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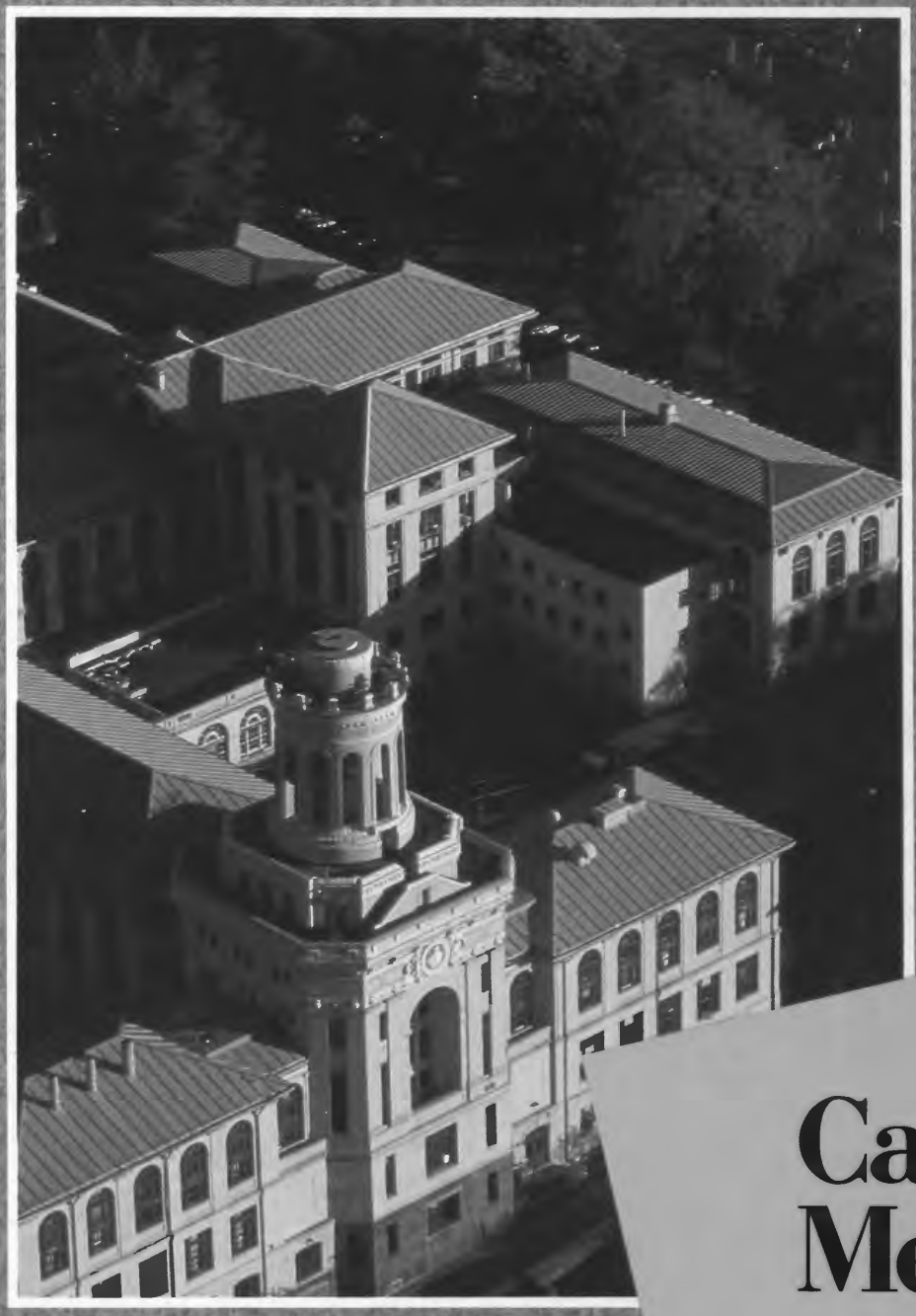

Carnegie Mellon

1994 - 1996
Undergraduate Catalog

Campus Directory

For general information about Carnegie Mellon, call (412) 268-2000.

Activities Board. 268-2105
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Tartan (newspaper). 268-2111
Treasurer. 268-2101
WRCT (radio station). 268-2883

Carnegie Mellon University

Undergraduate Catalog 1994-1996

Carnegie Institute of Technology

The College of Fine Arts

The College of Humanities and Social Sciences

The Graduate School of Industrial Administration

William Larimer Mellon, Founder

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

Mellon College of Science

The School of Computer Science

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.

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

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 1995. 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 1994 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. I will be happy to receive updated information from any member of the campus community so that this catalog will maintain its usefulness until 1996.

William F. Elliott, Editor and Publisher,
1994-96 Undergraduate Catalog;
Vice President for Enrollment

Karen J. Marron, Copy Editor

Published in August, 1994
Printed on recycled paper.

Contents

Look at Carnegie Mellon

Look at Carnegie Mellon

A Background Based on Achievement

A Community Striving Toward Excellence

Students come to Carnegie Mellon for a number of reasons. Some are excited by the richness of a university comprising seven different colleges and seek strong academic programs which allow them to focus on a program in one college while still exploring areas in others. Other students are stimulated by the presence of talented fellow students and faculty — by becoming part of a community where colleagues in the arts, business, humanities, engineering, science and public policy all strive to reach their full potential. Some value the close interaction with faculty who open their doors and their minds, and who include home phone numbers on a course syllabus. However, all students come to Carnegie Mellon with a common pursuit: excellence.

From Technical School to Renowned University

In a letter written in 1900, industrialist and philanthropist Andrew Carnegie offered to give the city of Pittsburgh one million dollars 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 school was designed to train the sons and daughters of working class families. The original institute included a school of Science and Technology to train draftsmen and engineer's assistants, a school of Fine and Applied Arts for designers and art workers, a school of Apprentices and Journeymen for mechanics in manufacturing and construction, and Margaret Morrison Carnegie College for students who aspired to be home economists or secretaries. Within two decades, bachelor's, master's and doctor's programs had been organized and the name was changed to Carnegie Institute of Technology.

The Carnegie Mellon of more recent years is a far cry from the institution envisioned by its founder. In 1967, the trustees of the Mellon Institute and Carnegie Institute of Technology merged the two institutions and adopted the name Carnegie Mellon University. In 1968, Margaret Morrison College was closed and a new College of Humanities and Social Sciences was organized. On the graduate level, other new colleges and schools also flourished. They include the Graduate School of Industrial Administration, the H. John Heinz III School of Public Policy and Management, and the School of Computer Science. New research centers and institutes developed on and off campus in such areas as software engineering and robotics.

Since the end of World War II, the Carnegie Institute of Technology has developed from a regional, technical college into a selective, international research university. Today Carnegie Mellon is made up of seven colleges. As undergraduates, students pursue majors through the Carnegie Institute of Technology (engineering), the College of Fine Arts, the Industrial Management Department of the Graduate School of Industrial Administration, the College of Humanities and Social Sciences, the Mellon College of Science, and the School of Computer Science.

A Special Educational Experience

Carnegie Mellon is a varied community. There are approximately 4300 undergraduates and 2500 graduate students, with a total faculty of more than 750. A small student-to-faculty ratio provides an opportunity for close interaction between students and professors. There is also a strong sense of independence at Carnegie Mellon. Professors expect students to assess their own progress, although they are more than willing to spend additional time with students. In the process, students and faculty come to know each other as people with individual talents, quirks, interests and viewpoints. Of course, in many fields, one to one interaction between students and professors is essential to academic success. A design professor critiquing a student's sketches of a logo for a hypothetical company is just one example. There are many other ways that faculty get to know their students. Some serve as academic advisors. Others seek undergraduate assistance with research projects or offer to oversee student-proposed projects. Professors at Carnegie Mellon take an interest in their students' questions and concerns beyond the classroom.

Depth and Breadth

While a Carnegie Mellon education is marked by a strong focus on fundamental and versatile problem-solving skills in a particular discipline, student's talents and interests rarely remain confined to one area. The university respects that diversity, and provides opportunities to explore more than one field of study. While its programs maintain a strong professional focus, Carnegie Mellon encourages students to think in new ways. Students take courses drawn from disciplines across the university.

Depending on the colleges in which they are enrolled, students may decide to pursue the option of a double major or a minor. They may even design their own majors, drawing on university offerings. In a community rich with seven colleges, the academic options can be as varied as the students who pursue them.

The Common Threads

Though academic pursuits may differ, the university has structured its programs so that students develop skills vital to all professions. Communication is a common thread connecting these skills. In order to excel in any field, students must be able to convey ideas and information effectively. Every student takes at least one entry-level writing course because sharp written communication is important to almost every field. Without it, ideas can fade or lie buried in confusion on paper.

Today, computing has also become an integral part of academic life, and all Carnegie Mellon students take a computing skills workshop. Though most students take advantage of the computer's word processing capabilities, computing at Carnegie Mellon actually extends much further.

The university has developed a sophisticated software system named "Andrew" for Carnegie Mellon's founders, Andrew Carnegie and Andrew Mellon. Eleven thousand outlets connect every office, classroom and dormitory room on campus. The system includes thousands of personal computers and workstations. This means that students, faculty and administrators can access the system from offices, living quarters, laboratories and public facilities all across campus.

Strength in Research and Artistic Creation

Carnegie Mellon faculty carry out two overlapping responsibilities: teaching and research or artistic creation. The university is alive with new information that finds its way into the classroom. At Carnegie Mellon, instruction is provided by people who are creating new knowledge at the frontier of their disciplines. Each college and dozens of special centers focus on issues and developments that affect the world beyond Carnegie Mellon. For example, four faculty members

from the Physics Department recently participated in the LEP (large electron-positron) project near Geneva, Switzerland, where over 1,000 researchers from around the world hope to discover at least one of the last two missing particles in the Standard Model of Particle Physics. In the College of Humanities and Social Sciences, the Psychology Department, in collaboration with the Center for the Study of Writing in the English Department, recently received a $1.5 million grant from the Andrew W. Mellon Foundation for a Literacy in Science Center to improve the level of scientific knowledge in America. The engineering college is the only institution in the country with two National Science Foundation engineering research centers. Researchers in the Field Robotics Center of the university's Robotics Institute continue to develop robots that can function in unpredictable and hazardous environments for such uses as nuclear maintenance, mining and space exploration. Faculty in the Music Department have worked with the School of Computer Science to develop a program called PIANO TUTOR. These are just a few examples of the innovative work at Carnegie Mellon.

Exploring Research and Creative Projects

Undergraduates hear news of research developments and artistic creation through professors, read about them in papers and magazines, or see them in galleries or on stage. Students can also initiate projects of their own or become involved with existing projects on campus. The Department of Biological Sciences, for example, assigns each student a faculty mentor who will help him or her find appropriate opportunities. Drama students are the stars of stage productions. Students can be assertive in pursuing their particular interests. Most departments offer courses for independent study which allow undergraduates to work on projects of their own design, overseen by professors.

Many sources of funding are available to aid students conducting independent research and creative projects. For instance, students may apply for grants through the Undergraduate Research Initiative's Small Undergraduate Research Grant (SURG) program. The Initiative offers many other services to undergraduates in all departments at Carnegie Mellon. For more information, please see the Undergraduate Research Initiative section in this catalog under "University Services."

