fall and Spring:  9-12 units  
A one hour private lesson per week for all music majors.  
Prerequisites:  

57-597  Senior Project  
Fall and Spring:  0 units  
A composition for orchestra required of all senior composition majors.  
Prerequisites:  

57-598  Junior Recital  
Fall and Spring:  0 units  
A half recital required of all junior performance majors.  
Prerequisites:  

57-599  Senior Recital  
Fall and Spring:  0 units  
A full recital required of all senior performance majors.  
Prerequisites:  

57-603  Practice Teaching (Elementary)  
Fall and Spring:  6-18 units  
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: 57355 and 57393  

57-604  Practice Teaching (Secondary)  
Fall and Spring:  6-18 units  
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: 57355 and 57393  

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 intended to introduce students to a variety of seasoned educators and instructional practices through a series of classroom and rehearsal observations. It is strongly suggested that this course be completed during the sophomore year with concurrent registration in 57-331.  
Prerequisites: Corequisites: 57-331  

57-610  Internship  
Fall and Spring:  3-36 units  

57-611  Independent Study in History  
Fall and Spring:  3-9 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.  

57-612  Independent Study in Theory  
Fall and Spring:  3-9 units  
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a full-time faculty member. The teaching is supervised by an experienced 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:  3-9 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.  

57-614  Independent Study in Performance  
Fall and Spring:  3-9 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.  

57-615  Independent Study in Electronic and Computer Music  
Fall and Spring:  3-9 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.  

57-616  Independent Study in Literature and Repertoire  
Fall and Spring:  3-9 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.  

57-617  Independent Study in Sound Recording  
Fall and Spring:  3-9 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.  

57-618  Independent Study in Conducting  
Fall and Spring:  3-9 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.  

57-619  Independent Study in Opera  
Fall and Spring:  3-9 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.  

57-620  Independent Study in Solfege  
Fall and Spring:  3-9 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.  

57-621  Independent Study in Eurhythmics  
Fall and Spring:  3-9 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.  

57-622  Independent Study in Conducting  
Fall and Spring:  3-9 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 Opera  
Fall and Spring:  3-9 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.
57-641 Dalcroze Research Paper  
Fall and 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: 3 units  
This first semester of a two semester course provides supervised practice teaching experience in applying Dalcroze principles for young children.  
Corequisites: 57-689  
57-692 Dalcroze Pedagogy/Practice Teaching  
Spring: 3 units  
This second semester of a two semester course provides supervised practice teaching experience in applying Dalcroze principles for older students.  
Prerequisites: 57-689  

 Naval Science - ROTC  
32-100 Naval Laboratory  
Fall and Spring: 3 units  
Military drill, physical fitness, and leadership seminars.  
32-101 Introduction to Naval Science  
Fall: 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. Includes 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 concepts 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  
Fall and 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. Military behavioral science is integrated with the professional competencies developed in prior course work and professional training.  
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.  
32-300 Naval Laboratory  
Fall and Spring: 3 units  
Military drill, physical fitness, and leadership seminars.  
32-301 Navigation and Naval Operations I  
Fall: 9 units  
An in-depth study of piloting and celestial navigation including theory, principles, and procedures. Students learn piloting skills including the use of charts, visual and electronic aids, and the theory and operation of magnetic and gyro compasses. Celestial navigation is a major topic including the celestial coordinate system, an introduction to spherical trigonometry, relative motion, vector analysis theory, relative motion problems, formation tactics, and ship employment. Also included is an introduction to navigation instruments and shipboard evolutions, vessel behavior and characteristics in maneuvering, applied aspects of ship handling, and afloat communications.  
32-310 Evolution Of Warfare  
Fall and 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.  
32-400 Naval Laboratory  
Fall and 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 course 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.  

 Philosophy  
80-100 What Philosophy Is  
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 procedures. 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 What is Philosophy Fall and Spring: Mini Session - 3 units
This three credits extension of 80-100 is open to Freshmen and Sophomores by invitation of their instructor only. The seminar examines interesting puzzles and open controversies concerning topics raised in 80-100.

80-103 Freshman Seminar: Voting Theory 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. Regarding to the requirements,we will examine several models 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?

80-104 Freshman Seminar: Mysticism Fall: 9 units
Mysticism begins with the practice of meditation, which involves concentrated inattention to sensory distractions. Expert mystic practitioners have reported an unshakable and joyful conviction that reality is more inter-connected than it seems at the everyday sensory level. Mystical philosophy grapples with the significance and interpretation of such reports and on what they tell us about the relationship between God and the human. The focus of this Freshman Seminar is to provide an introduction to a range of mystical traditions drawn from different cultures and historical periods and to examine their relationships to philosophy. Since Asian thought is not well represented at the University, the course will focus in particular on the historical interplay between Hindu and Buddhist philosophy, with special attention to the latter.

80-109 The Linguistics of Political Discourse 9 units
The Linguistics of Political Discourse: It’s hard to deny that political discussion these days - in the newspaper, on TV, or on the web is chaotic and contentious. It’s often unclear if the aim of the discussion is to persuade or to recruit a confused audience, or if it is to accomplish an otherwise unattainable or illogical result. Why do we have to address these topics? What can we do about all the controversy and disagreement anyway? To the extent that the problem is one of language use, linguistics - the study of language - is an ideal tool to help us in addressing these questions. In this course, we will develop a linguistically sophisticated analysis of political discussion and argument, based on actual cases drawn from media discussions of contemporary political events. We will be especially concerned with the use of logical fallacies - errors of reasoning, deliberate or inadvertent, which interfere with resolution-oriented discussion.

We will use linguistics to dissect the language of the discussion and to establish principles for effective response. We will see how tests devised by linguists to uncover the structure of discourse - political or otherwise - can be used as tools to help sort out various kinds of confusion and to expose tricks and disingenuous uses of language.

80-110 Nature Mathematical Reasoning Spring: 9 units
This course focuses on understanding mathematical reasoning, not on mastering a particular mathematical theory like linear algebra or calculus. It explores instances of mathematical reasoning and rigorous argumentation, with examples from the history of science and mathematics. We consider the “Let’s Make a Deal” puzzle, the counter-intuitive results of HIV testing, and how to assess the relative size of infinite sets, all problems which defy intuitive solution but which look simple after they are put in mathematical form. The course is designed for students at the freshman and sophomore levels who are not interested in a mathematically intense major.

80-130 Introduction to Ethics Spring: 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 and small group 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 university major. They may 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 Fall: 9 units
Epistemology, one of the cornerstones of philosophy since ancient times, concerns the relationships between belief, truth, and knowledge. This course will explore fundamental issues in epistemology, such as the analysis of the concept of knowledge, epistemic justification and scientific method, a priori knowledge, theories of truth, skepticism, reliabilism, and coherenceism. 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 Fall: 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 doing so, students develop the skills to analyze arguments, and carry out formal reasoning. The course will introduce several software packages recently developed at CMU that help students diagram arguments and carry out formal 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, how do we begin to understand the 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 review, substantive discussions and critical reflections supplement the on-line material.

80-211 Arguments and Inquiry Spring: 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 provides students with strategies for distinguishing among logical and philosophical arguments and explains the fundamental (in)completeness and (un)decidability theorems of modern logic.

80-212 Arguments and Logical Analysis Fall: 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 conclusions as well as means by 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 criticizing 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 in many cases, more effective. 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 with any discipline, but particularly those who would like to improve their writing and critical thinking skills.

80-220 Philosophy of Science Fall: 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 Fall: 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, free humans possess 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 phenomena? Do social norms evolve in the same way as do biological species? Is our understanding of social phenomena always value laden?

80-222 Measurement and Methodology Spring: 9 units
This course is intended as an introduction to the theory of measurement. How do we measure concepts? Under what conditions do qualitative relationships determine quantitative ones? Why, for example, is the zero-point a conventional choice for measuring temperature, but not so for their measurement of length with rulers? We shall investigate theories of extensive measurement, with and without error. Applications will be taken from the natural and social sciences, including the development of some "psychometric scales," such as measuring the intensity of personal preferences.

80-225 The Birth of Modern Science Fall: 9 units
This course will focus on three major episodes in the emergence of modern science. We begin with the Scientific Revolution of the 17th century. We consider the careers and scientific problems of scientists such as Galileo, Descartes, and Newton. We then consider the careers and scientific problems of scientists such as Galileo, Descartes, and Newton. Finally, we will consider the careers and scientific problems of scientists such as Galileo, Descartes, and Newton. We then consider the careers and scientific problems of scientists such as Galileo, Descartes, and Newton. Finally, we will consider the careers and scientific problems of scientists such as Galileo, Descartes, and Newton.

80-226 Revolutions in Science Spring: 9 units
Contemporary science emerged from a series of revolutionary innovations in scientific theory and scientific method. Starting with the Newtonian revolution of the 17th century, this course will consider the scientific and philosophical developments that led to several revolutionary scientific episodes, with lectures providing background and linkages. Besides the Newtonian revolution, topics may include: Antoine Lavoisier and the establishment of a new chemistry; John Dalton and the development of the atomic theory; Michael Faraday and James Maxwell and the theory of electromagnetic theory; evolution and genetics from Charles Darwin to Gregor Mendel and after; computers, technology, and the creation of statistics; the testing of the General Theory of Relativity as seen through the eyes of the woman who saved Einstein's theory from refutation; Alan Turing and the creation of the digital computer and the theory of computation. Students will work with some of the original historical data.

80-230 Ethical Theory Spring: 9 units
Every day, often in very subtle ways, we make judgments of value that shape our lives. Should we vote? Should we pursue love or money? How do we make such judgments? How do we justify them? What makes some actions right and some wrong? What makes some actions more important than others? How do we evaluate the consequences of our actions? How do we explain basic social norms like cooperation? Do social norms exist which explain basic social phenomena? Do simple social 'laws' exist which explain basic social phenomena? Do simple social 'laws' exist which explain basic social phenomena? Do simple social 'laws' exist which explain basic social phenomena? Do simple social 'laws' exist which explain basic social phenomena?
Have you ever wondered what would happen to you if you were charged with a criminal offense? Or, what sort of defenses would be available to you, according to the law, whatever the charges? Or, what sort of rationales unjustly? Or, what would the law do, or the courts, or the community, or the state take, if you were charged with a particular state of affairs? These are the limits of the legitimate authority of the state and how are they defined? This course provides a systematic investigation of the way these questions are answered by dominant schools of liberal political theory, such as the social contract tradition, libertarianism, and utilitarianism. Because the liberal political tradition is also strongly egalitarian in nature, the course will examine different conceptions of political equality and conflicting views on what the respective responsibilities of community members may have a just claim to equal treatment. This course also examines important critiques of this tradition from Marxist, communitarian, and feminist standpoints. Readings are drawn from classic works by Hobbes, Locke, Kant, and Mill, and from the works of contemporary theorists like Rawls, Nozick and others. Prerequisites: none.

80-235 Political Philosophy
Spring: 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 of affairs? Are the limits of the legitimate authority of the state and how are they defined? This course provides a systematic investigation of the way these questions are answered by dominant schools of liberal political theory, such as the social contract tradition, libertarianism, and utilitarianism. Because the liberal political tradition is also strongly egalitarian in nature, the course will examine different conceptions of political equality and conflicting views on what the respective responsibilities of community members may have a just claim to equal treatment. This course also examines important critiques of this tradition from Marxist, communitarian, and feminist standpoints. Readings are drawn from classic works by Hobbes, Locke, Kant, and Mill, and from the works of contemporary theorists like Rawls, Nozick and others. Prerequisites: none.

80-236 Philosophy and Law
Spring: 9 units
Have you ever wondered what would happen to you if you were treated will include: conflicts of interest, whistleblowing, business organization will be the focus of this course. Topics and web-based "guided inquiries" that students navigate and complete. There is also an international component to this course as we partner with students from Tec de Monterrey in the ITESM system to discuss cases in professional ethics via real time video conferencing. This course meets one day a week and employs a case study discussion format during class.

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 non-profit organizations. 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. As a hybrid course, it also explores different ethical theories and their applications to real-life scenarios and cases. The course emphasizes the importance of ethical reasoning and decision making, and includes case studies and discussion of ethical issues in professional life. Prerequisites: none.

80-242 Conflict, Dispute Resolution
Fall and Spring: 9 units
This course is about strategic choice and bases for choosing strategies for managing human conflict. The course has two dimensions: (1) methodology and (2) applications. (1) We will critically examine current models of conflict and conflict resolution, including specific techniques for negotiating conflict in practical ways. We will also examine 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. There is also an international component to this course as we partner with students from Tec de Monterrey in the ITESM system to discuss cases in professional ethics via real time video conferencing. This course meets one day a week and employs a case study discussion format during class.

80-243 Business Ethics
Intermitten: 9 units
Various moral mazes that confront managers in the contemporary business environment 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, and 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 Management, Environment and Ethics
Spring: 9 units
Participants in this course will examine and pose answers to the following question: What are the legitimate environmental responsibilities of organizational managers and how can they be 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) 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 explore answers to the lead question about management and the environment by employing the insights gained during the first half. Here participants will first empirically review and evaluate past and current management practices with respect to the environment, organizational policies on 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 and other responsibilities and examples of management responses to environmental crises will also be examined during this portion of the course. Case studies in management, environment and ethics will be analyzed.

80-245 Medical Ethics
Fall: 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 doctors and nurses; the ethics of medical treatment and medical research; the ethics of organ transplantation and organ donation; the ethics of reproductive technologies; the ethics of mental health treatment; the ethics of end-of-life care; the ethics of medical research; and the ethics of health care policy. The course employs a case study discussion format during class.

80-246 Criminal Justice in America: Ideals and Realities
Spring: 9 units
This course applies selected theories of procedural and social justice to a major public institution. It explores 1) the nature and impact of police, lawyer and prosecutor practices, 2) the effects of political and legal institutions on the criminal justice system, 3) the effects of political and legal institutions on the criminal justice system, 4) the impact upon organizational management, the emergence of the "environmental affairs manager" within organizations, balancing environmental responsibilities and other responsibilities and examples of management responses to environmental crises will also be examined during this portion of the course. Case studies in management, environment and ethics will be analyzed.

80-247 Health, Development, and Human Rights
Spring: 9 units
This course will explore answers to the lead question about management and the environment by employing the insights gained during the first half. Here participants will first empirically review and evaluate past and current management practices with respect to the environment, organizational policies on 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 and other responsibilities and examples of management responses to environmental crises will also be examined during this portion of the course. Case studies in management, environment and ethics will be analyzed.

80-248 Management, Environment and Ethics
Spring: 9 units
Participants in this course will examine and pose answers to the following question: What are the legitimate environmental responsibilities of organizational managers and how can they be 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) 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 explore answers to the lead question about management and the environment by employing the insights gained during the first half. Here participants will first empirically review and evaluate past and current management practices with respect to the environment, organizational policies on 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 and other responsibilities and examples of management responses to environmental crises will also be examined during this portion of the course. Case studies in management, environment and ethics will be analyzed.

80-249 Applied Ethics
Spring: 9 units
This course is about strategic choice and bases for choosing strategies for managing human conflict. The course has two dimensions: (1) methodology and (2) applications. (1) We will critically examine current models of conflict and conflict resolution, including specific techniques for negotiating conflict in practical ways. We will also examine 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. There is also an international component to this course as we partner with students from Tec de Monterrey in the ITESM system to discuss cases in professional ethics via real time video conferencing. This course meets one day a week and employs a case study discussion format during class.

80-250 Ancient Philosophy
Fall: 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 Nicomachian 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
Fall: 9 units
Contemporary philosophical portrayal of science, which worked as a physicist, but he was also deeply concerned with the movement's founder, C.S. Peirce, was trained in chemistry and the post-war reception by Quine and others. A debt to these sources, as does of course contemporary cognitive science, and information and computer sciences all owe

From Wittgenstein's language-oriented philosophy to the philosophy of mind and methods of the modern philosophers.

80-252 Kant
Spring: 9-12 units
Immanuel Kant's 'Critical philosophy' may be seen as the result of his attempts to determine the sources of human knowledge, and to find metaphysical foundations for Newton's mechanics. The course will include readings in Kant's Critique of Pure Reason/ and other texts. Emphasis will be placed on understanding Kant's thought in the context of contemporary intellectual developments and on his theory of human cognition.

80-253 Continental Philosophy
Spring: 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 (Being-in-the-World, Bad Faith). This part will involve selections from the works of, for example, Husserl, Heidegger, Sartre and Merleau-Ponty. Finally, current trends such as Structuralism, Hermeneutics and Post-modernism (C. Derrida, Foucault, Lyotard and Habermas) will be considered.

80-254 Analytic Philosophy
Spring: 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 the philosophical problems of the day. This 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 readings from Frege, Russell, Wittgenstein, and the Vienna Circle, as well as the post-war reception by Quine and others.

80-255 Pragmatism
Fall: 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 developing the role of general laws and the idea of the pragmaticity of the 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 he called 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 Philosophy: Value Theory
Fall: 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 philosophers of this period, with an emphasis on the work of Immanuel Kant.

80-257 Nietzsche
Spring: 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 has been 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 consider a broad range of Nietzsche's writings, focusing on his central concepts such as the Superman, eternal recurrence, and the often-misunderstood Ubermensch ("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.

80-258 Leibniz, Locke, and Hume
Spring: 9 units
The course will take a close look at the theories of knowledge of three major thinkers of the 17th and 18th centuries: John Locke, Gottfried Wilhelm Leibniz, and David Hume. Selections from Locke's An Essay Concerning Human Understanding, Leibniz's Essay on New Essays Concerning Human Understanding, and Hume's views in the An Enquiry concerning Human Understanding, as well as other texts, will be discussed.

80-270 Philosophy of Mind
Fall: 9 units
The course offers an introduction to some of the basic questions in the philosophy of mind. What is the real nature of mental states? (the ontological problem); What sort of property (if any) confers truth evaluability and content on certain psychological states? (the semantical problem); How do we know that other agents have consciousness and enjoy mental states at all? What are the minimal conditions of personhood? (the epistemological problem); What sort of data is admissible to construct a 'science of the mind'? What are the relationships between 'folk' and scientific psychology? (the methodological problem); Which is the role of contentful psychological states in the explanation of behavior? How does the intentional and psychological connect with their social nature and their communal experience? (the problem of psychological explanation). Each year the course pays particular attention to a family of topics. In the recent years focal points have been: (a) recent theories of consciousness, (b) the status of the so-called computational theory of mind (alias functionalism), (c) the tension between computational and and Aristotelian models of the mind (d) the nature of desires and emotions.

80-271 Philosophy and Psychology
Spring: 9 units
Throughout both of their histories, philosophy and psychology have had a close relationship. This course will examine some of the many ways in which philosophical and psychological theories have mattered for each other, both in the past and present. In particular, we will begin by examining a series of historical cases in which philosophy and psychology intersected, such as Kant's influence on Helmholtz's psychological theories, the influences of psychological behaviorism on philosophical logical positivism (and vice versa). We will also consider, in significantly
more depth, a more recent intersection of philosophy and psychology: the philosophical problem of free will, and recent research on its psychological and neuroscientific foundations.

80-275 Metaphysics
Spring: 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 philosophical texts will be studied.

80-276 Philosophy of Religion
Spring: 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. The remainder of the course will focus on 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
Fall: 9 units
The goal of this course is to equip students with the vocabulary and skills needed to engage in the analysis of linguistic data. The course will focus on one or more of the following topics: syntactic analysis (analysis of sentence structure), phonological analysis (analysis of linguistic sound systems) or semantic analysis (analysis of sentence interpretation). Other topics may be included. In this course you will develop your ability to describe linguistic phenomena accurately, to make linguistic generalizations, and to propose accounts of these generalizations within a given theoretical framework. Prerequisites: 80180
Prerequisites: 80180

80-281 Language and Thought
Spring: 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 about the meaning of verbs of mental, propositional, attitude and pragmatic. 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.

80-291 Issue 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 at a central figure in the history of computing, Alan Turing and Claude Shannon. We will consider how the ideas of these two figures have influenced the way we think about computing and communication. Prerequisites: 80-280, 80-380, 82-380, 82-383, 85-421, 76-385, 76-386, 76-387, 76-451 or 11-521/721.
Prerequisites: 11-721 or 76385 or 76387 or 76389 or 76-451 or 80-380 or 80-280 or 80-290 or 82-380 or 82-383 or 85-421 or 76-385 or 76-386 or 76-451 or 11-521/721.

80-300 Minds Machines, and Knowledge
Fall: 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: 80100

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, 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 cooperation, and the problem of fair division of goods as well as recent theories that abandon the Bayesian assumption that the decision maker's preferences 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.

80-306 Meaning in Language
Fall: 9 units
This course provides a survey of the different ways in which meaning is conveyed in spoken languages, and of the different types of meaning which are conveyed. Topics to be covered will include: word meaning (lexical semantics); structure and meaning (compositional semantics); inter and interstructural meaning; verb argument structure and thematic roles; intonational meaning and focus; presupposition; context dependents; discourse markers and utterance modifiers; and the role of inference in interpretation. The topics to be addressed bring together a variety of fields: linguistics; philosophy of language; communication studies and rhetoric; and language technologies. The course may be taken as an 8-unit (80-306) or 12-unit (80-606/11-725) course. The 12-unit course will include an additional component, which will relate the content of the course to linguistic, cultural, and technical developments, such as first-order logic. Other topics may be included. Prerequisites: Any course from the following list, or permission of the instructor: 80-100, 80-280, 80-380, 82-280, 82-383, 85-421, 76-385, 76-386, 76-387, 76-451 or 11-521/721.
Prerequisites: 11-721 or 76385 or 76387 or 76389 or 76-451 or 80-180 or 80-280 or 80-380 or 82-280 or 82-383 or 85-421, 76-385, 76-386, 76-387, 76-451 or 11-521/721.

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: 80-100 or 80211 or 80212 or 15251
Prerequisites: 15251 or 80210 or 80211 or 80212

80-311 Computability and Incompleteness
Spring: 9 units
The 1930's witnessed two revolutionary developments in mathematical logic: Gödel's famous incompleteness theorems, which demonstrate the limitations of formal mathematical reasoning, and second, the formal analysis of the notion of computation in the work of Turing, Gödel, Herbrand, Church, Post, Kleene, and Turing results on the limits of computation. This course will cover these developments, and related results in logic and the theory of computation. Prerequisites: 80-151 or 15399 or 21128 or 21300 or 80210 or 80211 or 80212 or 80310 or 80317
Prerequisites: 15151 or 15399 or 21128 or 21300 or 80210 or 80211 or 80212 or 80310 or 80317

80-312 Philosophy of Mathematics
Spring: 9 units
The 20th century witnessed remarkable and novel developments in the philosophy of mathematics, including new developments in logic, and related results in logic and the theory of computation. Prerequisites: 80-151 or 15399 or 21128 or 21300 or 80210 or 80211 or 80212 or 80310 or 80317
Prerequisites: 15151 or 15399 or 21128 or 21300 or 80210 or 80211 or 80212 or 80310 or 80317

80-341 Philosophy of Science
Spring: 9 units
The scientific revolution of the 17th century witnessed remarkable and novel developments in the philosophy of science, including new developments in logic, and related results in logic and the theory of computation. Prerequisites: 80-151 or 15399 or 21128 or 21300 or 80210 or 80211 or 80212 or 80310 or 80317
Prerequisites: 15151 or 15399 or 21128 or 21300 or 80210 or 80211 or 80212 or 80310 or 80317
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 theory and constructive approaches to 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.

80-314 Logic and Artificial Intelligence
Spring: 9 units
An introduction to several formalisms used in knowledge representation and database theory. The emphasis is placed on non-monotonic reasoning and artificial intelligence 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
Fall: 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 also treated, as well as computationally motivated models (like "after the computation terminates"). Several conceptual problems in formal ontology that motivate the field are reviewed, as well as recent applications in computer science and linguistics. Kripke models are used throughout the course, but we also study recent Kripkean-style systematizations of the modalities without using possible worlds. Special attention is devoted to Scott-Montague models of the so-called 'classical modalities'.

80-316 Probability and AI
Fall: 9-12 units
In this course we will examine foundational questions about the concepts of causality and probability, how artificial intelligence techniques can be used to solve some of the computational problems presented by these concepts, and how different representations of causal relations, and how probabilities and representations of causal relations have been incorporated into recently developed expert systems. The foundational questions we will examine are: What do causal and probabilistic statements mean? How can probabilities and causal relations be inferred? Are there any axioms relating causal relations to probability distributions? What are the advantages and disadvantages of using probabilities as compared to alternative representations of uncertainty? We will then discuss recent developments in Artificial Intelligence (e.g., Bayesian networks) which have solved some of the long-standing computational problems associated with the use of probabilities and statements about causal relations. Finally, we will study in some detail, such as QMR and Pathfinder, which have incorporated these new techniques in order to perform medical diagnosis. Prerequisites: 36-122 or 36-217 or 36-217 or instructor permission. Prerequisites: 36226 or 36202 or 36147.

80-317 Constructive Logic
Intermittent: 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.

80-318 Computability and Proof Search
Intermittent: 9-12 units
The broad question is one of artificial intelligence: Can one "mechanize" significant parts of "mathematical reasoning"? We address the question by presenting automated proofs of Gödel's incompleteness theorems and some theorems of set theory. To this we end in Part 1 problems that led to a notion of mechanical procedure as well as a convincing conceptual analysis of "computability". The theorem of Church and Turing asserts that there is no mechanical procedure deciding whether or not a sentence in the language of quantificational logic is a logical truth. However, Gödel's completeness theorem guarantees that every logical truth can be proved in a suitable calculus. A variety of problems have been developed to search systematically for proofs; Part 2 investigates "proof search procedures" for natural deduction calculi. In Part 3 these procedures are extended to obtain proofs of the theorems mentioned.

80-319 Computability and Learnability
Spring: 9 units
In deductive reasoning, the conclusion is already "contained" in the premises or information provided, whereas in inductive reasoning the conclusion "extends" the premises. Deduction is infallible and final. Induction is fallible and revisable. Deductive reasoning is associated with mathematics, proofs and algorithms, whereas inductive reasoning is usually associated with empirical science, statistics, and probability. This class presents a unified, perspective on both sorts of reasoning from the point of view of computational learning theory. First, a rigorous grounding in the classical theory of computability is provided. Then the theory is extended to cover problems, both formal and empirical, in which halting with certainty is impossible, but converging to the truth is still possible. Topics covered include the s-m-n and universal theorems, Kleene's recursion theorem, Goedel's first incompleteness theorem, many-one reducibility, Rice's theorem, the Rice-Shapiro theorem, the priority method, the recursion theorem, Putnam's n-trial predicates, and Gold's learnability theorem. Applications include an explanation of Ockham's razor in terms of efficient convergence to the truth. The final grade is based upon exercise sets which must be turned in on schedule. The exercises reinforce fundamental concepts and provide concrete practice in calculating upper and lower bounds on complexity. The prerequisite is a course in discrete mathematics or fundamental structures of computer science. A course in logic or familiarity with logical notation (e.g., quantifiers and prenex normal form) is strongly encouraged.

80-321 Causation and Social Policy
Fall: 9-12 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 tough drug laws reduce drug use? This course investigates how social and behavioral scientists establish causal claims, how policy makers evaluate the available evidence, and how policy makers use that evidence to formulate policy. We will also study recent issues in the logics of causation and probability. Philosophers have historically played a central role in these debates, and so we will 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.

80-322 Philosophy of Physics
Spring: 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
Spring: 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 all of these issues will be examined 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: 36201 or 36207 or 36217 or 36220 or 36225 or 36247. Prerequisites: 36201 or 36207 or 36217 or 36220 or 36225 or 36247.

80-324 Philosophy of Genetics
Spring: 9 units
Philosophical problems in the investigation of genetics. Topics include: the nature of genes and genetic information; the relationship between genes and their expression in the phenotype; the role of genetics in understanding evolution; the relationship between genetics and the study of human behavior; and the ethical implications of genetic research.

80-325 Philosophy of Economics
Spring: 9 units
Philosophical problems in the economic aspects of social policy. Topics include: the nature of economic rationality; the role of politics in economic decision making; the relationship between economics and ethics; and the implications of economic theories for social policy.

80-326 Philosophy of Statistics
Spring: 9 units
Philosophical problems in the use of statistical methods in social science. Topics include: the nature of statistical inference; the role of sample size in statistical conclusions; the relationship between statistical significance and practical significance; and the ethical implications of statistical research.

80-327 Philosophy of Perception
Spring: 9 units
Philosophical problems in the study of perception. Topics include: the nature of perception and its relationship to sensory experience; the relationship between perception and thought; and the implications of philosophical theories of perception for the study of human behavior.

80-328 Philosophy of Social Science
Spring: 9 units
Philosophical problems in the social sciences. Topics include: the relationship between social science and human behavior; the role of social science in understanding social phenomena; and the implications of philosophical theories of social science for the study of human behavior.

80-329 Philosophy of Psychology
Spring: 9 units
Philosophical problems in the study of psychology. Topics include: the nature of psychological phenomena; the role of psychology in understanding human behavior; and the implications of philosophical theories of psychology for the study of human behavior.
including ethical issues in clinical trial design, the concept of equipoise and the use of placebo controls, the requirements of justice in the research context, and the values of privacy and informed consent. The course will touch on ethical issues in non-biomedical areas of research such as psychology, the social sciences and computer science, and end with issues at the cutting edge of current debate. Prerequisites: none.

80-340  Environmental Ethics and Decision Processes
Fall: 9 units
The use of limited natural resources such as water, land, and energy sources inevitably produces conflicts over access, regulation and policy, environmental standards, and enforcement. Traditional means of settling such conflicts, and particularly the legal system, often do not address the fundamental differences in values and goals of the parties, or include all stakeholders (such as future generations). Legal battles are often costly, socially as well as economically, and it is increasingly recognized that adversarial procedures are not enough. This course will examine the application of the idea of negotiation and mediation to resolve environmental disputes. Based on a series of environmental case studies, this course will examine the central questions such as the nature of the environmental condition will be discussed in this course as well.

80-341  Computers, Society and Ethics
Spring: 9 units
This course explores many of the social and ethical issues that have emerged in the wake of the significant advances that 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 the privacy of individuals, while others fear that the means and ends may be more important than the means. In this course, we will address these and other issues such as privacy and free speech, surveillance in the workplace, intellectual property and copyright, information acquisition and ethics and the Internet.

80-344  Environmental Ethics
Fall: 9-12 units
This course will survey numerous philosophical and ethical aspects of the environmental movement. It will focus upon such topics as the nature of environmental responsibility, anthropocentrism vs. biocentrism, the nature of the environment, animal rights, obligations to future generations and the "land ethics" of Aldo Leopold. It will explore the arguments found in the debates over radical environmental activism, deep ecology, social ecology and eco-feminism. Environmental justice, issues of environmental rights, the possibilities of sustainable environmental practices and the causes of our ecological condition will be discussed in this course as well.

80-346  Value Fact and Policy
Fall: 9-12 units
This seminar is about how appraisals of value and fact interact in the deliberation and evaluation of public policy. Policy making and debate entail value judgments and evaluation (the weighing and balancing of competing values), as well as assidious fact finding. When we disagree about the facts of the matter, we may think that we have a good idea of how to go about settling the disagreement. But what do we do when we disagree about values? That is a central question for this seminar. But policy issues cannot be intelligently debated absent facts. And the factual issues may be arguable and complex: we encounter political, sociological, cultural, psychological issues as well as legal and ethical questions. For depth of perspective, so that we can become well versed in the relevant factual as well as value controversies, the seminar will focus on justifying and critiquing the work of Rips). In Part 2 connectionist networks are considered for a variety of cognitive tasks. Part 3 gives an automated search for proofs in logic (and its psychological use in the work of Rips). In Part 2 connectionist networks are considered for a variety of common 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

80-471  Cognitive Computation
Fall: 9 units
To start with, Turing's classical analysis of computations via "Turing machines" is given an axiomatic formulation. Comparing Turing's conjecture from 1950, mathematics will be done in 2000 largely and automatically by computers, with the actual developments, we look forward to the new policies relevant to the automated search for proofs in logic (and its psychological use in the work of Rips). In Part 2 connectionist networks are considered for a variety of cognitive tasks. Part 3 gives an analysis of parallel computations as discrete dynamical systems or "Gandy machines." The latter machines are seen to be their main focus as a problematic social issue. This course will address these and other issues such as privacy and free speech, surveillance in the workplace, intellectual property and copyright, information acquisition and ethics and the Internet.

80-481  Formal Semantics
Spring: 9 units
This course provides a high-level introduction to the field of formal semantics for natural language. The goal of formal semantics is to develop a theory capable of representing how the meanings of sentences are constructed from the meanings of their parts. The theory must thus be able to represent the meanings of sentence parts i.e. words and word constituents, and
provide rules for how these meanings are combined. In the course, we will adopt the model-theoretic, truth conditional approach which is standard in linguistic semantics. Our talk of "meaning" will thus be restricted to the assignment of model-theoretic objects -- individuals, sets, functions, and so on -- to expressions of the language. This approach utilizes translation of natural language into a formal language (logic); part of the task, therefore, is to identify an appropriate logic to serve as the translation. No background in linguistic theory is required for the course. Students should be comfortable with formal systems, although many basic concepts needed will be introduced in the course.

Prerequisites: 80110 or 80210 or 80211 or 80310

80-511 Thesis Seminar
Spring: 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.

80-512 Seminar on Causation
Fall: 12 units
This course explores the foundations of causation. It examines how causal claims connect to questions of probability and 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.

80-513 Seminar of Philosophy of Mathematics
Fall: 9-12 units
The seminar discusses mathematical, logical, and philosophical works that is important for the foundations of mathematics. The topics covered may range from constructive consistency proofs for classical theories through conceptual analyses of central mathematical notions to the discussion of ontological and epistemological issues.

80-514 Philosophy of Science
Fall: 9 units
A graduate level, critical review of standard issues in the philosophy of science. Topics will include determinism, predictability, causation, lawlikeness, explanation, the aims of science, the content of scientific claims, the rationality of belief in scientific claims.

80-515 Seminar on the Foundations of Statistics
9 units
The seminar focuses on some single important foundational work, or body of work, and investigates it and related research from a contemporary point of view. For example, when Savage's Foundations of Statistics is the course's focus, the class goals include understanding how Bayesian decision theory differs from its rivals, and understanding where Savage's position is located within the current Bayesian program. Other seminal thinkers whose writings have served as the course's focus in different terms include, R.A.Fisher, Harold Jeffreys, J.Neyman, and A. Wald. Prerequisites: This is primarily a graduate level class. Instructor permission is required for undergraduates.

80-516 Seminar on Metaphysics
Intermittent: 9 units
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, causation, the persistence of objects through time, and personal identity. This is an advanced undergraduate class.

80-517 Seminar in Social and Political Philosophy
Spring: 9-12 units
The seminar's topic changes every year. In the past, it covered subjects such as the nature of social norms, the evolution of institutions and the use of dynamic models in the social sciences.

80-518 Seminar on Epistemology
Spring: 9-12 units
This seminar focuses on prominent issues in contemporary epistemology. Standard topics in the field will be studied in the light of recent research in artificial intelligence, cognitive science as well as social and decision sciences. Topics considered in recent years include 'local' theories of induction, the problem of how to represent belief and how to justify belief change, as well as issues related to the viability and structure of current theories of radical probabilism in Bayesian epistemology. The seminar discusses not only issues in classical epistemology, but also more recent naturalistic and pragmatist approaches.