The World of Carnegie Mellon

Carnegie Mellon students will sometimes proudly count on one hand the number of hours they slept the previous night. You may assume that they were struggling with a problem set, perfecting a paper, putting the finishing touches on a piece of sculpture, and often they were. But many students spend free hours simply taking advantage of the company they share. Whether talking about individual interests and experiences or planning for the coming weekend, Carnegie Mellon students discover fascinating people and often develop some of the strongest friendships they have known.

A Tough Competitor: Yourself

Carnegie Mellon is often described as a competitive place, and it is. The university selects students from among the best in the country, so coming to Carnegie Mellon means that you may no longer necessarily be at the top of your class. Instead, students are more in step with each other, sharing abilities and sometimes goals. Carnegie Mellon students are serious students who want to excel. Their own toughest competitors are often themselves, pushing to absorb knowledge and reaching out for excellence. The atmosphere is intense but rewarding. Carnegie Mellon graduates enter society as very specially educated people, prepared to assume even greater challenges and equipped with an awareness of their own strengths and abilities.

Carnegie Mellon Affects the World Beyond Campus

As a graduate of the university, you join a highly respected group of productive individuals. Whether pursuing further education or entering the work force, Carnegie Mellon alumni consistently achieve the goals they have set for themselves.

Carnegie Mellon graduates don't fit neatly into one category. Carnegie Mellon alumni wrote the songs for *Godspell, Pippin* and *The Magic Show.* One alumna won the Helen Hayes Award as best actress for her role in a touring production of *Cats.* Alumna Holly Hunter received a Best Actress Oscar for her role in "The Piano." Carnegie Mellon alumni created and starred in the popular television series, *Hill Street Blues* and *L.A. Law.* Over 2,000 of our graduates are chairmen, presidents or vice presidents of corporations, including Standard Oil and Dansk International Design. More than 1,400 alumni teach as professors at universities and 30 are deans. Most major symphonies around the country include our alumni. Carnegie Mellon graduates in government include a former White House staff assistant , a U.N. delegate and a former first deputy chairman of the Presidium of the USSR. An Apollo 14 Astronaut who walked on the moon holds a degree from Carnegie Mellon as does the project director of NASA's Pioneer Interplanetary Probe. Astronaut Judith Resnik, who died in the explosion of the space shuttle Challenger, was a Carnegie Mellon graduate. In addition, the works of many former art students, including Andy Warhol, hang in the permanent collections of over 50 international museums. This is the variety that marks our university and our graduates.

Undergraduate Education at Carnegie Mellon University: Statement of Mission

A Carnegie Mellon undergraduate education aims to prepare students for life and leadership. In a continually changing world, the most important qualities we can help our students develop are the ability to think independently and critically, the ability to learn and the ability to change and grow. As future leaders they must have courage 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 considered set of values, including commitment to personal excellence and intellectual adventure, a 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. We are committed to bring together the traditions of liberal and professional education. In a world which has sometimes placed too little emphasis on "skill", we take pride in educating students who display excellence in application, students who can do useful things with their learning.

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

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

Degrees Offered
One University, Seven Colleges

To attend Carnegie Mellon is to be a member of a university made up of seven colleges listed below with their respective departments.

Carnegie Mellon offers bachelor's, master's and doctor's degrees in a variety of areas. Graduate students may also pursue joint degrees between two departments within the university and dual degrees with Carnegie Mellon or between Carnegie Mellon and the University of Pittsburgh.

Students at Carnegie Mellon can pursue majors in each of the university's departments. Possibilities exist to double or triple major upon the fulfillment of a department-determined set of courses.

A number of other possibilities for focused study exist for undergraduates. Many departments offer minors and options. Information on the requirements for each of these is available from the departments and colleges.

Carnegie Institute of Technology

- **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
  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

- **Mechanical Engineering**
  B.S. in Mechanical Engineering
  M.S. in Mechanical Engineering
  M.E. in Mechanical Engineering
  Ph.D. in Mechanical Engineering

- **Materials Science and Engineering**
  B. S. Materials Science and Engineering
  M.S. in Materials Science and Engineering
  M.E. in Materials Science and Engineering
  Ph.D. in Materials Science and Engineering

College of Fine Arts

Bachelor of Humanities and Arts (jointly with the College of Humanities and Social Sciences)
Master of Arts Management (jointly with the H. John Heinz II School of Public Policy and Management)

- **Architecture**
  B.Arch. in Architecture
  M.S. in Architecture
  Ph.D. in Architecture

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

- **Design**
  B.F.A. in Industrial Design
  B.F.A. in Graphic Design

- **Drama**
  B.F.A. in Drama
  M.F.A. in Directing
  M.F.A. in Costume Design
  M.F.A. in Production
  M.F.A. in Playwriting
  M.F.A. in Scene Design
  M.F.A. in Lighting Design

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

College of Humanities and Social Sciences

Bachelor of Humanities and Arts (jointly with the College of Fine Arts)

- **Economics**
  B.A. in Economics
  B.S. in Economics
  B.S. in Managerial Economics
  Ph.D. in Economics

- **English**
  B.A. in Literary and Cultural Studies
  B.A. in Creative Writing
  B.A. in Professional Writing
  B.A. in Rhetoric
  B.S. in Technical Writing
  M.A. in Communication Planning and Design (jointly with the Department of Design)
  M.A. in English
  M.A. in English (a fifth-year option, in conjunction with the Secondary School Pennsylvania State Teacher Certification Program)
  M.A. in Professional Writing
  Ph.D. in Rhetoric
  Ph.D. in Literary and Cultural Theory

- **History**
  B.A. in Social History
  B.S. in Social History

B.A. in History and Policy
B.S. in History and Policy
B.A. in Anthropology and History
B.S. in Anthropology and History
B.A. in European Studies (as part of a double major)
M.A. in History
M.A. in History (a fifth-year option, in conjunction with the 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 Program**
  B.A. in French
  B.A. in German
  B.A. in Spanish
  M.A. in French (a fifth-year option, in conjunction with the Secondary School Pennsylvania State Teacher Certification Program)
  M.A. in Spanish (a fifth-year option, in conjunction with the Secondary School Pennsylvania State Teacher Certification Program)
  Ph.D. in Second Language Acquisition

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

- **Psychology**
  B.A. in Psychology
  B.S. in Psychology
  B.S. in Cognitive Science
  M.A. in Psychology (a fifth-year option, in conjunction with the Secondary School Pennsylvania State Teacher Certification Program)
  Ph.D. in Psychology

- **Social and Decision Sciences**
  B.S. in Social and Decision Sciences
  B.S. in Information and Decision Systems
  B.S. in Policy and Management
  B.S. in Political Science
  Ph.D. in Social and Decision Sciences

- **Statistics**
  B.S. in Statistics
  M.S. in Statistics
  Ph.D. in Statistics

Graduate School of Industrial Administration

- **Industrial Management**
  B.S. in Industrial Management
  M.S. in Industrial Administration
  M.S. in Civil Engineering and Management (jointly with Carnegie Institute of Technology)
  M.S. in Information Networking (jointly with Carnegie Institute of Technology and the School of Computer Science)
  Ph.D. in Accounting
  Ph.D. in Economics
  Ph.D. in Financial Economics
  Ph.D. in Information Systems
  Ph.D. in Manufacturing and Operations Systems
  Ph.D. in Marketing
  Ph.D. in Operations Research
  Ph.D. in Organizational Psychology and Theory
  Ph.D. in Political Economy
  Ph.D. in Algorithms, Combinatorics, and Optimization (with the Department of Mathematics and the School of Computer Science)
  Ph.D. in Robotics (with the Robotics Institute)

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

M.S. in Public Management and Policy
Master of Arts Management (jointly with the College of Fine Arts)
M.S. in Public Management and Policy with a minor in Business Administration (jointly with the Graduate School of Industrial Administration)
M.S. in Public Management and Policy and Juris Doctor (dual degree program with the University of Pittsburgh's School of Law)
Master of Public Management
M. Phil. in Public Policy Analysis
Ph.D. in Public Policy Analysis
Ph.D. in Decision Sciences and Policy Analysis (jointly with the Department of Social and Decision Sciences)
Ph.D. in Political Economy (jointly with the Graduate School of Industrial Administration and the Department of Social and Decision Sciences)

Mellon College of Science

- **Biological Sciences**
  B.S. in Biological Sciences
  B. S. in Biological Sciences/Computer Science Track
  B.A. in Biological Sciences (and a discipline in the humanities or social sciences)
  Ph.D. in Biological Sciences
  Ph.D. in Biological Sciences/Biophysics and Biochemistry

- **Chemistry**
  B.S. in Chemistry
  B.S. in Chemistry /Computer Science Track
  B.A. in Chemistry
  M.S. in Chemistry
  M.S. in Polymer Science
  M.S. in Colloids, Polymers, and Surfaces (jointly with Chemical Engineering)
  Ph.D. in Chemistry
  Ph.D. in Chemistry/Biophysics and Biochemistry

- **Mathematics**
  B.S. in Mathematics
  B.S. in Applied Mathematics/Operations Research
  B.S. in Applied Mathematics/Statistics
  M.S. in Mathematics
  M.S. in Applied Mathematics
  D.A. in Mathematics
  Ph.D. in Mathematics
  Ph.D. in Algorithms, Combinatorics and Optimization
  Ph.D. in Pure and Applied Logic (jointly with the Department of Philosophy and the School of Computer Science)

- **Physics**
  B.S. in Physics
  B.A. in Physics
  B.S. in Physics/Computer Science Track
  M.S. in Physics
  Ph.D. in Physics
  Ph.D. in Applied Physics
  Ph.D. in Physics/Biophysics and Biochemistry

School of Computer Science

B.S. in Computer Science
M.S. in Software Engineering
Ph.D. in Computer Science
Ph.D. in Robotics
Ph.D. in Pure and Applied Logic (jointly with the Departments of Philosophy and Mathematics)
Ph.D. in Algorithms and Combinatorial Optimization (with the Graduate School of Industrial Administration and the Department of Mathematics)

Admission

Undergraduate Admission

Michael A. Steidel, Director of Admission
Office: Warner Hall, Room 101

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 — who can 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. We want to see how greatly each student has challenged him or herself in high school.

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 I or ACT and SAT II: 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 one'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. This adds a personal touch to our evaluation and gives students a chance to ask questions. Students can also take advantage of the chance to talk with a local Carnegie Mellon alumni representative. There are a number of other ways to show interest and learn more about Carnegie Mellon, too. Students can come to one of our Sleeping Bag Weekends, attend an area program in or near their town, interview in their hometown with one of our staff members 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 Departments of Drama and Music is based primarily on an audition or portfolio showing. Applicants to Art/Design will be evaluated not only on the basis of their portfolio but also on their academic performance.

Candidates for Architecture will be evaluated primarily on the basis of academic performance. The same holds true for students interested in the Carnegie Institute of Technology and the Mellon College of Science, but we will look additionally for strength in mathematics and science.

Academic performance is also the main criteria we use to evaluate applicants to the Humanities and Social Sciences or to the Industrial Management 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, counselor recommendation and interview recommendation—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 the student is asked to write, the guidance counselor's evaluation, and the teacher's recommendation.

Freshman Application Instructions

1. Student should apply for admission to the specific college(s) in which he or she is interested.

   • Student should indicate college by checking proper box on application for admission.

   • On the line provided, student should write the name of the program that interests him/her.

2. If student seeks admission to more than one college or department:

   • Student should enclose a cover letter with the application for admission, ranking program preferences.

   • Student does not have to submit two applications, and there is no additional cost. Student should simply indicate on the application the colleges to which he/she is applying.

   • Student should be sure to meet the admission requirements for each college or department.

   • Student may be granted the option of participating in our University Choice Program. (See application materials for more details.)

3. Student should follow these guidelines for each specific area of interest:

   Carnegie Institute of Technology (CIT)

   College of Humanities and Social Sciences (H&SS)

   Mellon College of Science (MCS)

   School of Computer Science (SCS)

   School of Industrial Administration (IM)

   Student should indicate program preference at the time he/she applies. Although student won't declare a major until the end of the freshman or sophomore year, Carnegie Mellon has had to limit access to certain departments in the past, such as Electrical and Computer Engineering and Computer Science.

   • College of Fine Arts

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

   • Bachelor of Humanities and the Arts

   To apply to the Bachelor of Humanities and the Arts (BHA) program, student should complete and submit the application as described above. In addition, student should include with the application an essay describing his/her interests in the fine arts and humanities. The BHA program is designed for students who wish to explore their interests in these areas. Student should tell us about past experiences and describe how he/she would like to explore the arts and humanities on a college level. Student is encouraged to submit any additional material that relates to his/her experiences (such as a resume, slides of art work, performance videos, sketches, writing, etc.).

Secondary School Preparation and Required Tests

College	High School Preparation	Tests
Carnegie Institute of Technology **Mellon College of Science** **School of Computer Science** **School of Industrial Administration**	4 years English 4 years Mathematics* 1 year Chemistry 1 year Physics 2 years Foreign Language (preferred) 4 electives	SAT I or ACT SAT II: Subject Tests(3) English Composition*** Math Level I or II or IIC Physics or Chemistry Biology****
College of Humanities and Social Sciences	4 years English 3 years Mathematics 1 year Science 2 or more years preferred) 2 years Foreign Language (preferred) 6 electives	SAT I or ACT SAT II: Subject Tests (3) English Composition*** Math Level I or II or IIC One additional test selected by applicant
Architecture	4 years English 4 years Mathematics* 1 year Physics 2 years Foreign Language (preferred) 5 electives	SAT I or ACT SAT II: Subject Tests (3) English Composition*** Math Level I or II or IIC Physics or Chemistry
Art	4 years English 2 years Foreign Language (preferred) 10 electives	SAT I or ACT SAT II: Subject Test(1) English Composition***
Drama, Music	4 years English 2 years Foreign Language (preferred) 10 electives**	SAT I or ACT
Design	4 years English 2 years Mathematics 2 years Science 2 years Foreign Language (preferred) 6 electives	SAT I or ACT SAT II: Subject Tests (3) English Composition*** Math Level I or II or IIC One additional test selected by applicant

* The four years of mathematics should include algebra, geometry, trigonometry, analytic geometry and elementary functions (pre-calculus).

** Music: Some prior training in solfege is helpful.

*** The English Composition SAT II: Subject Test which includes the written essay is strongly recommended.

**** The Biology SAT II: Subject Test is acceptable for MCS applicants: junior or senior test results only.

4. Student should enclose with the application the non-refundable 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 high school guidance counselor or principal requesting an application for a waiver must be submitted in is not accepted.

   If the student is applying to Music or Drama, the additional audition fee is $40. Student should submit all fees with his/her application.

5. Student should plan to visit the campus or interview with one of Carnegie Mellon's alumni, if possible. (See section on "Exploring Carnegie Mellon.")

6. Student should send all 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. However, after March 1 we will let students know when something is missing.

7. Student should take the SAT I or ACT and three SAT II: Subject Tests no later than January. The results of the March test arrive too late to receive proper consideration. (If student is applying to Drama or Music, SAT II: 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, student should request than 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 student's guidance office. The Carnegie Mellon code number is 2074.

   • Section on "High School Preparation and Required Tests" outlines which tests should be taken.

   • Students should register for tests at least six weeks prior to the test date.

8. International students whose native language is not English should must submit the results of the Test of English as a Foreign Language (TOEFL) in addition to other standardized tests.

9. If student is applying to the College of Fine Art's Departments of Art, Design, Drama or Music, he/she must complete the portfolio or audition requirements. Before student can arrange an audition or review, the application must be submitted by January 1.

10. Each applicant must sign the "Confidentiality Statement" on the Personal Evaluation Form and give it to the guidance counselor for completion. Counselor should return this form, along with the application for admission, directly to the Office of Admission as soon as possible.

11. Student should complete part I of the Teacher Recommendation Form and give it to a teacher to complete. Student should also provide teacher with an addressed, stamped envelope so the teacher can return the form by February 1.

12. The application deadline is February 1 (January 1 for fine arts applicants). Student or counselor should be sure to return the application, 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 student is applying for financial aid, he/she should obtain a Free Application for Federal Student Aid (FAFSA) and a Financial Aid Form (FAF) from a guidance counselor. Student should arrange to have these forms sent to Carnegie Mellon through the College Scholarship Service (CSS) by February 15. The Carnegie Mellon code number is 2074.

Application Notification

Students applying under the Early Decision Plan will be notified of our decisions by January 15. Students applying under the Regular Decision Plan will be notified of our decisions by April 15. Students who are applying for financial aid will also receive financial aid decisions by April 15.

Students who are offered admission and wish to enroll at Carnegie Mellon are required to pay a non-refundable enrollment deposit by May 1 (Candidate's Reply Date), even if they are receiving financial aid, in order to reserve places in the freshman class and in university housing. The university credits this deposit to the 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

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

Application Plans

Early Decision Plan

Students who have been exploring a number of universities and are strongly considering Carnegie Mellon may want to consider applying through our early decision plan. Under this plan, applicants are notified of our admission decisions early in the senior year. By applying early decision, students let us know that they will accept our offer of admission if we extend it. The plan generally involves no risk because, if a student is not admitted under early decision, his or her application will be deferred to our regular decision process and we will re-evaluate it in the spring.

Under the early decision plan, students are encouraged to submit applications to other schools. However, they must agree to withdraw these applications if Carnegie Mellon notifies them of acceptance and financial aid (when necessary).

The early decision plan is available in all areas of study with the exception of Drama. Interested students should take the initiative by following the guidelines below.

1. Indicate on the application that student would like to be considered under the early decision plan.

2. Submit the application by December 1 of the senior year. Applicants to Art, Design and Music should submit the application by November 1.

3. Submit all forms and credentials that are available (high school transcript, SAT I or ACT results, SAT II: Subject Test results), preferably by December 1 of the senior year. Note: Students can apply for early decision without having taken the required SAT II: Subject Tests.

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

5. Fulfill the portfolio, audition or interview requirements if applying to the College of Fine Arts.

Early decision applicants will be notified of our admission decisions by January 15. Students who are applying for financial aid will be informed of the necessary procedures to follow once they have submitted the Carnegie Mellon Financial Aid Application.

Applicants who are admitted under early decision are required to withdraw all other admission applications to other colleges or universities and to post a non-refundable enrollment deposit within two weeks of their admission notification.

Regular Decision Plan

Most students apply under the regular decision plan, which has an application deadline of February 1. Applicants will be notified of our decisions 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, even though the applicants have not received high school diplomas. In

general, early admission candidates are highly mature and responsible students who have usually exhausted the courses offered at their high schools. 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 Admission staff. Students should note that College of Fine Arts very rarely accepts early admission applicants.

While a high school diploma is not required in order to enter Carnegie Mellon, it is to the student's advantage to make arrangements to receive one eventually. The student can consult his or her high school for special arrangements upon successful completion of the freshman year at college. If such arrangements are impossible, students can contact their state Board of Education and ask about attaining a 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 deans will evaluate the scores, and in late summer, students will be informed of the AP credit awarded.

College level course work

The university may also award placement and credit for college work completed while the student was still in high school. Applicants who have taken college courses should arrange to have their college transcripts sent to the Carnegie Mellon Office of Admission for transfer credit evaluation and advanced placement. Students should also send descriptions of the college courses so that the university can make accurate evaluations. As a safeguard for engineering and science students, we grant calculus credit conditionally. If a student has been placed in a calculus course and finds it too difficult, he or she may move into a lower-level course in the sequence. The college will adjust the credit accordingly. In some cases, advanced placement and credit can permit a student to complete a bachelor's degree in less than four years.

International Baccalaureate Program

Similar to our Advance Placement policy, we also recognize the International Baccalaureate Examination. We may grant advanced standing and/or credit in various fields if scores on the higher level examination range from 6 and 7. If eligible, we encourage students to take the IB examinations. The results of the IB exams should be sent to Carnegie Mellon, where the appropriate dean will evaluate the scores. In late summer, students will be notified of the credit that has been awarded.

Attention 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, the College of Humanities and Social Sciences or the Industrial Management program, there must be space available in the particular department to which the student is applying. If there is space in the requested program, we will look at the applicant's college grades, college recommendations, high school grades and test scores (SAT I or ACT and SAT II: Subjects) and base our decisions on these factors.

In the College of Fine Arts, most transfer applicants compete with freshman applicants for a place in the entering class.

Transfer Application Instructions

1. Student should apply for admission to the specific college of interest, noting departmental preference. If interested in Music or Drama, student should specify the option.

   CIT, MCS, H&SS, SCS and IM:

   - fall transfer possible if space is available
   - spring transfer limited

   CFA:

   - fall transfer possible
   - no spring transfer opportunities (except for advanced students in the Department of Music)

2. Student should enclose a non-refundable fee of $45 (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. Check or money order should be made payable to Carnegie Mellon University. Cash is not accepted.

   If applying to Music or Drama, the additional audition fee is $40. Student should submit all fees with his/her application.

3. Student should send all transcripts which reflect secondary school and college/university studies to the Office of Admission. A catalog (labeled with student's name) listing course descriptions from each college/university attended should also be sent.

   IMPORTANT: If student wants to attend Carnegie Mellon as a transfer student and has previously applied to the university within the past three years, he/she must resubmit an updated application with fee (and audition fee if appropriate) and all other materials required of transfer students, but does not have to resubmit high school records.

4. If applying to the College of Fine Art's Departments of Art, Design, Drama or Music, student must complete the portfolio or audition requirements. Before an audition or review can be arranged, however, student must complete and submit the application for admission by January 1.

5. Student must sign the "Confidentiality Statement" on the Personal Evaluation Form. Form (and completed application for admission) should be given to a dean or an advisor at the college attended (or are attended). Dean or advisor should complete and return the form and the 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, student should be sure to print full name and social security number at the top of each document.