80-519 Seminar History of Philosophy
Spring: 9-18 units
This course focuses on seminal figures, eras, or movements in the history of philosophy. Although the specific topic of the seminar varies, the goals of the course are to situate important philosophical texts or ideas within a broader historical context and to provide a systematic critical investigation of those ideas. Specific emphasis is placed on examining the influence of this historical material on contemporary philosophical ideas or methods. Topics of the seminar might include: Aristotle's Ethics, Plato, Hume, Kant's Critique, The Rationalists, History of Philosophy of Mathematics.

Undergraduates need permission of instructor.

80-520 Categorical Logic
Fall: 6-12 units
This course focuses on applications of category theory in logic and computer science. It is an introduction to category theory 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 variety of algebraic methods into logic, leading naturally to the universal and other general models that distinguish functional from classical semantics. Such categorical models occur, for example, in the treatment of probability, computation, and deduction. We provide a brief introduction to the theory of Cartesian closed categories. Similarly, higher-order logic is treated categorically by the theory of topos.

Note: this course will begin with a 3 week refresher of basic category theory - CS students can start after immigration by reviewing on their own. Prerequisites: 80-413 or instructor permission
Prerequisites: 80413 or 80713

80-521 Seminar on Methodology
Fall: 9-12 units
This seminar has two major themes. The first is to present basic ideas behind this course is a deep mathematical analogy between Hume's problem of induction and uncomputability: Hume asks how you could tell for sure that the sun will always rise and Turing asks how a computer could tell for sure that a computation will never end. Systematic exploration of this analogy has led to a sub-discipline of computer science known as computational learning theory. The aim of this course is to apply ideas from computational learning theory to such standard philosophical issues as skepticism and underdetermination, the nature of scientific justification, how Ockham's razor helps us find the true theory could offer a computational solution of the problem about a radically non-computable theory, and a computational solution of the problem of infinite regresses. Graduate students from other departments and undergraduates with training equivalent to 80-311 or 80-319 are welcome.

80-522 Seminar on Ethical Theory
Fall: 9 units

80-523 Seminar on the Philosophy of Language
Intermittent: 9-12 units

80-595 Senior Thesis
Fall and Spring: 3-18 units

80-600 Minds, Machine and Knowledge
Fall: 9-12 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 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 John Searle 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.

80-602 Journal Seminar
Spring: 6-12 units
This course surveys contemporary philosophical issues by discussing a different set of journal articles each week. Frequently the discussion focuses on the work of faculty from the department, from nearby universities, or from visiting scholars. Discussions are often moderated by the person whose work is being discussed. The course therefore provides an survey of a wide range of philosophical issues and strives to situate more technically oriented work within a broader philosophical context by emphasizing links to traditional philosophical problems, methods, frameworks or assumptions. The course also provides an opportunity for graduate students to explore potential areas of interest and to foster contact with potential thesis or dissertation advisors. This course is required for first year graduate students. Advanced undergraduates may participate only with the permission of the instructor.
80-610 Logic & Computation
Fall: 12 units
Among the most significant developments in logic in the twentieth century is the formal analysis of the notions of provability and semantic consequence. For first-order logic, the two are related by the soundness and completeness theorems: a sentence is provable if and only if it is true in every interpretation. This course begins with a formal description of first-order logic, and proofs of the soundness and completeness theorems. Other topics may include: compactness, the Löwenheim-Skolem theorems, nonstandard models of arithmetic, definability, other logics, and automated deduction. Prerequisites: 80-210 or 80-211, or an equivalent course in Mathematics or Computer Science.
Prerequisites:

80-611 Computability and Incompleteness
Fall: 12 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 formal 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. This course will cover these developments, and related results in logic and the theory of computability. Prerequisites: 80-210 or 80-211, or an equivalent course in Mathematics or Computer Science. 12 units

80-612 Philosophy of Mathematics
Spring: 12 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, formalism, etc. With a view to the 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 then discuss fundamental metamathematical results and their philosophical implications. A “reductive structuralist” position will finally provide a perspective for understanding the development of mathematics as well as its usefulness in applications. Prerequisites: familiarity with logic and basic notions of modern mathematics (as provided, for example, by 80-212, 80-310, 21-127 or 21-300).
Prerequisites: 80210

80-614 Logic Artificial Intelligence
Spring: 9-12 units
An introduction to several formalisms used in knowledge representation and database theory. The emphasis is placed on nonmonotonic 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. Prerequisites: A basic course in logic is recommended but not required.

80-617 Constructive Logic
Fall: 12 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. Prerequisites: 80-210 or 80-211 and a programming course.
Prerequisites: 15151 and 15211 and 15212 and 80210 and 80211

80-635 Seminar: Philosophy Politics and Economics
Spring: 9-12 units
Theories of rational choice and strategic interaction occupy a central place in modern economics, political science and political philosophy. This course will explore applications of decision and game theory to these three fields, with a special emphasis on issues such as social cooperation, public goods, and distributive justice.
Prerequisites: 80135

80-680 Philosophy of Language
Spring: 12 units
What constitutes an adequate theory of meaning for ordinary language? This question, which is central to the philosophy of language, will be the focus of the course. In answering it, we will confront many additional questions, including: what is the meaning of a sentence and what a speaker means? What is the connection between linguistic form and linguistic meaning? While we will explore classic philosophical answers to these questions, we will also investigate recent work in which the emerging insights of formal linguistics are used to shed new light on these old problems. The course will involve a significant amount of reading, and several paper assignments. While this is an introduction to the philosophy of language, it is not an introduction to philosophy. Students enrolling in this course should have taken at least one philosophy course in which they are exposed to the philosophy of language and writing at least one paper. Students interested in the course who lack this background may request permission from the instructors to enroll.

80-705 Game Theory
Spring: 9-18 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 applications of game theory to problems in moral and political philosophy and the social sciences.

80-711 Proof Theory
Spring: 9-12 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 ways. This will be done using the framework of Gentzen, who presented a set of systems 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. A solid understanding of the syntax and semantics of first-order logic, as obtained from courses like 80-310/610 or 21-300/600, is required. A course covering issues topics like primitive recursive arithmetic, Peano arithmetic, and systems of second-order arithmetic. 9-12 units

80-712 Intuitionism and Constructive Mathematics
Intermittent: 9-12 units
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.

80-717 Statistical Approaches to Learning and Discovery
Spring: 12 units
This course (crosslisted as 10-602/15-802/36-712) is the sequel to the core sequence for the M.S. in CALD’s Knowledge Discovery and Datamining. It builds on the material presented in 10-601, introducing new learning methods and going more deeply into their statistical foundations and computational aspects. The applications and case studies from statistics and computer science are used to illustrate each topic. Applications and case studies from computer science are also used to illustrate each topic. Applications and case studies from computer science are also used to illustrate each topic. Applications and case studies from computer science are also used to illustrate each topic. Applications and case studies from computer science are also used to illustrate each topic.

80-718 Computation and Proof Search
9-12 units
The broad informal question to be addressed is this: Can one "mechanize" significant parts of "mathematical reasoning"? To answer the question, we carry out a case study for Gödel’s incompleteness theorems and some theorems of set theory. That
requires extensive preparatory work in Parts 1 and 2 of the course. We survey in Part 1 problems that led to the search for a notion of mechanical procedure or computability, look at a number of different notions, and give a convincing conceptual analysis that is based on work by Turing, Post and Gandy. The decision problem is one of the problems that were solved, negatively, using such a rigorous notion of computability. The theorem of Church and Turing asserts that there is no mechanical procedure deciding whether or not a sentence in the language first-order logic is a logical truth. However, Gödel's completeness theorem guarantees that every logical truth can be proved - in a suitable calculus. A number of procedures have been developed to search systematically for proofs; Part 2 investigates "proof search procedures" for natural deduction calculi.

80-721 Cognitive Architecture and Bayesian Networks
Intermittent: 9-12 units
Bayes networks are the modern representation of causal relations in computer science. A Bayesian network is a compact graphical representation and in development in psychological, cognitive psychology, cognitive neuropsychology and social psychology. This course will introduce the networks and discuss their use in theoretical representations and discovery procedures in each of these areas.

80-781 Formal Semantics
Spring: 9-12 units
This course provides a high-level introduction to the field of formal semantics for natural language, and in particular the problem of meaning. The goal of formal semantics is to develop a theory capable of representing how the meanings of sentences are constructed from the meanings of their parts. The student must thus be able to represent the meanings of sentence parts i.e. words and word constituents, and provide rules for how these meanings are combined. In the course, we will adopt the model-theoretic, truth conditional approach which is standard in linguistic semantics. Our topic of 'meaning' will thus be restricted to the assignment of model-theoretic objects -- individuals, sets, functions, and so on -- to expressions of the language. This approach utilizes translation of natural language into a formal language (logic); part of the task, then, is to identify an appropriate logic to serve as the translation language. No background in linguistic theory is required for the course. However, students must be comfortable with basic set theory and with quantified first-order (predicate) logic. This formal background will be assumed.

Prerequisites: 80110 or 80210 or 80211 or 80310

80-811 Thesis Seminar
Spring: 12 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. Prerequisite: for students working on a philosophy thesis

80-812 Seminar on Causation
Intermittent: 12 units
This course explores the foundations of causation. It examines historical causal claims and theories of causation and introduces students to causal 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

80-813 Seminar of Philosophy of Mathematics
Spring: 9-12 units
The seminar discusses mathematical, logical, and philosophical work that is important for issues related to the foundations of mathematics. That range may be detailed presentations of constructive consistency proofs through conceptual analyses of central mathematical notions to the discussion of ontological and epistemological issues. Prerequisites: dependent on the chosen topic.

80-814 Philosophy of Science
Intermittent: 12 units
A graduate level, critical review of standard issues in the philosophy of science Topics will include determinism, predictability, causation, the rationality of belief in scientific claims, 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 a functor such algebraic methods into logic, leading naturally to the universal and other general models that distinguish functorial from classical semantics. Local categorical models can, 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. Prerequisites: 80-417 or instructor permission

80-820 Categorical Logic Seminar
Fall: 9 units
This course focuses on applications of category theory in 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 a functor such algebraic methods into logic, leading naturally to the universal and other general models that distinguish functorial from classical semantics. Local categorical models can, 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. Prerequisites: 80-417 or instructor permission

80-821 Seminar on Methodology
Spring: 9-12 units
This seminar is on my favorite topic, reconceiving issues in the philosophy of science and induction in computational, rather than probabilistic terms so that understanding performance rather than "justification" is the primary concern. The theoretical background of the course is known as "computational learning theory", but it may better be called "computationist epistemology". Instead of promoting a single standard of "rationality" or a single "scientific method" for all empirical questions, we will think of such questions as having basic properties that determine the best sense in which the true answer can be found. The subject is open-ended, with opportunities for keen students to make an original mark. Possible topics include: the topological and combinatorial structure of algorithms, analogies between uncomputability and the problem of induction, learning theory and "historicism" conclusions about the nature of science (computers can learn anything they can learn about the environment, the learning power of belief revision algorithms, infinite regresses of methods, modal logics of convergent knowledge, a derivation of Ockham's razor from the aim of minimizing retractions or errors prior to finding the truth, and how all of this relates to standard approaches in the philosophy of science and statistics, such as model selection, Bayesian updating and classical statistical tests. Graduate students from other departments and undergraduates with training equivalent to 80-311 or 80-319 are welcome. Others are welcome to check with the instructor. The basic text will be the instructor's book The Logic of Reliable Inquiry, which will be augmented by articles
Physical Education

69-101 Racquetball
Fall and Spring: Mini Session - 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: Mini Session - 3 units
This course is designed to provide the opportunity for the inexperienced student to learn the carefully planned weight-training program as a method of body development and the contributing benefit to performance in many sports.

69-104 Integrated Strength Training
Spring: Mini Session - 3 units
This course improves functional strength, core strength balance, and functional flexibility.

69-105 Agility & Circuit Training
Spring: Mini Session - 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.

69-107 Power Walking
Spring: Mini Session - 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.

69-108 Jogging for Fitness
Fall and Spring: Mini Session - 3 units
This course will be a jogging 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. Guidelines will be enforced, but individual goals will be the main concern. Stretching, health and nutrition will be discussed.

69-109 Karate
Fall: Mini Session - 6 units
The student begins the study of application of the basic techniques in combinations (continuous execution of techniques in succession). Basic sparring is also introduced, along with additional formal exercises (Katas).

69-110 Personal Fitness
Fall: Mini Session - 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: Mini Session - 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 overall fitness while fusing the total package of mind, body, and spirit.

69-128 Shaolin (Kung Fu) Temple Boxing
Fall and Spring: Mini Session - 3 units
Shaolin Temple Boxing trains the external aspects of Chinese Kung Fu which helps beginning students attain firm balance, flexibility, agility, power, endurance, and strength, coordination, mechanical and structural alignment, coordination, stability while moving, and a physically strong body. A well-rounded physical regimen will warm up the muscles and elongate the tendons for the Stationary Basic exercises, Walking Basics, and Kicking Basics, leading into Empty Hand Forms Practice and Sparring. Emphasis will be placed on knowledge fundamental techniques and power-issuing methods. These basic skills are practiced in the context of developing all aspects of the fighting arts such as foot and leg work, striking with all parts of the body; seizing and locking (chin na); and throwing (shuai jiao). The instructor is Marc P. Black.

69-129 Rape Agression Defense Systems (RAD)
Fall and Spring: Mini Session - 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, a workplace, or an 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 Tennis
Fall and Spring: Mini Session - 3 units
Beginner/Intermediate Tennis: 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. Advanced Tennis: This course will consist mainly of tennis skills 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.

69-131 Volleyball
Fall: Mini Session - 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.

69-134 Beginning Golf
Fall and Spring: Mini Session - 3 units
This course is designed to give the student all the skills necessary to play a satisfactory game of golf. The long game, the short game and putting are covered. It is a leisure time sport that is challenging and can be used by the student for the rest of his/her life.

69-135 Soccer Skills
Fall: Mini Session - 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: Mini Session - 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.

69-140 Squash
Fall and Spring: Mini Session - 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
Fall and 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.

69-144 Diamond Sports
Spring: Mini Session - 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.

69-150 Beginning Swimming
Fall: Mini Session - 3 units
This basic course is designed to equip the non-swimmer with fundamental skills and knowledge to assure reasonable safety in,
A user-friendly style of yoga for the general population. In this 69-151 Advanced Beginner's Swimming Spring: Mini Session - 3 units This course is designed for individuals who are comfortable in shallow water and who can swim in any form from one side of the pool to the other. Areas covered include refinement of basic swimming strokes, basic diving, safe water entry and some elementary forms of rescue.

69-153 Lifeguard Training Spring: 6 units The American Red Cross Lifeguard Training course material will be taught. Students who complete the course will be eligible to be employed as lifeguards. Attendance required.

69-154 Intermediate Swimming Fall: Mini Session - 3 units This class is designed for the swimmer that can tread in deep water, has no fear of water, and would like to learn the proper techniques of the basic swimming strokes.

69-155 Aerobic Fitness 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: Mini Session - 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.

69-157 Swimming Stroke Improvement Fall and Spring: 6 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.

69-158 Beginning/Intermediate Yoga Fall and Spring: Mini Session - 3 units A user-friendly style of yoga for the general population. In this course, you will discover new ways to move, breathe, stretch, and relax using traditional yoga poses. Participants will breathe better, move easier, and become more comfortable in everyday activities.

69-159 Aqua @ Both Ends Fall and Spring: Mini Session - 3 units Discover a great way to effectively train and smoothly blend excitement and fun with directional changes and multi-dimensional movement while working your heart, toning your deepest muscle layers in your body. Participants are in either shallow or deep water. NO SWIMMING SKILLS REQUIRED! Buoyancy and resistance equipment supplied.

69-160 Swim-Fit Fall: Mini Session - 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.

69-161 Beginning/Intermediate Yoga Fall and Spring: Mini Session - 3 units A user-friendly style of yoga for the general population. In this course, you will discover new ways to move, breathe, stretch, and relax using traditional yoga poses. Participants will breathe better, move easier, and become more comfortable in everyday activities.

69-162 Beginning/Intermediate Yoga Fall and Spring: Mini Session - 3 units A user-friendly style of yoga for the general population. In this course, you will discover new ways to move, breathe, stretch, and relax using traditional yoga poses. Participants will breathe better, move easier, and become more comfortable in everyday activities.

69-175 Dance for Non-Majors (Fusion of Dance Styles) Fall and Spring: Mini Session - 3 units Students will learn basic concepts and techniques that focus on body awareness set to progressive and alternative music. The overall objective will be focus on releasing muscle tension, developing a stronger core, and attending to proper skeletal alignment all while having a good time and moving, moving. Open to non-drama and drama majors. Instructor - New York Professional Gia Cacino

69-190 Alternative Health Fall: Mini Session - 3 units This course is designed to expose students to various complementary and alternative health practices. The field of "integrative medicine" will be seen as providing novel insights and tools for human health. A broad range of healing philosophies (soma, fields of thought, and mainstream Western (conventional) medicine) will be discussed. Classes will be a series of guest lecturers and experienced professionals from the community. Please come prepared to experience some alternative practices. Dress comfortably.

69-191 Wellness Spring: Mini Session - 3 units This course is designed to be a do-it-yourself guide to whole person well-being (body, mind, and spirit). Students will learn that wellness is the right and privilege of everyone. No matter what the student's current state of health, they will learn how to appreciate themselves as growing, changing, developing people. This class will allow students to move toward health by integrating practices and philosophies that promote well living. Concepts include the classic work of John Travis and Regina Ryan (The Wellness Workbook).