6. Transfer application deadlines as follows:

   - Spring transfer: November 1
   - Fall transfer: April 1 (January 1 for non-Architecture CFA applicants)

7. If student is applying for financial aid, he/she should obtain a Free Application for Federal Student Aid (FAFSA) and a Financial Aid Form (FAF) from his/ her current college Financial Aid Office. Student should arrange to have these forms sent to Carnegie Mellon through the College Scholarship Service (CSS) by February 15. The Carnegie Mellon code number is 2074.

If planning on:	File FAF and FAFSA through CSS by this date:
Spring transfer	November 1
Fall transfer (CFA)	March 1
Fall transfer (all other colleges)	May 1

IMPORTANT: If applying for financial aid as a transfer student, student must send a Financial Aid transcript of aid applied for and/or received at all colleges previously attended. Even if student 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

Deposit information

If student is 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 student is offered admission to the College of Fine Arts (non-architecture) for the fall semester, he/she must pay a non-refundable deposit of $400 by May 1, even if receiving financial aid.

If student is offered admission to CIT, MCS, Architecture, H&SS, or IM for the fall semester, he/she must pay a non-refundable $400 deposit by June 15, even if receiving financial aid.

The enrollment deposit will reserve student's place at the university and a place in university housing. It will be credited to the first semester charges. If we are unable to assign campus housing to the student, a portion of the deposit will be refunded.

IMPORTANT: If student accepts our offer of admission, Carnegie Mellon assumes that the tuition deposit to Carnegie Mellon is the only tuition deposit the student is making. We reserve the right to cancel our offer of admission if student posts a tuition deposit at more than one university.

University housing for transfers

Carnegie Mellon expects to accommodate most transfer students who request housing on campus. A portion of the deposit will be returned if we can't offer a student on-campus housing. The Off-campus Housing Advisory and Referral Service is available to help students locate housing accommodations in the local area.

Transfer credit evaluated on individual basis

Carnegie Mellon's departmental faculty will determine transfer credit for courses 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 a student to meet the university's graduation requirements.

Transfer credit for courses being taken while we're reviewing the existing college record depends upon successful completion of each course. Grades are not transferred— only credit. Student may receive transfer credit for elective courses taken but will still have to take Carnegie Mellon courses to fulfill the elective space in the 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 a student to graduate will depend on the time needed for the student to complete the full university degree requirements—not on class standing at a previous institution.

If the student transfers into CIT, MCS, H&SS, IM, or SCS in the fall semester, he/she will receive an estimate of the additional academic work that must be completed in order to fulfill the university degree requirements.

If the student transfers into CIT, MCS, H&SS, IM, or SCS in the spring semester, he/she will have the opportunity to meet with a dean or department head in order to outline the additional academic work that must be completed in order to meet the university degree requirements.

If the student transfers into the College of Fine Arts, he/she will not receive credit for technical subjects until after he/she has completed their first semester at Carnegie Mellon. Under this policy, the student may lose a significant amount of credit. It is best for transfer students in the fine arts to assume freshman status.

Application as an international student

International students should apply to Carnegie Mellon by following the procedures outlined for either freshmen or transfer students. Students should also note this additional information:

- Preliminary application form will be sent to your for completion, and should be returned to the Admission Office as soon as possible. Because Carnegie Mellon does not offer financial aid to international students, we use this form to verify each student's ability to pay for a Carnegie Mellon education.
- Test of English as a Foreign Language (TOEFL) should be taken if student's native language is not English. It is strongly recommended that test be taken on a date when the Test of Written English (TWE) is being administered as part of the test. There is no extra fee to take the TWE. Carnegie Mellon strongly encourages TOEFL scores of 600 or better.
- Financial aid and installment payment plans are unavailable to international students.

Application to the Bachelor of Humanities and the Arts Program

To apply to the Bachelor of Humanities and the Arts program (BHA) program, the student should complete and submit the application form. In addition, the student should include with the application an essay describing his/her interests in the fine arts and humanities. The BHA program is designed for students who wish to explore their interests in these areas. Students should tell us about their past experiences and describe how they would like to explore the arts and humanities on a college level. We encourage students to submit any additional material that relates to their experiences (such as a resume, slides of work, performance videos, sketches, writing, ect.)

Requirements for the College Of Fine Arts

To arrange an audition or portfolio review, student should:

- Student should be sure to indicate his/her first and second choices for audition/ portfolio review dates on the application for admission.
- Submit application by January 1 (November 1 for Art, Design and Music early decision consideration), so we can make arrangements for audition/review.
- Student should expect to receive instructions from us for completing the audition/review, after we receive his/her application.
- Do not expect a final admission decision at the time of the audition/ review; we'll consider the results of the audition/review along with his/her other credentials and notify students by April 15 (January 15 for Art, Design and Music early decision applicants).

Department of Architecture

High school preparation

Because attrition in architecture programs nationwide is currently very high, Carnegie Mellon's Department of Architecture has developed guidelines to help students determine if their sincere interest and potential success in the field. We strongly encourage that students follow these guidelines if they are considering the study of architecture:

- At a minimum, the student should visit the architecture departments of each college he/she is seriously considering. The student should talk with faculty and enrolled students to "get a feel for" each program. At Carnegie Mellon, we'll make every effort to set up opportunities for the student to talk with our students and faculty. In addition, if the student would like to interview with one of our architecture alumni in his/her hometown, he/she should contact the Department of Architecture at (412)268-2354.
- If the student is seeking admission to Carnegie Mellon's architecture program, we encourage the student to take the highest level course available at his/her high school in mathematics (calculus), science (physics), English (advanced literature courses) and history (courses in western and non-western history).
- If the student is seeking admission to Carnegie Mellon's architecture program, we also encourage the student to pursue artistic and architectural opportunities while in high school (for example, part-time employment with a local, practicing architect).
- If the student is seeking admission to Carnegie Mellon's architecture program, we also encourage the student to participate in one of the many summer programs offered by architecture departments at colleges around the country. (Carnegie Mellon offers a program for students who've completed their junior year of high school-an excellent opportunity for the student to gauge his/her interest in architecture and for our faculty to assess the student's potential for success.)

Admission to the Department of Architecture is based primarily on academic credentials. We look closely at student's performance in English, mathematics, physics and social science courses because they're the best predictor of success in the program. In addition, high school experience with computers is valuable but not required.

Painting, sculpture and drawing skills help prepare students for Architecture at Carnegie Mellon. We prefer these courses to high school courses in mechanical drawing. Portfolios are not reviewed as part of the admissions process for architecture at Carnegie Mellon.

Pre-College Summer Program

The department offers a pre-college program to students who've completed the junior year in high school. The program is a great opportunity for students to sample the Bachelors of Architecture program at Carnegie Mellon and to explore and assess their interest in the field. Full-time university professors teach all courses.

If the student is admitted into Carnegie Mellon's architecture program, we'll strongly encourage him/her to participate in our summer program (if the student has not already participated in this or a similar program) before you enroll as a freshman. At the end of the summer program, the faculty will evaluate the match between the student's skills and the study of architecture. Most likely, our faculty will strongly encourage the student to continue the study of architecture as a freshman. But if the evaluation is not encouraging, the student will be free to continue in the architecture program without prejudice. If the student decides not to pursue architecture, he/she may enroll in any of the other programs at Carnegie Mellon for which the he/she meets the academic and artistic requirements and qualifications. (The student will not have to transfer to another university to continue his/her studies.) In either case, the student will earn nine units of university credit if he/she is admitted to the architecture program and subsequently participate in the summer program.

Transferring into Architecture

Whether student is transferring from another university or from one of Carnegie Mellon's other colleges, he/she will be classified as a freshman in the Architecture program unless a program equivalent to the Architecture Department's freshman year has been completed. If student is not sure whether or not the program is equivalent, it's best to assume freshman status.

Department of Art

Admission Procedure

We're seeking a class of Art students with a wide range of talents, aptitudes and backgrounds. In most cases, we give equal weight to academic performance and artistic ability when we evaluate art applicants.

Art Portfolio Guidelines

The Art Department is more interested in the creative potential than the technical skills demonstrated in a student's portfolio. Student should design a portfolio to reveal and/or highlight creative potential. We encourage student to include pieces that show both ability to work on a wide range of artistic concerns and ability to work in depth on a topic or sequence.

For both on-campus and by-mail portfolio reviews, the student should cover as many of the following categories as his/her background allows:

- drawing and painting, on a variety of subjects, done from observation and/or imagination.
- photography, printmaking, collage and other media.
- sculpture in any medium or of any size.
- environmental or"site-specific" installation (work made for a particular location either indoors or outdoors).
- work that changes with time such as kinetic sculpture or installation or performance.

The Art Department strongly encourages students to personally bring the portfolio for a review on campus. Students should expect to spend at least three hours on campus. The faculty will spend 90 minutes reviewing portfolios. On weekdays, students can arrange to have an admissions interview and a tour while the portfolio is being reviewed. Student exhibitions and classes are also open to visiting students. (If student can't come to campus, he/she must follow the procedures for showing a portfolio by mail.)

On-campus portfolio review guidelines:

- 15 to 20 recent works
- actual two-dimensional work rather than photographs of those works
- photograph, slide or photo CD documentation of two- and three-dimensional works that are large or bulky (such as a sculpture or framed painting)
- VHS video cassettes (10-minute maximum) and 3.5" or 5.25" floppy diskettes also acceptable (Indicate software used on disk)

To register for an on-campus portfolio review, student should:

- Submit application by November 1 (for early decision consideration) or by January 1 (for regular decision consideration)
- Indicate first and second choices of portfolio review dates (on the application for admission)
- Expect a confirmation of review date and time two weeks before the event.

Portfolio review by mail:

- Submitted work should be in the form of 35mm slides, numbered and organized in a standard 9X11" plastic slide sheet.
- Label each slide and sheet with your name.
- VHS video cassettes (10 minute maximum) and 3.5" or 5.25" floppy diskettes are also acceptable. Indicate software used on the diskette.
- Photo CD's are also acceptable.
- Do not send original work or sketchbooks.
- Include a one page statement about your interest in studying art.
- Include a self-addressed return envelope and a piece of cardboard (to prevent bending).
- Mail to the address below no later than February 15.

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

Transfer into Art

Whether transferring from another university or from one of Carnegie Mellon's other colleges, student will be classified as a freshman in the Art program unless a program equivalent to the Art Department's freshman year has been completed. If student would like to be considered for advanced standing, he/she should indicate the level of entry on the application for admission in the space provided. All applicants must complete the admission requirements as listed above for freshman applicants. Transfer applicants are considered for fall semester only.

Department of Design

Admission procedure

The Design Department is seeking a class of students with a wide range of backgrounds, creative talents and interests. We've found that successful design students maintain a balance among three areas, and we assess applicants by evaluating (in no particular order) the following factors:

- academics: high school transcript, class rank, SAT I scores and SAT II: Subject Test scores.
- visual and design ability: portfolio and /or Design Project (details below)
- interpersonal skills: interviews, extracurricular activities, letters of recommendation.

In order to demonstrate his/her abilities in each of these areas, the students must complete the application by January 1 (November 1 for early decision consideration) and fulfill the requirements outlined below. Student must complete at least one requirement from each of the first two columns or complete one requirement from the third column.