69-193 Healthy Eating, Healthy You Spring: Mini Session - 3 units The college setting can present a challenging environment for healthy eating. Away from home for the first time, students are often exposed to a variety of food choices available at all times of the day and night. Regulating eating habits and making healthy food choices can become an overwhelming task. This course will provide students with practical, up-to-date information, ranging from nutrition basics to food counsel and in contemporary issues involved in contemporary eating habits. Upon completion of this course, students will be able to make their own dietary behaviors and devise a plan for healthy eating that fits their lifestyle and academic schedule. This course is open to all students. The Registered Dietitian from Student Health Services will teach the course, Healthy Eating, Healthy You.

69-195 Emergency Medical Technician Spring: 6 units This course is designed to instruct a student to the level of Emergency Medical Technician-Basic. This includes all skills necessary for the individual to provide emergency medical service at a basic life support level with an ambulance service or other emergency service. Students who pass the state exam will receive Pennsylvania Accreditation as EMT-Basic.

**Physics**

33-100 Basic Experimental Physics Fall and Spring: 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.

33-101 Physics First Year Seminar: Science and Science Fiction Fall: Mini Session - 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.

33-102 Concepts of Modern Physics Spring: 9 units This course is designed to provide non-technical students an opportunity to learn about some of the frontier areas of physics in which active research is now going on. Topics that may be covered include the current models of elementary particles, how the fundamental forces are understood in terms of quantum physics, wave mechanics and atomic physics, Einstein's Special and General Theories of Relativity, and Astrophysics and Cosmology. Although the emphasis is on concepts rather than mathematical methods, algebra and trigonometry are used in order to enable students to reach a deeper and more quantitative knowledge of the concepts. Students write brief reports about current topics in science and give a seminar on a topic of current interest in physics.

33-104 Experimental Physics
Fall and Spring: 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 law of motion, 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.
Corequisites: 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. 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 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.
Corequisites: 21-120

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 include vectors, displacement, velocity, acceleration, force, equilibrium, mass, Newton's law of motion, 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.

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 propagation of electromagnetic waves. 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 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.
Corequisites: 21-120

33-132 Matter and Interactions II
Fall: 12 units

A more challenging alternative to 33-112, Physics for Science Students II. Emphasis on atomic level description and analysis of matter and its electric and magnetic interactions. Coulomb's law, polarization, electric field, plasmas, field of charge distributions, microscopic analysis of resistor and capacitor circuits, potential, macroscopic analysis of circuits, Gauss' law, magnetic field, atomic model of magnetism, Ampere's law, magnetic force, relativistic issues, magnetic induction with emphasis on non-Coulomb field, Maxwell's equations, electromagnetic radiation including its production and its effects on matter, re-radiation, interference. Computer modeling and visualization; desktop experiments.
Prerequisites: 21120 and 33106
Corequisites: 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 refraction. 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, atomic and nuclear backgrounds. The course will also be concerned with the origin of musical tones and the physics of music. There are no formal prerequisites, but an ability to read music and having some previous musical experience will be very useful.

33-115 Energy and Environmental Issues
Fall: 10 units

An introduction to the fundamental principles and methodology of physics. The course will introduce and use the physics concepts of energy and the laws of thermodynamics to analyze environmental issues, such as fossil fuel use, nuclear power, solar power and other forms of energy. Issues of risk assessment will also be discussed. This course is intended for students in the Colleges of H&SS and Fine Arts and does not require calculus, however, students are expected to have some facility with basic algebra.

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.

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, potential, angular momentum and other collective 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).
Corequisites: 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 field, Maxwell's equations, electromagnetic radiation including its production and its effects on matter, re-radiation, interference. Computer modeling and visualization; desktop experiments.
Prerequisites: 21120 and 33131
Corequisites: 21-122

33-201 Undergraduate 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 roughly one hour per week of reading and/or problem solving.

33-202 Undergraduate Colloquium II
Spring: 2 units

This course (together with 33-201) 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 roughly one hour per week of reading and/or problem solving.

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, who want 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.
Prerequisites: 33112 or 33132

33-213 Mini-Course in Special Relativity
Fall and Spring: Mini Session - 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: 33112 or 33132

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 horizons 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. Introduction to observational methods is required, but no previous physics will be introduced as needed in the course. The course is intended for science and engineering majors as well as students in advanced courses such as Physical Mechanics, Electricity and Magnetism, and Advanced Quantum Physics. Other topics of interest such as application to graduate school, areas of industrial research and job opportunities will also be presented.
Corequisites: 33-131, 33-111, 33-106

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 particles 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: 33107 or 33112 or 33132

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. Computer techniques are used to analyze all of the above linear systems. Finally, we examine and build some simple digital integrated circuits.
Prerequisites: 33107 or 33112 or 33132

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: 21122 and (33112 or 33132)

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 Quantum Mechanics, Electricity and Magnetism, and Advanced Quantum Physics.
Prerequisites: 33231

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 Schroedinger 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: 33211

33-241 Introduction to Computational Physics
Fall: 9 units
This 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: 15100 and 21122 and 33104 and (33112 or 33132)

33-301 Undergraduate Colloquium III
Fall: 1 unit
Junior and senior 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.

33-302 Undergraduate Colloquium IV
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: 21259 and 33232

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: 33331

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: 21259 and 33232

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 electrodynamical 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: 33338

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,
Prerequisites: 33107 or 33112 or 33132

Students should have taken a prior laboratory sign up for these laboratory sessions and perform the exercises. Atomic forces involved in various nanostructures. Students will apply to phase transitions 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: 33111 and 33234

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 to cases where a system is far from equilibrium. Equilibrium of multicomponent systems are developed and applied to phase transitions 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: 33111 and 33234

The 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: 33344

The student undertakes a project of interest under the supervision of one of the members of the faculty.

Prerequisites: 33353


Prerequisites: 33112

Nanoscience and Nanotechnology
Fall: 9 units

This course will explore the underlying science behind nanoscience and nanotechnology, the tools used to create and characterize nanomaterials, and the 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: 33107 or 33112 or 33132

Undergraduate Colloquium V
Fall: 1 units

A continuation of 33-301, 302 for seniors.

Prerequisites: 33-331

Introduction to BioPhysics
Fall: 10 units

This course introduces the use of physical methods in the study of biological systems. The biological systems to which the methods are applied will be surveyed and current interpretations of their structure and function will be discussed. Biological systems that have been discussed in recent years include membranes, nerves, muscle, photosynthetic systems and visual systems; not all these topics can be treated, and the particular selection of topics will be influenced by the interests of the individual student.

Prerequisites: 33234 and 33338

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: 33234

Corequisites: 33-331

Advanced 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, multiparticle states, identical particles; approximation methods.

Prerequisites: 33234

Corequisites: 33-331

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: 33445

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 methods are applied 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 concept of electronic bands and the idea of quantization of electronic wave functions. The concept of Fermi liquid theory is introduced. Fermi liquid theory is the basis for the description of Fermi liquids and Fermi gases.

Prerequisites: 33234 or 33225 and 33341

Senior Research
Fall and Spring: 1-12 units

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 will be responsible for the preparation 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 will be available before pre-registration in spring of the junior year 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 will emphasize 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: 33241

33-458 Special Problems in Computational Physics
Fall and Spring: 9 units
This course will consist of a research problem under the direction of a Department faculty member on a computational physics problem of mutual interest.
Prerequisites: 33456

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 studied 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 scenarios.
Prerequisites: 33224 and 33234

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: 33224 and 33234

33-499 Supervised Reading
Fall and Spring: 1-12 units
The student explores a certain area of advanced physics under the supervision of a faculty member.

33-650 General Relativity
Fall: 9 units
General Relativity (GR) is the foundation upon which we build a theory for the universe. The course will outline GR and provide students with a solid physical understanding of the elegant theory. The course will also use GR to explain the observable universe and students will get an appreciation of this theory through modern-day experiments.
Prerequisites: 33211 and 33339

33-658 Quantum Computation and Quantum Information Theory
Spring: 9 units
This course provides an overview of quantum computation and quantum information theory. The topics include quantum mechanics; quantum channels, both ideal and noisy; quantum cryptography; an introduction to computational complexity; Shor’s factorization algorithm; Grover’s search algorithm; proposals for the physical realization of quantum devices, such as ions in traps, solid-state devices, and nuclear magnetic resonance. Linear algebra at the level of 21-241 or 21-341, or as taken up in 33-345, is a prerequisite. Students who are not familiar with vector spaces over complex numbers, including unitary and Hermitian operators, will need to learn these topics on their own. Quantum mechanics is not a prerequisite, but some prior knowledge at the level of 33-234 or 33-445 will prove helpful. Algorithms and complexity theory are not prerequisites, but some prior knowledge at the level of 15-211, 15-251 or 15-451 will prove helpful. This course is also offered for 12 units as 33-758, which involves some additional work.

Psychology

85-100 Introduction to Intelligence in Humans, Animals and Machines
Fall: 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
Spring and Summer: 9 units
This course examines major areas of scientific psychology in some depth, the attempt being to develop an understanding 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, observance 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.

85-111 Self-Paced Lisp Lab
Fall: 3 units
Students enrolled in 85-213, Human Information Processing and Artificial Intelligence, who are not familiar with LISP are required to take this self-paced LISP-lab. Students who are already familiar with LISP cannot take the lab for extra credit.
Corequisites: 85-213

85-211 Cognitive Psychology
Fall and Spring: 9 units
This course will examine the cognitive processes underlying perception, mental imagery, short- and long-term memory, our language comprehension, decision making, problem solving and skilled performance. Both the theory and the basic experimental findings will be covered in each area and the emphasis will be on the underlying information processing mechanisms.

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: 15211

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. Topics will include: person perception, prejudice and discrimination, the nature of attitudes and how attitudes are formed and changed, interpersonal attraction, conformity, cooperation, altruism, aggression, helping 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 Spring: 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 with a slightly different viewpoint. Included among these approaches are the dispositional, psychoanalytic, learning, phenomenological, and cognitive self-regulation perspectives. This course will also 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.

85-310 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 repeated measures, qualitative and quantitative detection are also covered. Cognitive modeling will also be discussed. Topics include mental imagery, memory, and perception. This is a format consisting of lectures, discussions and student presentations. You must have either taken 36-309 previously or 36-309 can be taken as co-req. Prerequisites: 85211 or 85213 Corequisites: 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 in conducting research and in evaluating the research of others. Special emphasis will be given to the unique methodological problems associated with the study of developmental variables. You must have either taken 36-309 previously or 36-309 can be taken as co-req. Prerequisites: 85221 Corequisites: 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 and skills for doing research. Topics will cover measurement of dependent variables, questionnaire design, experimental and quasi-experimental, design and ethical issues involved in doing research and experimental techniques as applied in both field and laboratory settings will be covered. Students will be expected to critique completed research. They are also expected to design measures and complete their own original studies. During the course of the semester students will also be expected to design and carry out an original research project as well. You must have either taken 36-309 previously or 36-309 can be taken as co-req. Prerequisites: 85241 or 85251 Corequisites: 36-309

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 goal of giving 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, cognitive psychology and cognitive science.

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 patients with 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 mental control of action. In each instance, the emphasis will be on how the application of converging methodologies, particularly those related to brain organization, lead to insights into the nature of cognitive processes that would be difficult to obtain through any one conventional methodology alone. Prerequisites: 85211 or 85219

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 basic 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 will also have 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: (85241 or 85251) AND (85310 or 85320 or 85340)

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 with the 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 course is to think deeply about how our theories and research findings have been and could be used to support the development of children in a variety of contexts, such as at home, daycare, school, playgrounds, etc. and to evaluate different activities, materials, and contexts in relation to established theories and empirical findings. The overall purpose of the course is to understand how theory can inform practice and vice versa. Prerequisites: 85221

85-370 Perception Intermittent: 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: 85102 or 85211 or 85213 or 85219

85-375 Cross Cultural Psychology
Intermittent: 9 units
Human beings share a common genetic inheritance, but our cultural instincts differ in a large variety of ways. This course explores the many different cultural expressions of basic human cognitive and social abilities and needs. We will look at the sensory registers, i.e., how we perceive things; working or short-term memory; long-term memory or our knowledge base. This course will discuss the differences between procedural/skill 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: 85102 or 85108 or 85150 or 85198 or 85211 or 85219 or 85241 or 85251 or 85261

85-380 The Historical Development of Experimental Psychology
Intermittent: 9 units
This course will focus on three aspects of the origin and growth of the 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 major issues that have dominated psychology. This course will briefly examine relevant ideas about consciousness that arise in consciousness, cognitive anthropology, dialectic materialism, and modern ethology.

Prerequisites: 85100 or 85102 or 85108 or 85150 or 85198 or 85211 or 85219 or 85241 or 85251 or 85261

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 unconscious can be and another is on the interaction of conscious and non-conscious processes in the control of cognition. We will also 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 readings 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: 85310 or 85320 or 85340

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 would 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.

Prerequisites: 85211 or 85213

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 there a process of acquiring expertise and movement across different domains from music to sports to science? Research studied in the course will employ a variety of methodologies, from basic studies to protocol analysis to computational modeling.

Prerequisites: 85211 or 85213

85-406 Seminar on Autism
Intermittent: 9 units
Autism is a disorder that affects many cognitive and social processes, sparing none. It has been demonstrated to dramatically enhance student 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: 85211 or 85213 or 85219 or 85355 or 85429

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: 85213

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?)? Then we will examine what current research studies that have illuminated the nature of autism, focusing on its causes and the biological implications of its presence.

Prerequisites: 85211 or 85213

85-417 Cognitive Modeling and Intelligent Tutoring Systems
Fall: 9 units
This course addresses the use of cognitive psychology and artificial intelligence to create computer-based “intelligent tutoring systems”. Students will learn data-driven and theoretical methodologies for creating cognitive models of human problem solving. Such models have been used to create educational software that has been demonstrated to dramatically enhance student learning in domains like mathematics and computer programming. In addition to discussion and readings on methods and models of problem solving, learning, and tutor design, the course will have substantial “learning by doing” component. Students will be analyzing data, designing models and interfaces, and implementing an intelligent tutoring system. Students should either have programming skills (LISP experience is desirable but not necessary) or experience in the cognitive psychology of human problem solving. Additional pre-req preferred: 05-610 Intro to HCI or a course in Artificial Intelligence. This course is also cross-listed with 05-832 in HCI.

Prerequisites: 15211 or 85217 or 85411

85-419 Introduction to Parallel Distributed Processing
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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 more than one language? How do differences between languages reflect the mind in general or the specific development of language? What is so special about a second language? Are there important links between language change and cultural change that point to links between language and culture?
Prerequisites: 80150 or 80180 or 82382 or 85108 or 85211 or 85213

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: 85221

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 information processing capacity and the extent that differences in capacities have upon the child’s ability to interact with the environment in problem solving and learning situations.
Prerequisites: 85221

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 the brain imaging techniques that make possible the interpretation of brain responses to questionnaires and other tasks. We will begin with a discussion of the basic concepts of brain imaging and the different approaches for measuring brain activity, including PET and functional MRI (fMRI) and also some PET imaging. Several different technologies for measuring brain activity (e.g., PET and functional MRI) will be considered, attempting to relate brain physiology to cognitive functioning. The brain imaging in normal subjects and in people with various kinds of brain damage. Prerequisites: 85211 or 85213 or 85411 or 85412 or 85414 or 85419

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 research 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, helpfulness 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 social factors contribute to (or detract from) 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 Interpersonal Relationships
Fall: 9 units
The focus on this class will be on theories and studies of attraction and of relationship functioning. Definitions of attraction and of relationships, classical reinforcement theories of language, attribution theories of attraction, misattribution theories, self-evaluation maintenance theory, attachment theory and several other theoretical approaches to understanding attraction and relationships will be covered. Classes will be discussion- and debate-oriented and every student will be expected to: a) read original research articles and chapters, b) regularly turn in comments about those readings, c) participate in discussion and debate. You will be expected to: a) read original research articles and chapters, b) regularly turn in comments about those readings, c) participate in class discussions, and d) write four papers (to be handed in at the end of approximately every 3-4 weeks).
Prerequisites: (85241 and 85340) or (85251 and 85340)

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: 85241 or 85251

85-449 Emotion and Social Behavior
Intermittent: 9 units
This is an advanced seminar on emotion and social behavior. The course is new and the exact contents are still being developed. Examples of questions likely to be addressed are: What is emotion? How might one differentiate such things as emotions, moods, and temperaments? What are the physiological, cognitive, and behavioral determinants of emotions? What are the physiological, cognitive and behavioral consequences of emotions? How do individuals’ emotional lives differ (e.g., men’s versus women’s; secure versus insecure individuals; people in stable relationships versus those in unstable relationships)? How does relationship context influence emotion and how does emotion influence relationships?
Prerequisites: (85241 or 85251) and 85340

85-455 The Discovery of Spoken Language
Intermittent: 9 units
This class 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: 85211 or 85213

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This course is a cooperative effort by Carnegie Mellon University and a number of community and hospital-affiliated professionals. Through participation in this course, students will be exposed to didactic instruction and hands-on experience relevant to mental health treatment and applied clinical research.

Prerequisites: 85251 or 85261 or 85281.

85-482 Internship in Psychology
Fall and Spring: 3–12 units
The Internship in Psychology is designed to enable students to gain experience in professional settings related to their studies in Psychology and earn credit for the intellectual work involved. It is the students responsibility to locate an internship site and on-site supervisor, as well as to identify a CMU faculty sponsor. The student registers for the internship by submitting a completed internship form to Theresa Kurutz in Baker Hall 343.

85-484 Practicum in Child Development
Fall and Spring: 9 units
This guided field experience is designed to help students deepen their understanding of developmental psychology by assisting in a preschool or kindergarten classroom and discussing the ways that their experiences relate to the theories they have learned previously and to new readings. Each student will individually schedule a consistent 6 hours per week helping in a Children’s School classroom (preferably 2 or 3 chunks of time). Classroom duties will include working one-on-one and with small groups of students as well as puzzles, art projects (as well as helping with snack, playground supervision, classroom cleanup, and storytelling). Each student will be expected to keep a Journal of general experience (developmental theories 1 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: 85221.

85-490 Seminar on Implicit and Explicit Memory
Intermittent: 9 units
This seminar will discuss current topics in human memory as well as cover some of the basic conceptualization of the functionality of memory and information processing. Most weeks, the instructor will review an aspect of human memory or the literature relevant to the evening’s topic. In addition, we will discuss one or two journal articles. Students in the course will be responsible for reading all the articles but responsibility for leading the discussion will rotate. The course will require each student to either conduct an experiment relevant to a topic discussed or do a literature review relevant to one of the topics under discussion. Interested students must have taken a basic course in Cognitive Psychology to enroll.

Prerequisites: 85211 or 85213.

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 recent 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: (85241 and 85340) or (85251 and 85340).

85-505 Readings In Psychology
All Semesters: 3–12 units
As its 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 accepted for credit only if 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: 3–12 units
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 9, 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 (85-611,612) in that it does not require Honors standing in HSS, but it may be taken for any number of units up to 9 (i.e., there are no GPA requirements). This course differs from Problems 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 the 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 (85-611,612) in that it does not require Honors standing in HSS, but it may be taken for any number of units up to 9 (i.e., there are no GPA requirements). This course differs from Problems 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.

Robotics
16-199 Building the Future
Spring: 4 units
The goal of this project course is to teach undergraduates (especially freshmen and sophomores) how to build such things as robots and intelligent environments, and how to get involved in research. In the process we will develop our abilities to predict how technology will affect the future.

16-221 Robots to the Rescue: A Gentle Introduction to Mobile Robotics
All Semesters: 12, 18 units
This course has been designed to teach the basic tools and techniques of engineering and programming a mobile robot. Student teams will build an autonomous mobile robot (from kits that will be provided), and learn to program it to perform increasingly sophisticated behaviors. Besides providing an introduction to autonomous mobile robot technologies, the students also learn key concepts of mechanics, electronics, programming, and systems design and integration. Maybe most important, the students will be learn how to use the system for solving interesting and challenging problems in rescue robotics.

16-264 Humanoids
Fall: 12 units
This course will survey work on humanoid robots and simulated humans in movies, games and other applications. Topics will be taken from perception including visual, auditory, and tactile perception, cognition including reacting, planning, and learning, and movement generation including locomotion, dynamics, control, manipulation, and bipedal locomotion.

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 differential equations, Laplace transforms, system response, feedback control, time and frequency domain analysis, digital control, and robotic control. Laboratory work includes implementation of controllers for force feedback robotic devices. Prerequisites will be given to computer science majors with robotics minor.
Prerequisites: 15211 and 21122

16-311 Introduction to Robotics
Fall and Spring: 12 units
This course presents an overview of robotics in practice and research with topics including vision, motion planning, mobile mechanisms, kinematics, inverse kinematics, and sensors. In course projects, students construct robots which are driven by a microcontroller, with each project reinforcing the basic principles developed in lectures. Students nominally work in teams of three: an electrical engineer, a mechanical engineer, and a computer scientist. This course will put into practice some of the contemporary happenings in robotics, which includes current robot lab research, applications, robot contests and robots in the news.
Prerequisites: 15111 and 21122

16-362 Mobile Robot Programming Laboratory
Fall: 12 units
This course is a complete, hands-on introduction to Mobile Robot Programming. Using six Nomad Scout robots and portable computers, we will survey topics ranging from low-level control and obstacle avoidance, to high-level navigation, planning, robot-robot communication and cooperation.

16-363 Advanced Mobile Robot Programming
Spring: 9,12 units
Advanced Mobile Robot Programming is an advanced research and development course for graduates. In this class, teams of students conduct research and prototype working robot architectures that are research-quality. The best robot systems are generally demonstrated at the National Conference on Artificial Intelligence.
Prerequisites: 16362

16-464 Technical Animation
Fall: 12 units
This course introduces techniques for computer animation such as keyframing, procedural methods, motion capture, and simulation. The course also includes a brief overview of storyboarding, scene composition, lighting and sound track generation. The second half of the course will explore current research topics in computer animation such as dynamic simulation of flexible and rigid objects, automatically generated control systems, and evolution of behaviors. The course should be appropriate for graduate students in all areas and for advanced undergraduates.
Prerequisites: 15462

Social & 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. You may 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 include basic market behaviors, 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 assessing policies and priorities. What is the priority of human rights abuses/issues? And if 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
Interruption: 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 believe in ESP, alternative medicine, 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 pick from other students on a term paper describing its acceptance (by at least some people) and possible reasons for such acceptance. The major text will be Daniel'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."
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, peaceful assembly, and the freedom to petition the government for redress of grievances. This course examines the historical origins of the U.S. Constitution, of each of the first ten amendments to the Constitution (that refer to an “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 through cases that have challenged and been interpreted through the Bill’s articles.

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 refer to an “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 through cases that have challenged and been interpreted through the Bill’s articles.

88-198 Research Training: Social and Decision Sciences
Fall and Spring: 6.9 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 of lab in ways that might stimulate additional interest in research participation. Faculty and students devise a personal and regular-ized 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 Advising 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 approval; 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 public policy as the making of laws and rules and their implementation by government. Public policy will be analyzed as an alternative to private markets for making collective decisions. The US began in 1787 as a minimal nation providing mainly collective goods such as national defense, with markets making most of the decisions about the allocation of resources. The course will be organized around the general presumption that a justification for government activity is to do things that markets do not do well, that is, to rectify “market failures.” Among the policy areas to be considered are environmental protection, science and technology policy, competition policy, trade policy, homeland security. The course will consider the possibility that government intervention to remedy market failures can make things worse as well as better.

88-205 Comparative Politics
Fall: 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 presents the basic ideas of microeconomic analysis, providing an introduction to issues in policy analysis and management. The first part of the course consists of a positive analysis of private markets, examining consumer choice, the supply and demand of factors and produced goods, and general equilibrium. The second part of the course consists of a normative analysis of markets. This begins with an examination of the conditions necessary for markets to be economically efficient. This is followed by a detailed analysis of market failure, with private markets are not efficient. The strengths and weaknesses of markets are then examined in a broader framework encompassing conditions with information decentralization, constrained utility, compatibility, transactions costs, and property criteria such as equity and fairness. Markets are compared in this light with organizational, governmental, and other modes of resource allocation. Grading will be based on student progress, 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 government may use in attempting to correct market failures and in pursuing objectives other than efficiency. The basic concepts and tools of cost benefit analysis are presented. Students will 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 student contributions 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; methods for quantifying preferences and expert opinion; risk analysis and the development and use of computerized decision aids ranging from spread sheet programs to highly specialized decision support models. Prerequisites: 36201 or 36211 or 36217 or 36220 or 36225 or 36247 or 70207 or 36207

88-251 Empirical Research Methods
Spring: 9 units
This course emphasizes explicit procedures for analyzing complex decisions. The topics covered include: decision trees and other models of decisions; methods for quantifying preferences and expert opinion; risk analysis and the development and use of computerized decision aids ranging from spread sheet programs to highly specialized decision support models. Prerequisites: 36201 or 36211 or 36217 or 36220 or 36225 or 36247 or 70207 or 36207

88-260 Organizations
Fall: 9 units
Why do some firms operate effectively, while others struggle? Why do people join together in organizations rather than operate individually? This course explores organizations in a variety of contexts from firms competing in high tech industries to academic libraries educating the world to condominium associations protecting owners’ rights. Each instance is a case of
individuals seeking collective increases in social welfare or personal utility through organizing. We will look at how the effectiveness of and experiences in an organization are shaped by the organization's history and structure, advances in technology, and the competitive environment. The course will use cases to explain how organizations actually behave by examining the functioning of organizations at different levels: individuals members of employees, departments or subunits, and groups of organizations.

88-270 International Organizations
Spring and Summer: 9 units
The international system is often characterized as anarchical. Over time, however, nation states have created international organizations which can provide a structure for states to manage inter-state interaction. International organizations participate in a wide variety of global challenges: the regulation of the international commons, the promotion of economic and social development, the provision of public services, and the enforcement of global human rights norms. Are international organizations simply another way for states to pursue their national interests, or are they venues in which competing expectations about norms of international interaction can be created and reinforced? This course will explore and analyze a number of approaches to understanding international organizations and the roles and functions of international organizations in today's world: 1. Identify the various types of international organizations and discuss the characteristics of each; 2. Examine the various theories and concepts used to study international organizations; 3. Evaluate the past and present performance and future prospects of international organizations.

88-280 The New European Union: Old Europe, New Europe and the US
Intermittent: 9 units
Before the war in Iraq, a key member of the Bush administration talked about "Old Europe" and "New Europe". Old Europe, made of France, Germany, and Italy, backed the war in Iraq, which greatly benefited these countries. New Europe, made of countries like Eastern Europe (e.g., the United Kingdom, Italy) and Eastern Europe (e.g., Poland, the Czech Republic), supported the war in Iraq, endorsed market-oriented economic reforms, and looked at the US as an ally, and in some cases, even as a model. The future of Europe, however, is something more than old versus new. This course, against the above mentioned dichotomy, introduces students to the new European Union and the meeting of Western Europe with Eastern Europe as a result of the enlargement round in May 2004. Topics will include: the debate over the "European Union Constitution", the process made towards a common foreign and security policy, the relations with the US, and the strategy towards the developing world.

88-302 Behavioral Decision Making
Fall: 9 units
Behavioral decision making is the study of how people make decisions, in two specific belief systems: Nazism, and belief in satanic culture. The course begins with a survey of selected topics in Pseudoscience and the Paranormal (the title of the first textbook, by Terrance Hines). We then discuss cognitive principles that help explain: "How We Know What Isn't So" (title of the second textbook, by Thomas Gilovich) of Order Police Battalion 101, middle-aged men who volunteered for police work to help the war effort and ended up implementing the final solution in Poland. The satanic cult beliefs are covered in a number of journal articles, magazine write-ups, and a Frontline PBS presentation. Each days period will involve a presentation by a group of students and by Dawes. Finally, each student will pick an irrational belief system other than Nazism or satanic cult belief to study and analyze. Reviews of this belief system will be due approximately 60% of the way through the semester, and a final paper analyzing its cognitive and social supports will be due at the end. That final paper, with a class presentation, will be required in lieu of a final examination. Depending on the number of students in the course, these final projects may or may not be discussed with the other students in class. In contrast to the reviews and papers, three-hour-long quizzes will concentrate mainly on factual matters, so that we can be assured that all materials covered are known by all.

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 authoritarianism. Depending on the number of students in the course, reviews of this belief system will be due approximately 60% of the way through the semester, and a final paper analyzing its cognitive and social supports will be due at the end. That final paper, with a class presentation, will be required in lieu of a final examination. Depending on the number of students in the course, these final projects may or may not be discussed with the other students in class. In contrast to the reviews and papers, three-hour-long quizzes will concentrate mainly on factual matters, so that we can be assured that all materials covered are known by all.

88-316 Game Theory
Intermittent: 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 games as conceptual models, 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.

88-324 Electoral Systems and Processes
Intermittent: 9 units
Elections provide the commonest means of aggregating the preferences of individuals into societal outcomes. However, Arrow's Impossibility Theorem tells us that every electoral system must fail to satisfy one or more criteria of fairness or sensitivity. This course broadly explores the political consequences of electoral rules. It will cover elections in both governmental and non-governmental organizations, as well as more formal models of social choice. Specific topics will include proportional representation versus first-past-the-post, at-large versus district elections, redistricting, Arrow's Theorem, Duverger's Law, and Black's Median Voting Theorem. Grading will be based on a combination of written assignments and in-class exams.

88-325 Electoral Politics
Intermittent: 9 units
This course examines political competition in the electoral arena, an arena highly dependent on concentration of ownership, and aggregation of decisions by voters, candidates, activists, interest groups, and political parties. We will address questions such as: How do voters evaluate candidates, incorporate information, and decide to vote? What is the role of "culture" and "values," and is the public really polarized? Why do candidates run for office, "go negative," and what explains their positioning? Do activists, interest groups, or parties matter? Methods of empirical analysis will be discussed, and students will also design and conduct their own election survey. During appropriate election years, special attention will be paid to discussing current presidential and/or congressional elections.

88-326 Theories of International Relations
Fall and Spring: 9 units
This course has three major dimensions. Assumptions and propositions of the leading theories of international relations will be examined. We will begin with realism, with an emphasis on the beliefs of realists and on the experiences of realists (e.g., Boner, Feaver, Jervis, Krasner, Keohane, etc.). We will then move on to constructivism, with a focus on the beliefs of constructivists and on their experiences (e.g., Cohen, Price, Wæver, etc.). Finally, we will move on to neorealism, with a focus on the beliefs of neorealists and on their experiences (e.g., Walt, Waltz, et al.). In each case, we will examine the assumptions, propositions, and implications of each theory, and we will also examine the evidence that supports and contradicts each theory.
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 Doctrine, "New Look," "detente," the democratic peace, and contemporary approaches to combating global terror. Theoretical readings in history and political science will be used as analytic filters to assess both scholarly evaluations of American foreign policy and key historical episodes.

88-330 Political Economy of Inequality and Redistribution Intermittent: 9 units
Societies use welfare policies, social insurance, public enterprises, 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 characteristics included in the poverty literature. 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: (21111 or 21112 or 21115 or 21116) and (73260 or 36201 or 36207 or 36220 or 36225 or 36247 or 70207)

88-332 Foreign Aid: States, International Organizations, and Developing Countries Intermittent: 9 units
This course introduces students to the complex and often changing policy area of international development cooperation. Focusing on both multilateral and bilateral foreign aid over the past fifty years, it will answer key questions such as: Why do international donors give foreign aid? What are the links between development cooperation and foreign policy? Why are developing countries interested in receiving foreign aid? Does foreign aid work? The class will compare United States, Japanese, and European policies on aid giving and will assess the world commitment to alleviating poverty.

88-338 American Politics Intermittent: 9 units
This course considers the complex and often changing policy area of American government each semester, with a focus on how decisions are made in government. Particular topics may include Congress and the legislative process, the courts and juries, interest groups and representation, and voting and elections. Source material will be drawn from a combination of scholarly articles and textbooks. Prerequisites: 88-104, or the permission of the instructor.

Prerequisites: 88104

88-340 The Economics of Entrepreneurship in High-tech Industries Intermittent: 9 units
This course considers theories and evidence from the economics, business strategy and related literatures (including psychology and organizational behavior) that allow some understanding of the characteristics of successful entry and performance of new firms in high technology industries. The course will also look at the overall characteristics of the high technology industry, focusing on a few cases of businesses that seem to have been successful. The course will then consider the characteristics of the entrepreneurial environment, both academic rather than practitioner perspective. Nonetheless, it should provide prospective entrepreneurs with information, tools and frameworks for thinking about the prospects for successful start-ups in selected industries. The course will cover the concept of barriers to entry, the advantages and disadvantages of small firm size for technological competition, the implications of the evolutionary stage of industries for entry, the role of patents in providing the basis for successful entry, venture capital, commercial applications of university research, the decision making biases that can characterize the behavior of both entrepreneurs and the venture capitalists who finance them, and the impact of small firms on rates of technical advance.

Prerequisites: 73250 or 73251 or 88220

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 your ideas 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, we will study 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 in 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. The primary goal of this course is to give you theoretical and empirical underpinnings for the communication you will undoubtedly do when you return to work. Readings come from a wide variety of academic and popular 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: 36201 or 36207 or 36217 or 36220 or 36225 or 36247 or 70207

88-343 Economics of Technological Change Fall: 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 effects of government support of R&D and 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 studies and historical episodes.

Prerequisites: 73250 or 73251 or 88220

88-345 The Rise of Industrial Research and Development Intermittent: 9 units
The electric light, nylon, the atomic bomb, the transistor and integrated circuits, Post-it notes, Teflon, Silly Putty, Game Boys, and Viagra, among a plethora of other “miracle” goods, are products that emerged from organized research and development (R&D) programs. What factors led to the establishment of modern R&D laboratories in the United States and other industrialized nations? Did their creation change the character of science, technology, and business? How have the institutionalization of R&D affected the work of the individual inventor and scientist? Does big business now dominate R&D in the United States, or does “the little guy” (including “start ups”) continue to play an important role in technological innovation? How has federal R&D policy affected the organization and character of industrial R&D programs since the late nineteenth century? What about the role of universities? How has R&D been “managed” or organized to make the global “world” that has characterized science and technology in the late twentieth and early twenty-first centuries, is industrial R&D also going global, and if so, how are firms managing R&D on a global basis? 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 twenty-first century? These are some of the questions explored in this seminar, largely through critical analysis of case studies.

This advanced seminar is open to students from all colleges. It requires an extensive amount of reading and writing, and students must be prepared to participate fully in critical discussion of the readings and issues that surround this subject. Prerequisite: Junior or senior standing.

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 one can point to the railroads, the telegraph, and mass-produced automobiles running on paved roads and highways, telephones, and the telephone, radio, television, and personal computers. 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
international 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 Fissile Material, the conflicts in the Middle East, the end of communism, and the war in Afghanistan.

88-358 Policy Making Institutions
Fall: 9 units
This course examines how policies and institutions result from the political process and focuses on decision-making and strategic interaction in the U.S. Congress and Supreme Court. Rational choice theory provides a framework for understanding how policy choices of legislators and judges are shaped by their motivations and policy preferences, are constrained in the short-term by institutions and other political actors, and in the long-run determine the characteristics of institutions. Current political events and public policies are discussed in light of the theoretical perspectives, and students gain additional insights by participating in a simulated legislature. Prerequisites: 88104

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 economic rationality and investigate attempts by behavioral economists to improve economic analyses. Prerequisites: (21111 or 21120) and (88220 or 73251)

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 perception, attitude change, and how individual decisions are influenced by class, gender, and contemporary research in the area of persuasion will be examined in the form of course readings and assignments. Prerequisites: 85241

88-378 International Economics
Fall: 9 units
This course analyzes 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.