Design requirements

Preferred application procedure (choose one):

- On-campus portfolio review and interview with Design faculty
- on-campus Design Project review and interview with Design faculty
- participation in Carnegie Mellon Pre-College Program for Design

Alternative application procedure (choose one):

- submitting a slide portfolio for review by mail and interview with admission staff member or alumni interviewer

• submitting a Design Project for review and interview with admission staff member or alumni interviewer

Design portfolio guidelines

The Department of Design strongly recommends that the student have a portfolio review and a personal interview with their faculty. The student should include the following in their portfolio:

- actual works rather than photographs of works
- no more than 12 to 15 items in any one medium
- recent things the student has created, including original drawings from observation and imagination, crafts, textiles, clothing, costumes, construction, mechanisms, mechanical drawings, industrial art projects, models, ect.
- a sketchbook
- slides or photographs of three-dimensional items

Portfolio by mail

If the student would prefer to submit his/her portfolio by mail, he/she should:

- Follow the guidelines described above.
- Submit the work in the form of 35mm slides in a standard 9x11" clear, plastic slide page.
- Do not mail original work or sketchbooks.
- Include a key, including title (when appropriate), size, medium and objective of project.
- Include a self-addressed, stamped envelope and a sheet of cardboard to prevent bending, so we can return the student's slides.

The student should mail his/her portfolio to the address below no later then February 15 (December 1 for early decision consideration):

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

Design project procedure

If the student chooses to meet a portion of the admission requirements by completing the Design Project, he/she should check the appropriate box on the application form. When we receive the student's application, we will forward the project to him/her with instructions for completing it. The student should complete the project and bring it with him/her to the student's faculty interview or return it by mail before February 1 (December 1 for early decision consideration) to the address below:

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

On- and off-campus Design interviews

The Design Department recommends that the student bring his/her Design project to his/her interview, so that they can discuss the student's work. To arrange an on-campus interview and portfolio review the student should:

- Check the appropriate boxes on the application form, indicating first and second preferences of interview dates.
- Expect a confirmation of the student's review date and time two weeks before the event.
- We will assign the student's interview when he/she arrives on campus.
- To arrange an interview without a portfolio or project review, student should call the Department of Design at (412) 268-2822.

Transfer into Design

Whether the student is transferring from another university or fro one of Carnegie Mellon's other colleges, he/she will be classified as a freshman in the design program unless the student has completed a program equivalent to the Design Department's freshman year. If the student would like to be considered for advanced standing, he/she should indicate the level of entry on the application for admission in the space provided. The student must also interview with a member of the design faculty and submit a portfolio to qualify for advanced standing consideration; we will determine the student's standing through the portfolio review, the interview and the student's transferable program credits. The student should plan to come to campus on the portfolio review date specially scheduled for transfer applicants. If the student plans to enter at the freshman level and does not seek consideration for advanced standing, he/she should follow the procedures for application as freshman. Only fall semester transfer applicants are considered. All international applicants should contact the Design Department for further details.

NASAD Portfolio Days for Art and Design

Informal feedback on portfolio

Faculty members from our Departments of Art and Design participate in the National Association of Schools of Art and Design (NASAD) Portfolio Days sponsored by the National Portfolio Day Association. Portfolio Days give the student a chance to show off his/her work to Carnegie Mellon's art and design faculty members and ask for advice on preparing a portfolio for the campus showing or showing by mail.

Follow up by submitting the application:

If the student shows his/her portfolio during a Portfolio Day, he/she must still submit an application for admission. Art applicants, should also plan to show their portfolios on campus or by mail (optional for design applicants). Both art and design applicants must also submit academic records, SAT I or ACT scores and other required materials.

Department of Drama

Admission Procedure

The Department of Drama at Carnegie Mellon is a member of the Consortium of Conservatory Theatre Training Programs.

To apply to the Department of Drama, student should:

- Indicate on the application for admission the particular option the student wants to pursue.
- Also indicate first and second choices for audition/ portfolio review dates.
- Submit application by January 1 (no early decision consideration available for admission into Drama).
- Enclose a fee of $40 to cover the audition/ portfolio review, in addition to the $45 application fee (all checks payable to Carnegie Mellon University).
- Student should expect a confirmation of the time and place of his/her audition/ portfolio review two weeks before the event.
- Transfers follow same procedures as freshman applicants.
- Transfer students in Acting and Music Theater will be classified as freshman within the program.

Acting Option

If the student is applying to the Acting Option, he/she must fulfill an audition requirement, which is the main basis for admission.

Student should pay close attention to these guidelines:

- Student will be required to perform two contrasting monologues.
- Each monologue should be no longer than two minutes.
- One monologue should be classical, the other a contemporary piece written within the last 30 years.
- Both pieces should be within the student's natural age range.
- Student should be sure to read the entire play , so he/she can demonstrate an understanding of the character and situation involved.
- Student should not have been coached.
- Student may use hand props but not costumes.
- Student should bring a resume and a recent photograph to leave with the audition team.

Some pieces have become very popular in recent years, and we urge students not to use them. They include: Viola's ring speech from Twelfth Night, Ronnie's monologue in House of Blue Leaves,

Katherine's final speech in Taming of the Shrew, Juliet's potion speech, Romeo's banished speech and Cyrano De Bergerac's speeches. We prefer not to see anything from Dark at the Top of the Stairs, Equus, St. Joan, Zoo Story or the Actor's Nightmare.

Music Theater Option

We admit students to this option based mainly on their talent demonstrated through an audition. During the student's audition, the he/she will:

- learn to dance combinations with the group taught by a faculty member. (Student should wear appropriate dance attire.)
- perform those two dance combinations.
- perform two contrasting songs

  -Student should bring his/her own music.

  -Women should sing one legato piece and one "belt" song.
- perform two contrasting monologues

  -See "Acting Option" section for important guidelines.

Design Option

If the student is applying to the Design Option, he/she must demonstrate proficiency in drawing, painting and design by submitting a portfolio of his/her work. The portfolio should include about fifteen items of work in several art media and techniques. Not all samples of the student's work must pertain to the theater.

The portfolio should include examples of:

- use of color
- line drawing
- drafting or
- mechanical drawing

Production Option

If the student is applying to the Production Option, he/she should already have practical experience in the theater, as well as a strong background in mathematics and physics.

We expect the student to submit:

- evidence of the student's ability in drawing, drafting or model making.
- a letter describing the student's training, experience, and ambitions in theater.
- two letters of recommendation from people capable of describing the student's work and evaluating his/her professional promise.

Student should ask those who write letters of recommendation for him/her to send them directly to:

Office of Admission
Production Option- Drama
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890
Fax (412)268-7838

Directing Option

The Directing Option provides a solid grounding in theater arts if the student is seeking a career in theater, film or if he/she has an interest in future graduate studies in production, directing or dramaturgy.

During the first two years, the student will:

- study the artistic, physical, technical and managerial needs of a production.
- pursue rigorous studies in text analysis, acting and directing.
- learn how to combine skills to enable the student to work with reality in the imagined world of the play.
- prepare for future graduate studies by taking elective courses in literature, art, music, psychology and philosophy.
- study non-department electives.

During the second two years, the student will:

- take advanced courses in directing, production and management.
- work on productions as an assistant director and/or stage manger.
- have opportunities to study playwriting and criticism on an introductory level.
- direct in the Studio Theater.

To apply to the Directing Option, the student should follow the audition guidelines outlined in the "Acting Option" with one major change-the student should plan to perform only one monologue. Student should bring to the audition a statement describing why he/she is interested in pursuing this line of study, explaining his/her choice of monologue and including a critical analysis of the play. Student should also bring any prompt books, director's scripts, design portfolio or dramatic writing he/she might have.

Department of Music

Admission procedure

To apply to the Department of Music, the student should:

- Indicate on the application for admission the particular option the student wants to pursue.
- Also indicate first and second choices for audition review dates.
- Plan to audition in Pittsburgh if the student lives within 200 miles of the city.
- Submit the application by January 1 (November 1 for early decision consideration).
- Expect a confirmation of the time and date of the audition two weeks before the event.
- Plan to spend at least three hours on campus on the day of the audition.
- Transfers should follow same procedures as freshman applicants.

To be considered for admission into music, the student must fulfill the following two requirements (both take place on audition date):

- audition in a performance area
- tests in sight-singing, melodic dictation and theory.

Requirements for Performance Area

Keyboard Options

Performance-Piano

1. An invention, suite, or prelude and fugue by Bach (by memory).
2. One or more contrasting movements of a piano sonata by Haydn, Mozart or Beethoven (by memory).
3. A romantic, impressionistic or 20th century composition (by memory).
4. An elementary composition to be read at sight.

Performance-Organ

1. One of the Eight Little Preludes and Fugues by Bach (by memory).
2. A movement of a sonata by Mendelssohn (by memory).
3. An elementary composition to be read at sight.

Voice Option

Performance-Voice

Candidates are expected to have a voice with professional potential and some experience in solo or choral singing. They should be prepared to sing two contrasting songs from the standard concert repertoire (i.e., Italian, French, German, or English art songs; operatic or oratorio arias, ect.) The songs may be sung in the original language or in English. If the student is auditioning outside of Pittsburgh, he/she must bring their own accompanist.

Performance-Instrumental Options

Violin

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 Vivaldi, Handel or Mozart, or a representative work of the romantic or contemporary period.

Viola

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, concerto or sonata by Bach or Telemann or a representative work of the romantic or contemporary period.

Violoncello

1. Scales:any major or minor scale in three octaves as requested.

2. One etude by Duport, Popper or Piatti.

3. A movement of a concerto by Haydn or Boccherini or a representative work of the romantic or contemporary period.

String Bass

1. Scales:any major or minor scale in two octaves 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.

All Woodwinds and Brass

1. Scales: any major or minor scale 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.

Performance-Percussion Option (Auditions in Pittsburgh only)

Audition in the snare drum, mallet and /or timpani. The candidate is required to provide a snare drum, sticks and stands. Applicants should be prepared to play:

Snare Drum

1. Technical rudiments: long roll (soft-loud-soft), fine stroke roll, flam accent, ect. (This is not intended as a review of all rudiments.)

2. One solo etude the equivalent of Grade V rudimental solo, Advanced Snare Drum Etudes (Peters) or Contemporary Studies for the Snare Drum (Albright).

Mallet

1. Scales: any major or minor scale and arpeggios in two octaves as requested.

2. One solo etude the equivalent of: Rondo for Marimba and Piano (Frazeur), Miniatures for Marimba (Matthies) or Sonata Allegro (Peters).

Timpani

1. Tuning technique on two drums.

2. One solo etude the equivalent of: Grade V rudimental (Hochrainer), Modern Method for Timpani (Goodman) or the Solo Timpanist (Firth).

Performance-Guitar Option

1. Scales: any major or minor scale as requested.

2. Any composition by Tarriga or Llobet (excluding transcriptions).

3. Any prelude or etude by Villa-Lobos or Ponce.

4. A prelude or other movement from a suite by J.S. Bach.

5. A piece of the applicant's choice.

If for any reason the students wishes to perform music not included in the above categories, he/she must obtain permission from the guitar faculty. The head of the Department of Music should be contacted in such cases well in advance of the audition date.