88-379 Social Cognition
Intermittent: 9 units
Social cognition research identifies the social factors that shape cognitive processes. This seminar focuses on ten selected topics in social cognition. Each of these topics elucidates a classic or contemporary theoretical argument in the field. Seminar participants will gain in-depth knowledge of these topics, rather than surface knowledge of the field as a whole. We will begin the seminar with topics revolving around the individual level of analysis (i.e., intrapersonal processes). We will progress to interpersonal processes, and end with the group level of analysis. Seminar components include weekly participation in discussion of assigned readings, presentations of assigned readings, and two open-note exams.

88-381 Business, Politics, and Public Policy
Intermittent: 9 units
The purpose of this seminar 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
This course examines the relationships among business, government, and interest groups as strategic actors in the nonmarket environment. Companies compete with interest groups for support of the public and politicians in order to shape public policy through government processes. Public policy considerations also depend on market and industry characteristics. Emphasis is on developing theory and applications in such politics and economics. Development of nonmarket institutions and areas of public policy. Topics include media, lobbying, environmental policy, intellectual property, international business, trade policy, technology, and business ethics. Prerequisites: 88104 AND (88220 or 73100)

88-382 Climate Change, Energy Policy and Environmental Protection
Spring: 9 units
Early in 2001 the Intergovernmental Panel on Climate Change will issue its Third Assessment Report on the state of the world's climate. A summary of the report was recently released to governments in advance of the November, 2000 COP-6 meeting of the parties to the 1992 Framework Convention on Climate Change (FCCC) and its 1997 Kyoto Protocol, the key international instruments dealing with the problem. The IPCC's 3rd assessment report paints a considerably bleaker picture of global warming than its 2nd report issued in 1995, which predicted an increase of between 1.8 and 6.3 degrees Fahrenheit in the earth's average surface air temperature due to anthropogenic emissions of greenhouse gases (GHGs) if mitigation measures were not taken. The new report predicts an increase of no less than 11 degrees fahrenheit at the end of this century, and confirms that "there is stronger evidence of human influence" on climate. Significantly, much of the increase is attributed to a decline in sulfate emissions resulting from air quality control measures implemented by many industrialized nations and hence a decline in the cooling effect of these sulfates, a classic example of the interrelated nature of air and atmosphere related environmental problems. The goal of the COP-6 negotiations is to work out the details of the methods and mechanisms by which states parties may implement the commitments made in the Protocol. These include direct domestic reductions in emissions of six GHGs, and the use of "sinks" to increase carbon absorption, as well as Joint Implementation (JI) programs with other states, Emissions Trading and the Clean Development Mechanism (CDM). This course will examine the problem of climate change and energy policy, and the interconnection with national energy policies, laws and regulations and the energy-related environmental impacts and policy.

88-383 Latin America in the New International System
Intermittent: 9 units
This is an introductory level course on Latin America and its place in the international system. How have the region's historical brushes with outside influences such as colonialism, import substitution industrialization, and neoliberalism affected its development? Are there new models of development and democracy emerging, at either the international, national, or local level? The course will focus on the consequences of Latin American models of development and examines a selection of Latin American countries. It then explores the different relationships between Latin American governments, the civil society and the international system through the case studies of democracy-building, indigenous movements, regional trading groups and non-governmental organizations. Course Goals To understand the evolution of Latin American political systems; To understand the social and economic context within which Latin American political systems are located (including political culture, class, race, and urban and rural cleavages); To examine political processes in specific countries focusing on their democratic content (or lack thereof); To examine governmental policies as they affect citizen rights and social and economic development; To examine likely future political scenarios in Latin America based on projections from current political trends.

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 decisions. This course addresses this topic by focusing on how decisions are 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. Prerequisites: 73250 or 73251 or 88220

88-390 Technology Entrepreneurship: Principles for Practice

88-398 Independent Study
All Semesters: 1-18 units
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 apply strategies for evaluating these techniques, to determine whether they have been effective. Throughout the semester, students will conduct a multi-stage research project, including assessing theories, testing a hypothesis 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 reports throughout the semester relating to class readings. Prerequisites: empirical research methods or psychology research methods class

88-421 Advanced Topics in Emotion and Decision Making
Intermittent: 9 units
This advanced seminar will examine important theoretical and empirical perspectives on emotions and decision making. The course will begin with consideration of foundational issues, such as: (a) how to define emotion, (b) physiological causes and consequences of emotion, (c) cognitive causes and consequences of emotion, and (d) distinguishing different kinds of emotional phenomena, such as moods, temperaments, etc. The course will go on to consider different theories on emotion and decision making. Depending on class interests, a few special topics in emotion and decision making may receive extra emphasis, such as anger, health (emotional) well-being, and adolescence. Throughout the course, the primary goals are to: (a) learn about the academic field of emotion and decision making, its major theories, results, and debates; (b) become a critical consumer of research findings by learning to apply the methodological standards for evaluating the soundness of research. (c) Consider the applicability of research results to every day problems. This is an advanced seminar in social psychology, and you will be expected to: (a) read original research articles and chapters on the selected topics, (b) regularly turn in comments and questions about the readings, (c) participate regularly and actively in class discussions, and (d) write several papers. The majority of class time will consist of discussion and debate. At key points, the instructor will give focused lectures. Prerequisites: 85449 or 88120

88-437 Strategic Analysis: Game Theory for Social Scientists
Spring: 9 units
Both political and economic interaction involves strategic interaction. Non-cooperative game theory is a form of multi-person decision theory that provides tools for analyzing stable behavior that results when individuals make optimal decisions given that others also act optimally. The basic theory is developed, including strategic games and Nash equilibrium, extensive games with imperfect information and corresponding equilibrium concepts. The theory is applied to topics in politics and economics such as cooperation and coordination, oligopoly entry, bargaining, candidate competition, lobbying, legislative agenda setting, and information transmission. Students will develop skills in rigorously analyzing theoretical models.

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
Major 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 Division faculty; and approved entry into the Colleges Honors Program.

88-502 SDS Senior Honors Thesis II
Spring: 9 units
Major 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: 88501

88-505 Undergraduate Internship
All Semesters: 36,9 units
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 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.

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.

Statistics
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 the 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. The course will cover simple and multiple regression and analysis of variance methods. Other topics will be selected from the following: Logistic regression, non-parametric methods, probability models. The objectives of this course is to develop the skills of applying the basic principles and methods that underlie statistical practice and empirical research. Not open to students who have received credit for: 36-208/70-208, 36-309, 88-250.
Prerequisites: 36201 or 36207 or 36220 or 36247 or 70207

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, elementary probability theory, statistical inference in simple settings, basic categorical analysis, and statistical methods for quality control. In addition to two lectures a week, students will attend a computer lab once a week. Students will have received credit for 36-201, 36-220, 36-625, or 36-247. Cross-listed as 70-207.
Prerequisites: 21112 or 21116 or 21120 or 21121

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 lecture 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: (21116 or 21120 or 21121 or 21112) AND (36207 or 70207 or 36201 or 36220 or 36247)

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. The use of a computer package will be an integral part of this course (depending on the instructor). Not open to students who have received credit for 36-225, or 36-625.
Prerequisites: 21118 or 21122 or 21123 or 21256

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. 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 36-201, 36-207/70-207, 36-226, 36-626, or 36-247.
Prerequisites: 21116 or 21120 or 21121 or 21112

36-225 Introduction to Probability and Statistics I
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 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. Not open to students who have received credit for 36-217 or 36-625.
Prerequisites: 21112 or 21118 or 21122 or 21123 or 21256

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. Not open to students who have received credit for 36-216.
Prerequisites: 36217 or 36225

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, 36-226 or 36-626.
Prerequisites: 21116 or 21120 or 21121 or 21112

36-295 Independent Study
Fall and Spring: 0-36 units
Statistics majors are provided with the opportunity to conduct original research under the direction of a faculty member. Students are expected to propose a research topic, design and implement the study, analyze the data, and prepare a written report describing the investigation and results.
Prerequisites: 36201

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 survey sample.
Prerequisites: 36202 or 36208 or 36226 or 36309 or 36625 or 70208 or 73260 or 73261 or 88250

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, exploratory 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. Not open to students who have received credit for 36-202.
Prerequisites: 36201 or 36207 or 36217 or 36220 or 36247

36-310 Fundamentals of Statistical Modeling
Spring: 9 units
This course provides a one-semester introduction to the theory of probability and mathematical statistics, suitable as background for more advanced 400-level statistics courses such as 36-401 and 36-402 (Modern Regression and Topics in Data Analysis). The course will emphasize probability models and distribution theory; the practice of statistical inference based on the use of maximum likelihood estimation; and applications of statistical modeling and inference, using case studies drawn from the social, physical and biomedical sciences. The use of a computer examanates package drawn from integral part and the various. Students who have taken 36225 or 36-625 may not receive credit for this course. Students who have taken 73-261 or 73-360 need permission of the instructor.
Prerequisites: (21112 or 21116 or 21121 or 21120) AND (36303 or 36309 or 36247 or 36208 or 36202 or 36220 or 88250)

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 some 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: 36202 or 36208 or 36226 or 36303 or 36309 or 36625 or 88250

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, and nonparametric density estimation. Confirmatory methods include confidence intervals, posterior distributions, and Bayes factors. In addition, students will learn how to think in terms of probabilistic models and use data mining software effectively. Some computer programming required.
Prerequisites: 36226 or 36310 or 36626

36-401 Modern Regression
Fall: 9 units
The material in this course concentrates on methods for the analysis of data. The emphasis is on description, validation, and interpretation. Topics include exploratory data analysis, statistical computing, and regression analysis. Real-world examples will be drawn from current research in neuroscience, genetics, finance and psychology. Data analysis requires the application and extension of statistical methods and computing skills learned in 36-461. A key objective of the course is to expose students to the variety of challenges faced by the data analyst. Students research the scientific background of their problem, consult with subject-area scientists, and communicate their methods and results both in writing and in class presentations. At the end of the semester, each team presents a poster of their project at the “Meeting of the Minds” undergraduate research symposium.
Prerequisites: 36401

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: 21325 or 36217 or 36225 or 36625

36-461 Topics in Statistics
Fall: 9 units
The format and content of this course are flexible and vary from year to year depending on the instructor and demand. Past topics included statistics and the law, Bayesian statistics, non-parametric statistics, decision theory, biostatistics, and time series analysis. The objective of the course is to expose students to important topics in statistics and/or interesting applications which are not part of the standard undergraduate curriculum.
Prerequisites: 36226 or 36310 or 36626

36-462 Topics in Statistics
Intermittent: 9 units
The format and content of this course are flexible and vary from year to year depending on the instructor and demand. Past topics included statistics and the law, Bayesian statistics, non-parametric statistics, decision theory, biostatistics, and time series analysis. The objective of the course is to expose students to important topics in statistics and/or interesting applications which are not part of the standard undergraduate curriculum.
Prerequisites: 36309 or 36310 or 36626

36-625 Probability and Mathematical Statistics I
Fall: 12 units
This course is a fast-paced, rigorous introduction to the mathematical theory of probability, and statistical inference. It is ideal for students who want a crash-course in probability and mathematical statistics. A good working knowledge of calculus and basic linear algebra is required. Topics include sample spaces, probability, conditional probability, generating functions, sampling distributions, law of large numbers, the central limit theorem, maximum likelihood, the bootstrap, hypothesis testing, Bayesian inference, decision theory. Students studying Computer Science, or considering graduate work in Statistics or Operations Research, should carefully consider taking this course instead of 36-225 after consultation with their advisor. Not open to students who have received credit for 36-217 or 36-225.
Prerequisites: 21118 or 21122 or 21123 or 21256

36-626 Probability and Mathematical Statistics II
Spring: 12 units
A continuation of 36-625 emphasizing statistical models and methods. Topics include regression, multivariate models, causal inference, directed graphs, undirected graphs, curve estimation, classification, simulation. Students studying Computer Science should carefully consider taking this course instead of 36-226 after consultation with their advisor.
Prerequisites: 36625
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Administration, Board of Trustees and University Professors

*Alumnus/a

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Key to Buildings and Services

ACADEMIC BUILDINGS

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<th>Location</th>
<th>Name</th>
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</thead>
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<td>B-6</td>
<td>16. Alumni House</td>
</tr>
<tr>
<td>C-5</td>
<td>3. Baker/Porter Hall</td>
</tr>
<tr>
<td>A-7</td>
<td>27. Brome House</td>
</tr>
<tr>
<td>D-4</td>
<td>172. Collaborative Innovation Center</td>
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<tr>
<td>E-7</td>
<td>7. College of Fine Arts</td>
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<tr>
<td>C-6</td>
<td>13. Curt Hall</td>
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<tr>
<td>D-6</td>
<td>4. Doherty Hall</td>
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<tr>
<td>D-4</td>
<td>140. Facilities Management Services Building</td>
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<tr>
<td>D-5</td>
<td>110. Future Site of Gates Center for Computer Science and Unnamed Center for Computer Science</td>
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<td>E-7</td>
<td>9. Graduate School of Industrial Administration (GSA)</td>
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<td>E-8</td>
<td>10. Gymnasium</td>
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<td>17. Hamborg Hall</td>
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<td>2. Hameschlag Hall</td>
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<td>E-6</td>
<td>8. Hunt Library</td>
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<td>D-7</td>
<td>11. Margaret Morrison Carnegie Hall</td>
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<td>14. Mellon Institute</td>
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<td>28. Mellon—Simon Hall</td>
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<td>41. Pittsburgh Technology Center</td>
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<td>36. Posner Center</td>
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<td>33. Roberts Engineering Hall</td>
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<td>28. Robotics Engineering Consortium</td>
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<td>24. Software Engineering Institute</td>
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<td>80. University Center</td>
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<td>5. Warner Hall</td>
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<td>29. Whetted Hall</td>
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<td>140. 300 South Craig Street</td>
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<td>37. 4516 Henry Street</td>
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<td>C-4</td>
<td>38. 4616 Forbes Ave.</td>
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<td>32. 6555 Penn Avenue</td>
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RESIDENCE BUILDINGS

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<th>Name</th>
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<tr>
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<td>58. Boss Hall</td>
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<tr>
<td>A-4</td>
<td>213. Cathedral Mansions</td>
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<td>61. Doherty Apartments</td>
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<td>62. Donner Hall</td>
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<td>209. Fairfax Apartments</td>
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<td>83. Fraternity Quadrangle</td>
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<td>54. Hameschlag House</td>
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<td>E-9</td>
<td>55. Henderson Hall</td>
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<tr>
<td>A-2</td>
<td>218. London Terrace Apartments</td>
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<td>D-9</td>
<td>68. Margaret Morrison Apartments</td>
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<td>70. Margaret Morrison Sorority Houses</td>
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<td>51. Morewood Gardens</td>
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<td>64. Rosellon Terrace</td>
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<td>79. Shirley Apartments</td>
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<td>59. Spirit House</td>
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<td>67. Tech House</td>
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<td>A-4</td>
<td>210. Veronica Apartments</td>
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<td>56. Welch Hall</td>
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<td>D-10</td>
<td>82. West Wing</td>
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<td>C-9</td>
<td>63. Woodrow Apartments</td>
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<td>D-9</td>
<td>200. 99 Godstone Road</td>
</tr>
<tr>
<td>D-2</td>
<td>201. 1094 Devon Road</td>
</tr>
<tr>
<td>C-8</td>
<td>142. 5045 Margaret Morrison St.</td>
</tr>
</tbody>
</table>

* Off Campus, See City Area Map.

PARKING AREAS

<table>
<thead>
<tr>
<th>Location</th>
<th>Name</th>
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<tbody>
<tr>
<td>A-7</td>
<td>P1. Fine Arts</td>
</tr>
<tr>
<td>D-8</td>
<td>P2. Sororities</td>
</tr>
<tr>
<td>D-7</td>
<td>P3. Children's School</td>
</tr>
<tr>
<td>B-8</td>
<td>P4. Bohery</td>
</tr>
<tr>
<td>P5. East Campus Garage</td>
<td></td>
</tr>
<tr>
<td>P6. 6555 Penn Avenue</td>
<td></td>
</tr>
<tr>
<td>B-6</td>
<td>P7. Fraternities</td>
</tr>
<tr>
<td>B-5</td>
<td>P8. Morewood</td>
</tr>
<tr>
<td>C-9</td>
<td>P9. Warner</td>
</tr>
<tr>
<td>C-2</td>
<td>P10. Bingham Street Garage</td>
</tr>
<tr>
<td>E-4</td>
<td>P11. Porter-Hameschlag—Wean</td>
</tr>
</tbody>
</table>

* Off Campus, See City Area Map.

Colleges

- Carnegie Institute of Technology (CT) — Scaife Hall
- Mellon College of Science (MCS) — Mellon Institute and Doherty Hall
- College of Humanities and Social Sciences (H&SS) — Baker Hall
- College of Fine Arts (CFA)
- Tepper School of Business (Tepper) — GSA
- The H. John Heinz School of Public Policy and Management — Hamborg Hall
- School of Computer Science (SCS) — Wean Hall

Services

- Office of Admission — Warner Hall
- Housing Office — Morewood Gardens
- Security — 300 South Craig St.

Information is available in the University Center and the Office of Student Affairs, Warner Hall.

City Area Map

Off-Campus Buildings.

Approximate Scale

0 1 MILE 2 MILES 3 MILES
# 2006-2007 Academic Calendar

## Fall 2006 Semester

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 18</td>
<td>Fall Semester Payment Due</td>
</tr>
<tr>
<td>August 28</td>
<td>M Semester &amp; Mini-1 Classes Begin</td>
</tr>
<tr>
<td>September 1</td>
<td>F Mini-1 Course Add Deadline without Dean’s Permission (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>September 1</td>
<td>F Mini-1 Course Audit Grade Option Deadline (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>September 1</td>
<td>F Mini-1 Course Drop Deadline to Receive Tuition Adjustment (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>September 4</td>
<td>M Labor Day; No Classes</td>
</tr>
<tr>
<td>September 7</td>
<td>Th Mini-1 &amp; Semester Course Add Deadline without Dean’s Permission (TSB only)</td>
</tr>
<tr>
<td>September 7</td>
<td>Th Mini-1 &amp; Semester Course Audit &amp; Pass/Fail Grade Options Deadline (TSB only)</td>
</tr>
<tr>
<td>September 7</td>
<td>Th SEMESTER 1 &amp; SEMESTER DROP TO RECEIVE TUITION ADJUSTMENT (TSB only)</td>
</tr>
<tr>
<td>September 11</td>
<td>M Mini-1 Course Audit Grade Option Deadline (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>September 11</td>
<td>M Semester Course Audit Grade Option Deadline (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>September 11</td>
<td>M Semester Course Drop Deadline to Receive Tuition Adjustment (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>September 11</td>
<td>M Mini-1 Course Add Deadline without Dean’s Permission (TSB only)</td>
</tr>
<tr>
<td>September 11</td>
<td>M Mini-1 Course Audit Grade Option Deadline (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>September 27</td>
<td>W Mini-1 Course Drop &amp; Pass/Fail Grade Option Deadline; Assign Withdrawal Grade for Course Dropping After This Date (except HNZ/ISM)</td>
</tr>
<tr>
<td>October 2-16</td>
<td>M-M Mini-1 Faculty Course Evaluations (HNZ/ISM only)</td>
</tr>
<tr>
<td>October 9-16</td>
<td>M-M Mini-1 Faculty Course Evaluations (except TSB and HNZ)</td>
</tr>
<tr>
<td>October 15</td>
<td>M Mini-1 Last Day of Classes</td>
</tr>
<tr>
<td>October 15</td>
<td>M Mini-1 Course Drop Deadline to Receive a Withdrawal Grade¹</td>
</tr>
<tr>
<td>October 16-19</td>
<td>M-Th Graduate Mini-1 Exam Days (HSN/ISM only)</td>
</tr>
<tr>
<td>October 17</td>
<td>T No Graduate Mini-1 Course Meetings (Reading Day) (except for TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>October 17-19</td>
<td>T-Th No Undergraduate Mini-1 Course Meetings (Reading Period)</td>
</tr>
<tr>
<td>October 18-21</td>
<td>W-SA Graduate Mini-1 Exam Days</td>
</tr>
<tr>
<td>October 20</td>
<td>F Undergraduate Mini-1 Exam Day</td>
</tr>
<tr>
<td>October 20</td>
<td>F Mid-Semester Break; No Classes (Mini-1 exams will take place)</td>
</tr>
<tr>
<td>October 23</td>
<td>M Semester Mid-Term &amp; Mini-1 Final Grades Due by 9 p.m.</td>
</tr>
<tr>
<td>October 23</td>
<td>M Mini-2 Classes Begin (except for TSB)</td>
</tr>
<tr>
<td>October 23-24</td>
<td>M-T Mini-1 Mid-Semester Break; No Classes (TSB only)</td>
</tr>
<tr>
<td>October 25</td>
<td>W Mini-2 Classes Begin (except TSB)</td>
</tr>
<tr>
<td>October 27</td>
<td>F Mini-2 Course Add Deadline without Dean’sPermission (except TSB)</td>
</tr>
<tr>
<td>October 27</td>
<td>F Mini-2 Course Audit Grade Option Deadline (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>October 27</td>
<td>F Mini-2 Course Drop Deadline to Receive Tuition Adjustment (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>November 3</td>
<td>F Mini-2 Course Add Deadline without Dean’sPermission (TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>November 3</td>
<td>F Mini-2 Course Add/Fail Grade Options Deadline (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>November 3</td>
<td>F Mini-2 Course Drop Deadline to Receive Tuition Adjustment (TSB only)</td>
</tr>
<tr>
<td>November 6</td>
<td>M Semester Course Drop &amp; Pass/Fail Grade Option Deadline; Assign Withdrawal Grade for Course Dropping After This Date (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>November 13-17</td>
<td>F, Spring 2007 Registration Week</td>
</tr>
<tr>
<td>November 21</td>
<td>T Mini-2 Course Drop &amp; Pass/Fail Grade Option Deadline; Assign Withdrawal Grade for Course Dropping After This Date (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>November 22-24</td>
<td>W-Th Thanksgiving Holiday; No Classes</td>
</tr>
<tr>
<td>Nov. 27-Dec.</td>
<td>M-M Semester &amp; Mini-2 Faculty Course Evaluations (through Dec. 11 at 8 a.m.) (except TSB and HNZ)</td>
</tr>
<tr>
<td>December 8</td>
<td>F Semester &amp; Mini-2 Last Day of Classes (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>December 8</td>
<td>F Semester &amp; Mini-2 Course Drop Deadline to Receive a Withdrawal Grade (except TSB)</td>
</tr>
<tr>
<td>December 11-12</td>
<td>M-F Final Examinations (except TSB)</td>
</tr>
<tr>
<td>December 13</td>
<td>W Reading Day (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>December 14-15</td>
<td>Th-F Final Examinations (except TSB)</td>
</tr>
<tr>
<td>December 15</td>
<td>F Semester Last Day of Classes (TSB only)</td>
</tr>
<tr>
<td>December 15</td>
<td>F Mini-2 &amp; Semester Course Drop Deadline to Receive a Withdrawal Grade (TSB only)</td>
</tr>
<tr>
<td>December 16-20</td>
<td>Sa-W Final Examinations (TSB only)</td>
</tr>
<tr>
<td>December 18-19</td>
<td>M-T Final Examinations (except HNZ/ISM)</td>
</tr>
<tr>
<td>December 21</td>
<td>Th Final Grades Due by 6 p.m.</td>
</tr>
</tbody>
</table>

## Spring 2006 Semester

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 4</td>
<td>F Spring Semester Payment Due</td>
</tr>
<tr>
<td>January 14</td>
<td>M Semester &amp; Mini-3 Classes Begin</td>
</tr>
<tr>
<td>January 18</td>
<td>F Mini-3 Course Add Deadline without Dean’sPermission (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>January 18</td>
<td>F Mini-3 Course Audit Grade Option Deadline (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>January 18</td>
<td>F Mini-3 Course Drop Deadline to Receive Tuition Adjustment (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>January 21</td>
<td>M Martin Luther King Jr. Day; No Classes after 12:30 p.m. (all classes &amp; all courses - including evening classes)</td>
</tr>
<tr>
<td>January 24</td>
<td>Th Mini-3 &amp; Semester Course Add Deadline without Dean’sPermission (TSB only)</td>
</tr>
<tr>
<td>January 24</td>
<td>Th Mini-3 &amp; Semester Course Audit &amp; Pass/Fail Grade Options Deadline (TSB only)</td>
</tr>
<tr>
<td>January 24</td>
<td>Th Mini-3B Semester Course Drop Deadline to Receive Tuition Adjustment (TSB only)¹</td>
</tr>
<tr>
<td>January 25</td>
<td>F Makeup Class Day for Martin Luther King Jr. Day (TSB only)</td>
</tr>
<tr>
<td>January 25</td>
<td>F Semester Course Add Deadline without Dean’sPermission (TSB only)</td>
</tr>
<tr>
<td>January 25</td>
<td>F Semester &amp; Mini-4 Course Grade Option Deadline</td>
</tr>
<tr>
<td>January 25</td>
<td>F Semester Drop Deadline to Receive Tuition Adjustment¹</td>
</tr>
<tr>
<td>January 25</td>
<td>F Semester Course Drop/Fail Grade Option Deadline (HSN/ISM only)</td>
</tr>
<tr>
<td>February 12</td>
<td>T Mini-3 Course Drop &amp; Pass/Fail Grade Option Deadline; Assign Withdrawal Grade for Course Dropping After This Date (except TSB &amp; HNZ/ISM)²</td>
</tr>
<tr>
<td>February 29</td>
<td>F Mini-3 Course Drop Deadline to Receive a Withdrawal Grade (TSB only)²</td>
</tr>
<tr>
<td>March 3</td>
<td>M Mini-3 Last Day of Classes (except TSB)</td>
</tr>
<tr>
<td>March 3</td>
<td>M Mini-3 Course Drop Deadline to Receive a Withdrawal Grade (except TSB)</td>
</tr>
<tr>
<td>March 3-6</td>
<td>M-Th Graduate Mini-3 Exam Days (TSB only)</td>
</tr>
<tr>
<td>March 7</td>
<td>F Undergraduate Mini-3 Exam Day</td>
</tr>
<tr>
<td>March 7</td>
<td>F Mid-Semester Break; No Classes (Mini-3 Undergraduate Exams will take place)</td>
</tr>
<tr>
<td>March 10</td>
<td>M Semester Mid-Term &amp; Mini-3 Final Grades Due by 9 p.m.</td>
</tr>
<tr>
<td>March 10-14</td>
<td>M-F Spring Break; No Classes</td>
</tr>
<tr>
<td>March 17</td>
<td>M Mini-4 Classes Begin (except for TSB)</td>
</tr>
<tr>
<td>March 21</td>
<td>F Mini-4 Course Add Deadline without Dean’sPermission (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>March 21</td>
<td>F Mini-4 Course Drop Deadline to Receive Tuition Adjustment (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>March 23</td>
<td>Th Mini-4 Course Drop Deadline to Receive Tuition Adjustment (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>March 27</td>
<td>Th Mini-4 Audit Grade Option Deadline (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>March 27</td>
<td>Th Mini-4 Course Drop Deadline to Receive Tuition Adjustment (except TSB &amp; HNZ/ISM)²</td>
</tr>
<tr>
<td>March 31</td>
<td>M Semester Course Drop &amp; Pass/Fail Grade Option Deadline; Assign Withdrawal Grade for Course Dropping After This Date (except HNZ/ISM)²</td>
</tr>
<tr>
<td>April 12</td>
<td>M Summer 2006 Registration begins</td>
</tr>
<tr>
<td>April 15</td>
<td>T Mini-4 Course Drop &amp; Pass/Fail Grade Option Deadline; Assign Withdrawal Grade for Course Dropping After This Date (except TSB &amp; HNZ/ISM)²</td>
</tr>
<tr>
<td>April 17</td>
<td>Th No Classes (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>Apr. 18-19</td>
<td>F-Sa Spring Carnival; No Classes (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>Apr. 21-25</td>
<td>M-F Fall 2006 Registration Week</td>
</tr>
<tr>
<td>Apr. 21-May</td>
<td>M-M Semester &amp; Mini-4 Faculty Course Evaluations (through May 5 at 8 a.m.) (except TSB and HNZ)</td>
</tr>
<tr>
<td>May 2</td>
<td>F Semester &amp; Mini-4 Last Day of Classes</td>
</tr>
<tr>
<td>May 2</td>
<td>F Semester &amp; Mini-4 Course Drop Deadline to Receive a Withdrawal Grade²</td>
</tr>
<tr>
<td>May 3</td>
<td>S Mini-4 &amp; Semester Final Examinations (TSB only)</td>
</tr>
<tr>
<td>May 3</td>
<td>S Reading Mini-4 Last Day of Classes (except TSB)</td>
</tr>
<tr>
<td>May 5-6</td>
<td>M-T Final Examinations (except TSB)</td>
</tr>
<tr>
<td>May 5-7</td>
<td>M-W Mini-4 &amp; Semester Final Examinations (TSB only)</td>
</tr>
<tr>
<td>May 7</td>
<td>W Mini-4 &amp; Semester &amp; Mini-4 Course Drop Deadline to Receive a Withdrawal Grade (except TSB &amp; HNZ/ISM eve classes)</td>
</tr>
<tr>
<td>May 9-10</td>
<td>Th-F Final Examinations (except TSB)</td>
</tr>
<tr>
<td>May 12</td>
<td>T Final Grades due by 6 p.m. (TSB only)</td>
</tr>
<tr>
<td>May 12-13</td>
<td>M-T Final Examinations (except TSB &amp; HNZ/ISM)</td>
</tr>
<tr>
<td>May 15</td>
<td>T Final Grades for graduating students due by 6 p.m.</td>
</tr>
<tr>
<td>May 18</td>
<td>Su Commencement</td>
</tr>
<tr>
<td>May 20</td>
<td>T Final Grades for non-graduating students due by 4 p.m.</td>
</tr>
</tbody>
</table>

## Notes:

1. Exceptions for TSB refer only to graduate programs.
2. Not Applicable for Graduate Students except graduate students in MCS & TSB.
Notes:

1. Students dropping a course while maintaining enrollment will receive a tuition adjustment only if they drop by this date. Students taking a Leave of Absence or Withdrawing from the University should consult the official Tuition Adjustment Policy.

2. Not Applicable for Graduate Students except graduate students in MCS & TSB.
Fall 2006 Addendum

This addendum to the 2006-2008 Carnegie Mellon Undergraduate Catalog presents corrections and additions to the 2006-2008 academic year. The editorial staff apologizes that due to space limitations, certain material such as the addition of new faculty could not be included.

New programs are approved and existing programs are changed at various times throughout the year. The complete Undergraduate Catalog can be accessed via www.cmu.edu/egs-cat. The 2008-2010 catalog will be published during the summer of 2008. All changes and suggestions for improvement will be considered. Please direct your comments to:

William F. Elliott
Vice President for Enrollment

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Intercollege

Science and Humanities Scholars Program (95)
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 invited 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 have the choice to live in a residential cluster that promotes the integration of academic and social interests. Beyond the first year, students continue to participate in occasions that foster their intellectual community. The program also 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 General Education Program
There are 14 requirements in the SHS General Education Program. The program is designed to expose students to a variety of subjects and methodologies that will not only make them better-informed citizens of the world, but also broaden their range of possible subsequent major choices. The SHS General Education Program is structured to provide a great deal of flexibility and independence in selecting courses to fulfill these requirements.

Mathematical Sciences (29 units)
1.21-120 Differential and Integral Calculus or 21-131 Analysis I
2.21-122 Integration, Differential Equations, and Approximation or
21-132 Analysis II
3.36-247 Statistics for Lab Sciences (or appropriate substitute)

Writing/Expression (9 units)
Broadly considered, language is a tool used to communicate, as well as a way to organize thinking. This requirement focuses on the social nature of language and the ways in which writing constitutes thinking.

4.76-101 Interpretation & Argument

Notes: This requirement should be completed in the first year. A student who received a 5 on either of the English AP exams may elect to take an advanced English course instead, selected from a list approved annually by the English department. In any event, the course taken to fulfill this requirement cannot be double-counted towards any other graduation requirement.
World Cultures (9 units)
This requirement seeks to recognize cultures that have shaped and continue to shape the human experience, as well as analyze material that provide clues as to how these cultures work.
5. 79-104 Introduction to World History

Freshman Seminar (6-9 units)
6. Choose one full-semester freshman seminar from H&SS, or two half-semester freshman seminars from MCS and/or H&SS.

Computational Reasoning (9-10 units)
7. Choose from the following courses
15-100 Introductory / Intermediate Programming
15-111 Intermediate / Advanced Programming
21-127 Concepts of Mathematics
80-210 Introduction to Logic
80-211 Arguments & Inquiry

Science Core (28 units)
8-10. Choose three of the following courses. Science majors must take at least two that are outside their major and in different departments.
03-121 Modern Biology
03-130 Biology of Organisms
09-105 Introduction to Modern Chemistry
09-106 Modern Chemistry II
33-111 Physics I for Science Students
33-112 Physics II for Science Students

Distribution Requirements (36 units)
11-14. Choose a minimum of four courses, minimum 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. Please see the SHS Director for approval.

Cognition, Choice, and Behavior
11. This category uses model-based analysis to broaden an understanding of human thinking, choices, and behavior on an individual basis across a variety of settings.
80-130 Introduction to Ethics
80-150 Nature of Reason
80-180 Nature of Language
80-181 Language and Thought
80-221 Philosophy of Social Science
80-230 Ethical Theory
80-241 Ethical Judgments in Professional Life
80-242 Conflict, Dispute Resolution
80-270 Philosophy of Mind
80-271 Philosophy and Psychology
85-100 Introduction to Intelligence in Humans, Animals and Machines
85-102 Introduction to Psychology
85-211 Cognitive Psychology
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Personality
85-261 Abnormal Psychology
88-120 Reason, Passion, and Cognition

Economic, Political, and Social Institutions
12. This category examines the ways in which institutions organize individual preferences and actions into collective outcomes using model-based reasoning.
36-303 Sampling, Surveys, and Society
70-332 Business and Society
73-100 Principles of Economics
79-223 Protest and Dissent in American History
79-311 Crime and Punishment
79-335 Drug Use and Drug Policy
79-345 American Environmental History: Critical Issues
79-350 Theories of International Relations
80-135 Introduction to Political Philosophy
80-136 Social Structure, Public Policy, and Ethical Dilemmas
80-235 Political Philosophy
80-236 Philosophy and the Law
80-243 Environment Management and Ethics
80-341 Computers, Society, and Ethics
88-104 Decision Processes in American Political Institutions
88-110 Experiments with Economic Principles
88-205 Comparative Politics

Creative Production and Reflection
13. This category is designed to encourage exploration of the artistic and intellectual creation of others while allowing for personal expression, and reflection upon the creative process.

Mathematics Sciences (B.S.)

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 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) that 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
21-122 Integration, Differential Equations, and Approximation
21-127 Concepts of Mathematics
21-241 Matrix Algebra
21-259 Calculus in Three Dimensions
21-292 Operations Research I
21-355 Principles of Real Analysis I
21-369 Numerical Methods
21-xxx Mathematical Science Elective
21-xxx Mathematical Science Elective
Probability and Statistics: 36 Units
21-325 Probability
or
36-225 Introduction to Probability and Statistics I

Note: 21-325 Probability is preferred.