Composition Option

Applicants must submit manuscripts of original compositions in advance of the audition date to the head of the Department of Music. Arrangements are welcome but will be considered as supplementary to the basic requirement.

Music Education Option

Program begins in the sophomore year. Applicants must be enrolled in a performance degree program with a required grade point average of 2.5 on a scale of 4.0.

Music audition by mail

To audition by mail, student must follow the same guidelines outlined previously, and also:

- Complete the one-page audition sheet (which the Department of Music will send to the student) with information about the student's personal activities as they relate to your intended study of music (if the student cannot interview in person with a member of our faculty).
- Student should submit his/her work on cassette or VHS of good fidelity. Make sure the word "Music", student's name and address are included inside the audition package. The completed audition sheet must also be enclosed with the audition tape.
- Transfer applicants should include a description of college studies, number of years of college, colleges attended and details of music courses studied.
- An audition fee of $40 must also be received before our faculty can evaluate the audition tape.

Audition tapes and materials should be sent to the address below no later than February 1:

Office of Admission
Music Audition
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-3890

Transfer into Music

Transfer candidates are admitted at the beginning of the fall and spring semesters.

- Spring semester transfer candidates should arrange an audition during the November audition date.
- All transfer candidates must complete the admission and audition requirements just as the freshman applicants do.

Exploring Carnegie Mellon

Visiting campuses is one of the best ways for students to find out which schools may be right for them. At Carnegie Mellon, we strongly recommend that students attend a group information session or interview with a member of the Admission staff while on campus. The interview is actually an information exchange. We want to get to know students, just as students may want to learn more about us. Interviews help the Admission staff develop an appraisal of each student as an individual and serve as one more piece of information that we use to make decisions. During the interview, students have the opportunity to ask questions about:

- admission
- entrance requirements
- financial aid
- undergraduate life (which the student will get to see firsthand)

Students who interview before submitting their applications are urged to bring a transcript (official or unofficial) of their high school work and any available results of standardized tests (SAT I or ACT and SAT II: Subject Tests). This is not required but is helpful.

Students should be sure to request an interview appointment at least three weeks prior to the date they would like to meet with us. The Admission staff interviews Monday through Friday throughout the year. However, because we spend a great deal of time reviewing applications between January 17 and April 1, we do not conduct interviews during this time period. In the fall and early spring, we hold group information sessions on Saturday mornings. To schedule a group information session or an interview, students may call (412) 268-2082 on any weekday from 8:30 a.m. to 5 p.m. (eastern standard time).

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 three hours on campus during these events.

Campus Tours

Campus tours are conducted by student guides and leave from the Office of Admission, 101 Warner Hall. On weekdays during the academic year, we conduct four tours at 9:30 a.m., 11:30 a.m., 1:30 p.m., and 3:30 p.m. Saturday tours and group discussions are held during the fall and early spring at 11:30 a.m.(During the fall and the month of April only.) Tours may not be available during university holidays, vacations or final exam periods (in mid-December, late March, mid-April and early May). To make sure a tour is being given on the day you plan to come 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 students to come to campus. We still enjoy having the chance to meet applicants. Therefore, the Admission staff travels to various parts of the country to interview students in their hometowns. Students who wish to arrange a hometown interview with us must make an appointment. Information about making an appoint-

ment 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. Students who do not receive an invitation but would like to arrange an appointment may call (412) 268-4968 between 8:30 a.m. and 5:00 p.m. Eastern Standard Time.

The specific dates and locations for Hometown Interviews are listed in the Carnegie Mellon application packet.

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. We place just as much value on an alumni interview we do on as a Hometown Interview or on-campus interview with an admission counselor.

Students must request an alumni interview by February 1. Students should:

- either call the Office of Admission or
- return the CMAC reply card enclosed with the application packet or
- expect to receive by mail a copy of the Directory of Carnegie Mellon Alumni Interviewers (further instructions enclosed in directory).

Sleeping Bag Weekends

We believe that the more information students have, the better decisions they will be able to make. The Admission staff invites students to learn more about Carnegie Mellon by actually living like a university student for a day and a half. Visits begin on Sunday afternoon and last through Monday afternoon.

Sleeping Bag Weekends give students the opportunity to find out everything they may want to know about Carnegie Mellon by experiencing and questioning what happens here. During our Sleeping Bag Weekends, students have the chance to:

- meet current students, faculty members, deans and admission counselors.
- attend information sessions prepared for students and parents.
- stay overnight in a residence hall.
- tour the campus.
- attend classes.
- eat at the dining facilities.

Students on our mailing list should expect to receive an invitation to the Sleeping Bag Weekends from us in the fall. To reserve a place at a Sleeping Bag Weekend, students should return the reply card attached to the invitation. If a student does not receive an invitation, he/she should call us at (412) 268-2082.

Students who come to Carnegie Mellon from outside of the Pittsburgh area can schedule an admission interview for Monday. We will send details concerning arrangements for such interviews.

The specific dates of the fall Sleeping Bag Weekends are listed in the Carnegie Mellon application packet. (In April, two Sleeping Bag Weekends are held for admitted students only.)

Area Programs

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 and show a film describing student life on campus. Prior to the event, students will receive an invitation giving the time and location of the program. No appointment is necessary, and we urge students and parents to attend whether they have specific questions or just a general curiosity.

A list of locations and dates that we will be visiting this fall is available in the Carnegie Mellon application packet.

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 a section of the city called Oakland
- accessible by ground, rail, or air transportation (major airlines at Greater Pittsburgh International Airport and frequent limousine service to major hotels; Greyhound, Continental Trailways, Amtrak).

Driving from the East:

- Take the Pennsylvania Turnpike West to Exit 6, Pittsburgh/Monroeville
- Follow Interstate 376 West to Exit 9, 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 3 miles to campus.
- Immediately after crossing the intersection of Forbes and Beeler Street, turn left into the Skibo Parking Lot on campus.

Driving from the West/ North:

- Take the Pennsylvania Turnpike East to Exit 3, Perry Highway
- Follow Interstate 79 South to 279 South (Exit 21).
- Stay on 279 South toward Pittsburgh.
- As you near the city, follow signs for 279 South and the Fort Pitt Tunnel Bridge (left hand lanes).
- Follow signs for 279 South/376 East onto the bridge (right hand lanes).
- Watch carefully for signs on and after the bridge for 376 East (toward Monroeville).
- Take 376 East to Exit 5, Forbes Avenue/ Oakland.
- Stay in right hand lanes, following Forbes Avenue about 1.3 miles through the Oakland business district to campus
- Immediately after crossing the intersection of Forbes and Morewood avenues, turn right into the Skibo Parking Lot on campus

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 5, Forbes Avenue/ Oakland.
- Stay in the right hand lanes, following Forbes 1.3 miles through the Oakland business district to campus.
- Immediately after crossing the intersection of Forbes and Morewood avenues, turn right into the Skibo Parking Lot on campus.

Summer Opportunities

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, the Advanced Placement Early Admission Program, and the Careers in Applied Science and Technology Program. Three sessions of summer school are held for college students who wish to make up or advance their degree program studies. In addition, there is offered one teacher training institute in Advanced Placement English. Every service and support organization is available to summer students: the Computer Center , the Health Office, the Counseling Center, the libraries, the Admissions Office, the Career Center, Student Activities, etc.

Summer Pre-College Programs for High School Students

Office of Admission, Warner Hall 101

The Pre-College Programs are designed to be previews of actual college experiences. Along with their program orientation, the Summer Pre-College Programs for high school students afford each student many opportunities for personal growth and development within a university setting. The campus is in full operation during the summer, populated by students and faculty from a wide variety of programs. In addition to various recreational facilities, service and support organizations are available to the Pre-College Program students such as the Health Service, the Counseling Center, the libraries, the Admissions Office, and the Career Center. A wide range of social, cultural, and recreational activities is also planned by a staff of resident counselors to enrich the learning experience and 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.

Advanced Placement Early Admission 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 dormitory and participating in educational, social, and recreational activities.

The faculty teaches courses in biology, calculus, chemistry, chemical engineering, computer science, 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. A three-course load would be somewhat excessive, but a request to take three courses at no additional expense will be considered.

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. Carnegie Mellon is always interested in academically talented high school juniors who have the academic ability to skip their senior year entirely to accept early admission to college. This is especially true for capable students whose academic and career goals are clear. Student 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, Department of Industrial Management (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 in Mathematics-Computer Science.

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 adventuresome young students who are years away from college (ninth graders, for example). 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 and concurrent registration in calculus; and that the chemistry and biology 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 important, 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, student 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 Department 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, we 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 chose electives in three comprehensive areas of study in three-week modules during the program. The areas include two-dimensional (painting, drawing, computer graphics and printmaking), three-dimensional (sculpture, installation and materials) and time-based art (video, sonic media and interactive sculpture installation).

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 freshmen admission to the department may schedule an interview with Admissions. Students may request portfolio help from faculty throughout the summer.

Careers in Applied Science and Technology

The rigorous intellectual approach to teaching science and technology often makes those subjects appear to be authoritarian. The scientific method is often presented as a step-by-step process of hypothesis formation, testing, and refining, laden with rules and procedures. The human elements of science' openness to new ideas, curiosity, inspiration, and serendipity are usually lost in such presentations, and with them are lost many talented young people who do not identify with the authoritarian approach.

This is a genuine tragedy, both for the individuals and for science as a whole. In contrast to the "macho" image of their field, most practicing scientists, engineers, and technologists chose their profession for its ability to liberate their creativity. They pursue their studies of natural phenomena for the sense of wonder, not because they feel compelled to test a particular hypothesis. The CAST summer program will expose the participants to this human side of the scientific endeavor. It will include a series of visits to laboratories the exhilaration of discovery as they describe, with as much hands-on involvement of the visitors as possible, the various aspects of their jobs. The laboratories to be visited include a broad range of science: microelectronics, medical imaging, artificial intelligence, robotics, recombinant DNA, modern materials including superconductors, and hazardous substance handling, among others.

The program will also stress the connections between science and other aspects of life and learning through two workshops, one on science writing and one on the complex interplay of science, technology, and society. The science, technology, and society workshop will be a modified version of the ongoing Engineering and Public Policy course "Technology and People." It will take a case-study approach and include role playing in such issues as passive restraints and automobile safety, PCB disposal, and the tragic loss of the space shuttle Challenger. Successful role playing will require the participants to research technical and social issues and to study the procedures, hearings, and investigations of actual incidents.

The science writing workshop will include an adaptation of materials from introductory courses in Carnegie Mellon's highly regarded program in Technical and Professional Writing. In addition, it will capitalize on one of the faculty's experiences in writing children's science books and articles. Also participating in discussions of periodical writing, graphics, and design will be experts from Carnegie Mellon University Publications, and local Pittsburgh newspapers and magazines.

The two workshops are intended to broaden the participant's view of possible science-related careers. Science writing, technical communication at other levels, and technology policy-making are important career options. Although they are not jobs in science as it is normally practiced, they require substantial scientific training and take the practitioner into the heart of current research. These will be explicitly explored. Other career options, such as science and technology, law, and science teaching, will also be discussed in the workshops.

The laboratory tours and the two workshops will take place over a three-week period. During the fourth week, some participants will be expected to apply their lessons by developing a sample issue of a science magazine for use in Middle School classrooms, i.e., for readers just a few years younger than themselves. The faculty anticipate that the magazine will be field-tested by Middle School teachers, especially those involved with the program. Other participants will be involved in research in the areas of microscopy, biotechnology, information storage and engineering design.

Pre-College Design Program

Design has an important influence on contemporary life. Nearly everything that has been manufactured or printed- packages, appliance, 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 a integrated study program of graphic design, industrial 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 has the nation's oldest drama department. Its graduates work in every branch of theater, film, television and radio. It is a department for the serious student, and one that feeds the profession.

If you are a serious theatre student, or debating whether to become one, Carnegie Mellon's Pre-College Drama program is for you. You can come here with a lot of experience or almost no experience, as long as you come ready to dive in and work, ready to find out how hard work leads to good theatre.

A Carnegie Mellon summer is a rich and exciting experience. It leaves the student knowing what professional training is all about. Students will learn how to decide what kind of professional training is best, and prepare to get it. The program consists of one of three options, Acting, Music Theatre, Design and Technical Production.

There will be focus on the audition preparation for actors and music theatre students, and design portfolio review for technical apprentices, the kind you will have to do for any good drama school. Carnegie Mellon Drama faculty members will coach you, evaluate your work, and help steer you into the right kind of training, whether that right kind of training is here at Carnegie Mellon or elsewhere. Outstanding students have the possibility of fulfilling the talent portion of the Admissions process through this program.

Pre-College Music Program

Carnegie Mellon's Department 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 Department has become a leader in the field of computer music. New state-of-the-art computer music facilities challenge the most adventurous young musician to learn more about acoustics and discover new sounds. Music theory software, developed at Carnegie Mellon, enhances the curriculum, and the finest compositions 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 recent cassette tape, representative of their level of performance, or copies of original compositions, with the application materials. A brief outline of resume of previous musical training is also required. Students will be accepted into one or more areas of study by virtue of their specific interests and proficiencies.

For more information

Requests for applications and further information should be addressed to:

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

University Sessions

Office of the Registrar, Warner Hall 201

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 Industrial Management Department (IM).

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.

For more information

Requests for applications and further information should be addressed to:

Office of the Registrar
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213-9959
(412) 268-2004
FAX: (412) 268-6651

Finances

Finances

Estimated Costs for 1994-95

Estimated educational expenses at Carnegie Mellon for the 1994-95 academic year are as follows:

	On/Off Campus Resident	Commuter
Tuition	$17,900	$17,900
Activity Fee	100	100
Orientation Fee	160	160
Room and Board	5,800[1]	
Books and Supplies	450[2]	450
Incidentals	1,050	1,050
Meals		890
Transportation	Variable[3]	500
Total	**$25,460**	**$21,050**

The two budgets depicted above reference a typical On/Off Campus Student and a Commuter Student. The University reserves the right to change its charges without notice.

[1] The $5,800 item for room and board is an estimate of the charge based upon a double room in University housing and a constant pass food service contract. $5,300 will be the room and board estimate for students living off campus in non-University-sponsored housing.

[2] Students enrolled in the departments of Art, Design, and Architecture customarily spend $400 more for books and art supplies than the amount listed above. Their budget is adjusted to reflect this.

[3] A travel allowance will be calculated and added to the $25,460 educational cost. This supplemental allowance is based on the distance from the resident student's home to Carnegie Mellon and varies from $50 to $1,950.

The tuition charge, $17,900 per year, is for all full-time undergraduate students. A full-time student is one registered in a degree program and carrying a schedule of not less than 36 units per semester. A student enrolled for 35 units or less per semester will be charged tuition on a unit basis of $249 per unit. A student activities fee of $50 per semester (in addition to tuition) is charged to all undergraduate students (including special undergraduate students) who enroll for 19 units or more.

Undergraduate students who are enrolled for a full-time program of off-campus work (e.g. Argonne National Laboratory, Washington Semester Program, WQED, drama practicum in repertory companies, etc.) for which the University must assign a grade, are assessed tuition at the rate of $125 per unit up to a maximum of 24 units per semester for a maximum of two semesters. Units in excess of 24 per semester are assessed at the regular tuition rate of $249 per unit. Off-campus work scheduled for more than two semesters is assessed at the regular tuition rate. Undergraduate students who are enrolled for both on-campus and off-campus work or enrolled in the Washington Semester or one of our Tuition Exchange programs will be charged the regular tuition rate.

Private music instruction is available and can be arranged for non-Music students through the Music Extension Program. Private music instruction for non-Music students is not included in the basic tuition charge of $17,900.

Payment of Charges

Financial obligations which include tuition and fees, housing and food charges, housing security deposit, library fines, parking fines, emergency loans, and/or any other charges due the University, must be paid in full before a student may enroll in the ensuing semester. No scholastic credit, transcript, or diploma will be issued to a student who fails to meet their financial obligation to the University. A student whose fees to the University remain unpaid after they are due will be administratively withdrawn and will be required to cease using college buildings or using any other privileges as a student until financial obligations with the University have been settled satisfactorily at the Office of the Cashier.

An invoice is mailed in early July for the semester beginning in August and in early November for the semester beginning in January. Exact settlement dates are available from the Cashier's Office and will also be noted on the invoice. Enrollment consists of registration for courses and payment of charges. Students who are paid and registered by the due date are enrolled by mail and will be notified of such. Failure to meet the published payment deadline will necessitate enrollment in person. Enrollment is held during the first week of classes. Student accounts must be settled during enrollment week. Unpaid balances will be subject to late fees.

Payment Plans

The University has a tuition installment payment plan through CICU and a longer term loan option through Knight Education Resources. Brochures explaining the plans are sent on or about May 1. Applications for these Payment Plans should be submitted on or before June 1. The CICU payment plan can also be opened for just one semester/five payments. Carnegie Mellon does not offer an internal payment plan.

International Students

International Students who plan to enroll at the university must assume the total cost of their educational expense for the full duration of their academic program. Total cost includes health insurance but not travel expenses. Financial aid is not available for undergraduate international students.

International students must make financial arrangements well in advance of travel time. Certification that financial obligations can be met will be required by the university and also by the United States Consulate which issues the necessary entry visa. After an international student is offered admission, he or she must make an enrollment deposit (as specified in our application packet) by May 1 and submit the appropriate financial documents. This deposit will be credited to the student's account with the university and is not refundable or transferable. A Certificate of Eligibility (Form I-20 or Form IAP-66) will be sent to the student upon the receipt of the enrollment deposit and the financial documents, so that he or she may secure the necessary entry visa.

International students will need additional funds for living costs during the two major vacation periods of the academic year, the period between semesters and the spring holiday. Summer recess from mid-May until September may be used for travel or study. During these periods, students must provide their own room and board. International students taking summer session courses will be charged tuition and room and board fees at the rate established by the university for the current year's summer session.

The regulations of the United States Immigration and Naturalization Service only allow limited work opportunities to some non-immigrants. Therefore, students should not plan to meet any of their college expenses through part-time employment during the school year.

Health insurance is necessary and the university offers a student plan. International students who are married and whose spouse and children are in the United States with them may purchase the family plan health insurance. J-1 students are required to have health insurance for themselves and their dependents.

Financial Aid

Linda M. Anderson, Director of Financial Aid
Office: Warner Hall 312

Our financial aid staff is ready to assist you throughout your undergraduate education. Please feel free to call or visit us to discuss any questions or concerns.

Carnegie Mellon University administers an extensive financial aid program designed to bridge the gap between family contribution and the cost of attending the University. This goal can be reached only if every family contributes as much support as it can reasonably afford.

Tuition income does not meet the cost of educating students enrolled at the University. The remaining costs are met in part by income from our endowment and by annual gifts and grants from friends of the University.

Financial aid awards 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. Financial aid awards are renewed each year upon proper resubmission of application material by May 1, continued evidence of financial need and satisfactory academic performance.

To Apply for Financial Aid

1. Complete the Carnegie Mellon Financial Aid Application.

2. Complete a 1994-95 Free Application for Federal Student Financial Aid (FAFSA) and a Financial Aid Form (FAF). The FAFSA and FAF are available from the Department of Financial Aid.

3. Apply to your state grant agency for financial assistance. Contact your state grant agency for details. Carnegie Mellon assumes eligible students will apply accurately and on time. We will not substitute University funds for a state grant forfeited by a student who doesn't apply.

4. Send our Department of Financial Aid a signed copy of your parent/s' and your latest U.S. Federal Tax Return, Form 1040, 1040A, or 1040EZ with all schedules. Also send copies of W-2 and/or 1099 Forms. Print your name (student's) and social security number at the top of all forms.

5. If your parent/s have financial interest in a business or farm, in a partnership or in a corporation, you are required to complete the Business/Farm section of our application. You must also forward a complete and signed copy of the latest corporate/partnership tax return for each business entity. Schedules K and K-1 as well as any recently prepared financial statement must accompany this information. Additionally, for each sole proprietorship, a copy of the current balance sheet must also be submitted.

6. If your parents are divorced or separated, Carnegie Mellon requires a copy of the latest federal income tax return for both parents (custodial and noncustodial). In addition, your noncustodial parent must complete and return the Divorced/Separated Parent's Statement, included in our application, to the Department of Financial Aid.

7. If you are a transfer student, you must provide a financial aid transcript listing a history of all prior financial aid awards. This form is available from our Department of Financial Aid.

What is Financial Need?

Financial need is the difference between the amount of money a student and parent/s can provide to meet educational expenses and the cost of that education. Two elements that must always be considered:

a. The amount of money the student and parent/s can reasonably expect to contribute toward a definite period of education, usually an academic year.

b. The expense of the education during that same period, usually an academic year.

How is Family Contribution Determined?

The information recorded on the FAFSA and the FAF concerning the income and assets of the parent/s and student is used to determine the expected family contribution. The expected parental contribution is derived by applying a standard formula to the income and assets of the parent/s after adjustments have been made for all taxes paid, extraordinary expenses, other children in school, age of the older parent (for the purpose of estimating retirement needs), a cost-of-living allowance based on the size of the family, and other demands on the family budget.

The University also expects that each student receiving aid will obtain summer employment and contribute to his/her educational expenses.

In addition, any applicant for financial aid will be expected to use 35% of any personal assets, e.g., savings accounts, trust funds, etc., to assist in meeting educational expenses. The calculated parent/s' contribution plus the appropriate amount from students' summer savings and a share of student assets are combined to determine the family contribution.

The Financial Aid Package

Once our staff determines what you and your family can reasonably contribute to your college cost, we combine different types of financial support into a package. The package attempts to meet your family's demonstrated financial need.

Packages can include:

- Federal grants (including Federal Pell and Federal SEOG)
- State grants
- Carnegie Mellon grants
- Federal loans (including Federal Stafford and Federal Perkins)
- University student employment opportunities.