36-226 Introduction to Probability and Statistics II
36-410 Introduction to Probability Models
36-461 Undergraduate Seminar

Data Analysis: 27 Units
36-247 Statistics for Laboratory Sciences
36-309 Experimental Design for Behavioral and Social Sciences
or
36-303 Surveys, Sampling & Society
36-401 Advanced Data Analysis I

Statistics and Data Analysis Electives: 18 Units
Complete two courses from the following:
36-402 Advanced Data Analysis II
36-462 Applied Multivariate Methods

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
21-127 Concepts of Mathematics
76-101 Interpretation and Argument
33-111 Physics for Science Students I
99-10x Computer Skills Workshop

Freshman Year: Spring
21-122 Integration, Differential Equations, and Approximation
36-247 Statistics for Laboratory Sciences
79-104 World History
xx-xxx Science
xx-xxx Freshman Seminar

Sophomore Year: Fall
21-201 Undergraduate Colloquium
21-241 Matrix Algebra
36-309 Experimental Design
xx-xxx Economic, Political and Social Institutions
xx-xxx Science
xx-xxx Elective

Sophomore Year: Spring
21-201 Undergraduate Colloquium
21-259 Calculus in Three Dimensions
21-292 Operations Research I
xx-xxx Cultural Analysis
xx-xxx Electives

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

Junior Year: Spring
21-xxx Mathematical Science Elective
36-226 Introduction to Probability and Statistics II
36-410 Introduction to Probability Models
xx-xxx Creative Production & Reflection
xx-xxx Electives

Senior Year: Fall
21-393 Operations Research II
36-401 Advanced Data Analysis I
36-461 Undergraduate Seminar
xx-xxx Electives

Senior Year: Spring
21-xxx Mathematical Science Elective
36-402 Advanced Data Analysis II
36-xxx Senior Research Elective
xx-xxx Electives

Major in Psychology & Biological Sciences
This unified major is intended to reflect the interdisciplinary nature of 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 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 or the SHS programs.

Students entering the Mellon College of Sciences receive a diploma.

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
21-127 Concepts of Mathematics
76-101 Interpretation and Argument
33-111 Physics for Science Students I
99-10x Computer Skills Workshop

Freshman Year: Spring
21-122 Integration, Differential Equations, and Approximation
36-247 Statistics for Laboratory Sciences
79-104 World History
xx-xxx Science
xx-xxx Freshman Seminar

Sophomore Year: Fall
21-201 Undergraduate Colloquium
21-241 Matrix Algebra
36-309 Experimental Design
xx-xxx Economic, Political and Social Institutions
xx-xxx Science
xx-xxx Elective

Sophomore Year: Spring
21-201 Undergraduate Colloquium
21-259 Calculus in Three Dimensions
21-292 Operations Research I
xx-xxx Cultural Analysis
xx-xxx Electives

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

Junior Year: Spring
21-xxx Mathematical Science Elective
36-226 Introduction to Probability and Statistics II
36-410 Introduction to Probability Models
xx-xxx Creative Production & Reflection
xx-xxx Electives

Senior Year: Fall
21-393 Operations Research II
36-401 Advanced Data Analysis I
36-461 Undergraduate Seminar
xx-xxx Electives

Senior Year: Spring
21-xxx Mathematical Science Elective
36-402 Advanced Data Analysis II
36-xxx Senior Research Elective
xx-xxx Electives

Major in Psychology & Biological Sciences
This unified major is intended to reflect the interdisciplinary nature of 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 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 or the SHS programs.

Students entering the Mellon College of Sciences receive a diploma.

Mathematical Sciences/Statistics
21-120 Differential Calculus and Integral Calculus
21-122 Integration & Differential Equations and Calculus of Approximations
36-247 Statistics for Laboratory Sciences
36-309 Experimental Design for Behavioral and Social Sciences
* 36-201 can be used as an alternative, but 36-247 is strongly encouraged.

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

Computational Reasoning
99-101/102/103 CSW
15-100 Introductory/Intermediate Programming

Discipline Core Requirements
Biological Sciences
03-121 Modern Biology
03-231 Biochemistry
03-240 Cell Biology
03-330 Genetics

Psychology
85-102 Introduction to Psychology

Complete three of the following courses (85-219 should be included as one of the three):
85-211 Cognitive Psychology or
85-213 Human Information Processing and Artificial Intelligence
85-219 Biological Foundations of Behavior
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Personality
Laboratory/Research Methods Requirements
- 09-221 Chemistry Laboratory I
- 09-222 Chemistry Laboratory II
- 03-343 Experimental Genetics and Molecular Biology

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

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)

See p. 238 (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.

H&SS Interdepartmental Majors

The Major in Economics and Statistics
Faculty Advisor: Oded Meyer.
Office: Baker Hall 232C

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 to advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics. Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills – especially those in economics, finance, education, and public policy.

Curriculum

I. Prerequisites - 65 units
1. Writing Prerequisite
   - Choose one:
     - 73-270 Professional Writing for Economics
     - 76-270 Writing in the Professions
     - 76-271 Intro to Professional and Technical Writing
   9 units

2. Mathematical Foundations
   - 21-120 Differential and Integral Calculus
   - 21-122 Integration, Diff Equations, and Approximations
   - 21-256 Multivariate Analysis and Approximation
   - 21-241 Matrix Algebra
   38 units

3. Statistical Foundations
   - 36-201 Introduction to Statistical Reasoning and Practice*
   - and one of the following:
     - 36-202 Introduction to Statistical Methods
     - 36-208 Regression Analysis (cross listed as 70-208)
     - 36-309 Experimental Design for Behavioral & Social Sciences
   18 units

* Acceptable equivalents for 36-201 are 36-207, 36-220, 36-247.

II. Disciplinary Core - 108 units
1. Economics Core
   - 73-150 Introduction to Micro Economics
   - 73-200 Macroeconomics
   - 73-251 Economic Theory
   - 73-261 Econometrics
   36 units

2. Statistics Core
   - 36-225 Introduction to Probability and Statistics I
   - 36-226 Introduction to Probability and Statistics II
   - 36-401 Modern Regression
   - 36-402 Advanced Data Analysis (Project Course)
   36 units

3. Economics Electives
   - Choose two courses.
   18 units

4. Statistics Electives
   - Choose two courses at the 36-300 level or above.
   18 units

Total number of units for the major 173 units

Total number of units for the degree 360 units
Sample Program
The following sample program illustrates one (of several) 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 comment following the schedule).

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>Freshman</td>
<td>21-120</td>
<td>21-122</td>
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<td>36-201</td>
<td>36-202</td>
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<tr>
<td>Sophomore</td>
<td>21-256</td>
<td>21-241</td>
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<td>36-225</td>
<td>36-226</td>
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<td>73-200</td>
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<tr>
<td>Junior*</td>
<td>36-401</td>
<td>36-402</td>
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<td>73-261</td>
<td>Stats Elective</td>
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<td>Writing Req.</td>
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<td></td>
<td>Econ Elective</td>
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<tr>
<td>Senior</td>
<td>Stats Elective</td>
<td>Econ Elective</td>
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</table>

* 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.

Department of History (250)
This curriculum chart contained a black mark in the printed catalog that covered the course number of the Junior Year, Fall Survey Course. The correct course number is 79-xxx.
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 analyses, 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 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 at the Western Psychiatric Institute and Clinic (the teaching hospital of the Department of Psychiatry at the University of Pittsburgh), and Contact Pittsburgh (the Pittsburgh area community hotline). 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: 21-111/112 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 science 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 Introductory 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, development, 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 are required. 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  Calculus I
and/or
21-112  Calculus II
or
21-120  Differential Calculus/Integral Calculus (10 units)
and
21-256  Multivariate Analysis and Approximation
or
21-120  Differential and Integral Calculus (10 units)
and
21-122  Integration and Differential Equations and Approximation (10 units)
36-201  Experimental Design for Behavioral and Social Sciences
(Prerequisite: 36-201 or equivalent)
36-309  Experimental Design for Behavioral and Social Sciences
(Prerequisite: 36-201 or equivalent)

**Breadth Requirement**  \(9\) units

85-102  Introduction to Psychology or a fourth Survey Course*

* 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
85-219  Biological Foundations of Behavior
85-221  Principles of Child Development
85-241  Social Psychology
85-251  Personality

**Research Methods**  \(18\) units

Complete two courses.

85-310  Research Methods in Cognitive Psychology*
85-320  Research Methods in Child Development*
85-340  Research Methods in Social Psychology*

*Prerequisites for all Research Methods courses: 36-309 or equivalent, and corresponding psychology survey course.

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

**Advanced Courses**  \(18\) units

Complete two courses.

85-341 or higher
Any advanced content course or seminar in psychology or any psychology course higher than 85-351 exceptions: 85-480, 85-482, 85-484, 85-505, 85-506, 85-507, 85-508

**Computer Science Requirement**  \(10\) units minimum

15-100 or higher
Introductory/Intermediate Programming

**Natural Science Requirement**  \(B.A. 9\) units \(B.S. 27\) units

The Psychology major requires (for B.S. candidates) three additional natural science courses (with two in the same science) beyond the College's General Education natural science requirement. For the B.A. the requirement is one course beyond the General Education requirement in natural science. Given the growing relevance of biology to psychology, it is strongly recommended that for the B.S. a minimum of two courses in biology be included as part of the natural science requirement.

More generally for the B.S., at least two courses should come from the same are (biology, chemistry or physics).

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**Junior Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Senior Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Course</td>
<td>Survey Course</td>
<td>Advanced Course</td>
</tr>
<tr>
<td>Experimental Design for Behavioral and Social Sciences</td>
<td>Research Methods Course</td>
<td>Research Methods Course</td>
</tr>
<tr>
<td>36-309</td>
<td></td>
<td>Elective</td>
</tr>
<tr>
<td>Supplementary Science Requirement B.A./B.S.</td>
<td>Supplementary Science Elective for B.S. only</td>
<td>Supplementary Science Elective for B.S. only</td>
</tr>
<tr>
<td>Computer Science</td>
<td>Elective</td>
<td>Elective</td>
</tr>
</tbody>
</table>

This is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed 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.

**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 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 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 or the SHS programs.

Students entering from the Mellon College of Sciences receive a Bachelor of Science in Biological Sciences and Psychology.

**Mathematical Sciences/Statistics**

21-120  Differential Calculus and Integral Calculus
21-122  Integration & Differential Equations and Calculus of Approximations
36-247  Statistics for Laboratory Sciences*
36-309  Experimental Design for Behavioral and Social Sciences

* 36-201 can be used as an alternative, but 36-247 is strongly encouraged.
Natural Sciences
09-105 Introduction to Modern Chemistry
09-106 Modern Chemistry II
33-xxx Physics I for Science Students
09-217 Organic Chemistry I
09-218 Organic Chemistry II

Computational Reasoning
99-101/102/103 CSW
15-100 Introductory/Intermediate Programming

Discipline Core Requirements

Biological Sciences
03-121 Modern Biology
03-231 Biochemistry
03-240 Cell Biology
03-330 Genetics

Psychology
85-102 Introduction to Psychology

Lab/Laboratory/Research Methods Requirements

Research Methods in Psychology

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

Additional Laboratory Requirement:

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)

See p. 238 (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 21-120/256 (or alternatively 21-120/122)* and a statistics sequence (36-201 or equivalent and 36-309). In addition, candidates complete 15-111 Intermediate/Advanced Programming, 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 15-111 and 21-127 early in their program of studies will allow students to move into the 15-211/212 sequence by the junior year and prepare them for further work in artificial intelligence.

*The 3-semester sequence 21-111/112/256 may be substituted by students who have already taken 21-111 before deciding on the major.

Computing Prerequisite 10 units
15-111 Intermediate/Advanced Programming*

Mathematics & Statistics Prerequisites 37-38 units
21-120 Differential and Integral Calculus (10 units)*
and
21-256 Multivariate Analysis and Approximation
or
21-120 Differential and Integral Calculus (10 units)
and
21-122 Integration, Differential Equations and Approximation (10 units)
21-127 Concepts of Mathematics+
36-201 Statistical Reasoning, Statistical Practice or equivalent
36-309 Experimental Design for the Behavioral and Social Sciences

+Along with 15-111, prerequisite for 15-211.

Artificial Intelligence Core (minimum) 33 units
15-211 Fundamental Data Structures and Algorithms I
15-212 Principles of Programming
15-381 Artificial Intelligence: Representation and Problem Solving or
85-412 Cognitive Modeling or
85-419 Introduction to Parallel Distributed Processing

Cognitive Psychology Core 27 units
85-211 Cognitive Psychology or
85-213 Human Information Processing and Artificial Intelligence 85-310 Research Methods in Cognitive Psychology
(Prerequisite for all research methods courses 36-309 and corresponding psychology survey course)

Plus complete one of the following:
85-412 Cognitive Modeling
85-419 Introduction to Parallel Distributed Processing
85-423 Cognitive Development
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 four of the following: 85-412, 85-419, 85-392, 85-417 (05-432 cross-listed course number in HCI) and 05-811 Cognitive Modeling for HCI. Another area might be cognitive neuroscience and could involve four of the following: 85-370 Perception, 85-408 Visual Perception, 03-360 The Biology of the Brain, 85-414 Cognitive Neuropsychology, 85-419 Introduction to Parallel Distributed Processing, 85-429 Cognitive Brain Imaging, and 85-465 Cognitive Neuroscience.

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
15-385 Artificial Intelligence: Computer Vision
15-453 Formal Language and Automata
15-681 Machine Learning
05-410 Introduction to Human Computer Interaction Methods

Psychology

85-219 Biological Foundations of Behavior
85-352 Evolutionary Psychology
85-355 Introduction to Cognitive Neuroscience
85-370 Perception
85-375 Cross Cultural Psychology
85-382 Consciousness & Cognition
85-390 Human Learning and Memory
85-392 Human Expertise
85-406 Seminar on Autism
85-412 Cognitive Modeling
85-413 Human Factors
85-414 Cognitive Neuropsychology
85-417 Cognitive Modeling and Intelligent Tutoring Assessment
85-419 Introduction to Parallel Distributed Processing
85-421 Language and Thought
85-422 Infancy
85-423 Cognitive Development
85-429 Cognitive Brain Imaging
85-601/602 Senior Thesis
66-501/502 Honors Thesis

Philosophy

80-210 Logic and Proofs
80-211 Logic and Mathematical Inquiry
80-220 Philosophy of Science
80-254 Analytic Philosophy
80-270 Philosophy of Mind
80-271 Philosophy and Psychology
80-300 Minds, Machines and Knowledge
80-310 Logic and Computation
80-311 Computability and Incompleteness
80-314 Logic in Artificial Intelligence
80-316 Probability and Artificial Intelligence
80-319 Computability and Learnability
80-471 Cognitive Computation
80-518 Seminar in Epistemology

Linguistics

76-385 Introduction to Discourse Analysis
80-280 Introduction to Linguistic Analysis
80-306 Meaning in Language
80-481 Formal Semantics I

Decision Sciences

88-302 Behavioral Decision Making
88-356 Rational Choice

Neurosciences

03-360 The Biology of the Brain
42-301 Physiology

Appropriate courses offered by the Department of Neurosciences 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 Neurosciences):

- NROSCI1000 Introduction to Neuroscience
- NROSCI1011 Functional Neuroanatomy
- NROSCI1012 Neurophysiology
- NROSCI1107 Synaptic Transmission
- NROSCI1030 Psychiatric Disorders and Brain Function
- NROSCI1032 Funcit Organization of the Human Nervous System
- NROSCI1104 Neural Basis of Cognition
- NROSCI1106 Neurobiology of Aging
- NROSCI1040 Biological Basis of Learning and Memory
- NROSCI11041 Developmental Neuroscience
- NROSCI11042 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, 03-360, The Biology of the Brain.

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<th>Junior Year</th>
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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 is 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.

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 (15-111), 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

I. Introductory courses  
Complete only one of these courses.

85-100 Cognitive Processes: Theory & Practice
85-102 Introduction to Psychology

II. Area Survey courses  
Complete two courses.

85-211 Cognitive Psychology
or
85-213 Human Information Processing and Artificial Intelligence
85-219 Biological Foundations of Behavior
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Personality

III. Statistics  
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*
85-320 Research Methods in Child Development*
85-340 Research Methods in Social Psychology*

*Prerequisites (or corequisite) for all Research Methods courses: 36-309 and the appropriate survey course.

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 85-599. In cases where it is not obvious which advanced course belongs to 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—.

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—.

ANNA FISHER, Assistant Professor — Ph.D., The Ohio State University; Carnegie Mellon, 2006—.

BROOKE C. FEENEY, Assistant Professor of Psychology — Ph.D., State University of New York at Buffalo; Carnegie Mellon, 2001—.

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—.

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—.

DAVID KLAHR, Professor of Psychology — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1969—.

ROBERTA KLATZKY, Professor of Psychology, — Ph.D., Stanford University; Carnegie Mellon, 1993—.

KENNETH R. KOEDINGER, Associate Professor 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—.

MARGARET LOVETT, Assistant Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 2000 —.

BRIAN MACWHINNIE, Professor of Psychology — Ph.D., University of California, Berkeley; Carnegie Mellon, 1981—.

DAVID RAKISON, Assistant Professor — D.Phil., University of Sussex; Carnegie Mellon, 2000 —.

LYNNE M. REGER, Professor of Psychology — Ph.D., University of Michigan; Carnegie Mellon, 1978—.

MICHAEL SCHEIER, Professor of Psychology, Head, Psychology Department — Ph.D., University of Texas; Carnegie Mellon, 1975—.

ROBERT S. SIEGEL, 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—.

ERIK D. THIESSEN, Assistant Professor — Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 2004 —.