Gift Aid

Grants/scholarship awards are based on past academic/artistic performance and evidence of demonstrated financial need. Funds administered for this purpose by the University are derived from several sources. These include the University's operating income, annual gifts, endowed funds, and Federal Supplemental Educational Opportunity Grants (SEOG) funded by the Federal Government. All annual gifts, many endowed funds and SEOG funds carry with them certain restrictions to which the University must adhere when allocating such resources. All applicants will be considered for those specific scholarships and grants for which they are eligible.

Students should also explore outside scholarship and grant assistance through local, state, and federally sponsored programs when possible.

Federal Perkins Loan

The Perkins Loan is a long-term, low-interest (5%) loan. Repayment of interest and principal is required and begins 9 months after graduation or after you cease half-time study.

Federal Stafford Loan Program

The "subsidized" Federal Stafford Student Loan (SSL) is a long-term, low-interest loan. You can obtain a loan application from your local lender, complete your portion of the application and follow forwarding instructions. Students must demonstrate financial need to participate in the Federal Stafford Student Loan Program. Each student's eligibility for the SSL is determined by the Federal Need Analysis Methodology. Freshmen may borrow a maximum of $2,625 for their first year of study.

The interest rate for subsidized Federal Stafford Loans borrowed after October 1, 1992 varies annually (a new rate is effective each July 1),

and the rate is based on the 91-Day U.S. Treasury Bill rate plus 3.10%. The rate through June 30, 1994 is 6.22%. For loans first disbursed on or after July 1, 1994, the interest rate shall not exceed 8.25%.

The University will process loans beginning May 1, 1994. We recommend that you apply for this loan no later than June 30, 1994. The proceeds from an SSL will not be reflected on a student invoice until the student endorses the disbursement check. Federal law requires that all SSL approvals be disbursed in two equal payments (one-half the loan amount minus fees each term). The loan checks are mailed directly to the University.

Unsubsidized Federal Stafford Loans

The "unsubsidized" Federal Stafford Loan is for students who do not qualify, in whole or in part, for a "subsidized" Federal Stafford Loan.

Under the new unsubsidized Federal Stafford Loan program, the student borrower (and not the federal government) pays the interest that accrues on the loan during in-school periods. Eligibility for an unsubsidized Federal Stafford Loan is determined by the Department of Financial Aid (using a federally-mandated formula), from the information students provide on the Free Application for Federal Student Aid (FAFSA).

Eligible freshmen may borrow up to $2625 per year. A student who shows need for only part of an annual subsidized Federal Stafford Loan may borrow the remainder through an unsubsidized loan.

The interest rate for unsubsidized Federal Stafford Loans borrowed after October 1, 1992 varies annually (a new rate is effective each July 1), and the rate is based on the 91-Day U.S. Treasury Bill rate plus 3.10%. The rate through June 30, 1994 is 6.22%. For loans first disbursed on or after July 1, 1994, the interest rate shall not exceed 8.25%.

Repayment of interest begins within 30 days from disbursement of the loan proceeds, and repayment of principal begins six months after the borrower's last enrollment on at least a half-time basis. The borrower may make arrangements with the lender to pay interest as it accrues or may "capitalize" interest so that all payments begin six months after the borrower's last enrollment on at least a half-time basis. Repayment may extend over a maximum of ten years with no prepayment penalty.

Federal Parent Loan for Undergraduate Students

The Parent Loan for Undergraduate Students (PLUS) is a federally insured loan made by private lenders. Parents of dependent students should obtain a loan application from a local lender, complete their portion of the application and follow forwarding instructions. Repayment of principal and interest begins 60 days after the loan proceeds have been disbursed.

The interest rate for the federal PLUS loan varies annually (a new rate is effective each July 1), and the rate is based on the 52-week U.S. Treasury Bill rate plus 3.10%, capped at 9%. The rate through June 30, 1994 is 6.64%.

Federal PLUS loans are disbursed to the University in two installments, one in the Fall semester and one in the Spring semester, after registration for each semester. When the loan is disbursed, a nonrefundable insurance premium of up to 1% (varies by state) is deducted from the loan proceeds by the loan guarantor. An additional federally required "origination fee" of 3% (which is used to offset the administrative cost of the program) is deducted from the loan proceeds by the lender.

Repayment begins within 30 days from disbursement of the loan proceeds, unless the borrower makes arrangements with the lender to defer principal and/or interest payments. The borrower is responsible for the interest that accrues while the student is in school. Parents may elect to pay the interest as it accrues or may elect to "capitalize" (interest is added to the loan principal) so that payments do not begin until the student leaves school or enrolls less than half-time. The maximum repayment period is ten years and there is no prepayment penalty.

Parents of dependent students may borrow up to the cost of education minus any financial aid. These loans, in combination with all other aid (including the Federal Stafford Loan), may not exceed the educational cost. Financial need is not an eligibility factor.

Student Employment

Career related work experiences are important. We encourage students to take advantage of the many job opportunities on campus. Over 55 percent of our undergraduates work in one of our employment programs; the Federal Work-Study Program, the State Work-Study Program, Non-College Work-Study Program or the Job Location and Development Program. Carnegie Mellon incorporates a work component in the majority of our student's financial aid packages. We believe that student employment is an effective vehicle in helping you meet a portion of your educational costs as well as a way to receive valuable work experience. We also know that academics come first. While the decision to work is yours, working more than 15 hours per week may have a detrimental impact on your academic performance. Contact the Student Employment Office at extension 87050 for more information regarding our work programs.

Satisfactory Performance Standards

All students receiving Title IV student financial assistance must demonstrate satisfactory academic progress. Federal Title IV funding includes: Federal Stafford Student Loans (SSL), Parent Loan for Undergraduate Students (PLUS), Federal Work-Study Program, Federal Perkins, Federal Supplemental Educational Opportunity Grants (SEOG), Federal Pell Grants and State Grants.

Satisfactory Academic Progress is defined as meeting or exceeding the minimal yearly units necessary for the timely completion of the program of study which one is pursuing. The minimum number of units per academic year (3 units = 1 credit) varies with college and major and ranges from 75 for students in the Carnegie Institute of Technology, Mellon College of Science, Industrial Management, and Humanities and Social Sciences, to 84 for College of Fine Arts, drama majors. Additionally, a minimum cumulative quality point average of 2.0 must be maintained.

Student records are reviewed on an annual basis beginning at the end of the student's second academic year. Students determined as not achieving satisfactory academic progress are notified in writing and given the opportunity to appeal.

A summary sheet outlining the satisfactory academic progress standards is available from the Department of Financial Aid.

Reserve Officer Training Corps (ROTC) Scholarships

Air Force ROTC

Two- and three-year scholarships are available to qualified freshmen and sophomores who join the Air Force ROTC program. These scholarships cover a portion of tuition, books and academic fees. The scholarships range from $2,000 each year up to full tuition, depending on the student's major and academic performance. Students on scholarship are required to attend AFROTC courses (for more information, see page 80).

Army ROTC

Two- and three-year scholarships are available to qualified freshmen and sophomores who join the Army ROTC program. These scholarships cover a portion of tuition, books and academic fees. The scholarships range from $2,000 each year up to 80 percent tuition. Students on scholarship are required to attend Army ROTC courses (for more information, see page 81).

Naval-Marine Corps ROTC

The NROTC offers four- three- and two-year scholarships based on competitive national selection. The Navy pays 80 to 100 percent of tuition, the cost of textbooks, fees and uniforms and a subsistence allowance of $100 per month. In addition, NROTC midshipmen receive full active duty pay and benefits while on summer training cruises.

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 82 for more information.

University Policies

University Policies

Some of the following policies are presented in abbreviated form. Please refer to the current Student Handbook for complete policy and procedure information. In all cases, the policies published in the Student Handbook supercede those articulated here.

Computing and Information Resources

Computing Facilities

Computing resources, like other resources of the university (such as library books) are provided for the use of Carnegie Mellon faculty and students. The privilege of use by a student is not transferable to another student, to an outside individual, or to an outside organization. The theft or other abuse of computer time or facilities is not different from the theft or abuse of other university property, and violators of the computing privilege will be subject to disciplinary action.

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. No one 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 which involve academic dishonesty will be considered particularly serious.

Controversial Speakers

The statement following, from a motion 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 unthinkable and where no alternative is withheld from their consideration.

The great paradox of a free society is that the freedom it cherishes also protects those who would destroy it. In the area of action, the freedom of some is restricted by the rights of others; but in the realm of ideas, free men and women are circumscribed only by the limits of their own insight, imagination and conscience.

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.

The basic functions of a college or university go to the very heart of these assumptions. Through teaching, they attempt to prepare students to choose wisely; to analyze alternatives; to weigh evidence; to evaluate motives; to perceive the difference between truth and half-truth; to be at once skeptical but open-minded. Through research and scholarship, the university attempts to increase the alternatives available for consideration; to re-examine old ideas; to reinterpret old facts; to discover new facts; and to offer them for the consideration of others.

It is inevitable that such an environment will from time to time appear to threaten the larger community in which it exists.

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.

To fulfill this responsibility, the university must ensure not only that no viewpoint is withheld, but that, within reasonable limits, all major alternatives are made available to its students.

Dangerous Drugs

The laws of the Federal Government and of the Commonwealth of Pennsylvania concerning dangerous drugs are published in the Student Handbook.

The university cannot deny access to its property to properly constituted law enforcement agents. Therefore, activity involving the use or sale of drugs by one student may also, by bringing law enforcement agents to the campus, risk compromising the privacy of the academic community. With the legal and medical welfare of the student in mind, the university cannot approve the medically unsupervised use, possession or distribution of any of these drugs. When such medically unsupervised use, possession or distribution comes to the attention of the university, the student will be subject to disciplinary action.

In any instance where a violation of the laws concerning dangerous drugs occurs on the Carnegie Mellon campus or in connection with the activities of Carnegie Mellon's students, the judicial policy of the school will permit taking action beyond or separate from any which may be taken by civil authorities.

Campus Police officers at Carnegie Mellon are under instructions to turn over to the Narcotics Squad of the Pittsburgh Police any significant quantity of dangerous drugs discovered in the course of performing their duty. In such cases they are required by the law to report all information available to them about the persons and circumstances involved in the discovery.

The medically unsupervised use or distribution of potentially harmful drugs such as marijuana, hallucinogens, amphetamines, barbiturates and opiates is illegal and subject to very harsh penalties. Although the university does not assume the responsibility of acting as an arm of the law, members of the academic community have no immunity from enforcement of the law. Use of many of these drugs may threaten the physical and mental health of the user. Use by one student may also threaten the welfare of other students. Distribution by any student clearly threatens the welfare of the academic community.

Demonstrations

The university recognizes the right and privilege of all students to exercise the Constitutional guarantees of free assembly and expression. As a university sincerely espousing the philosophy of academic freedom, the university urges and supports its students' desires and efforts to pursue these rights.

In instances where students wish to use these rights through protest or demonstrations, the rights and privileges of others must be considered. To insure this, the protest or demonstration must be of an orderly nature so that no acts of force or violence shall occur and the normal orderly operation of the university will not be impeded; the protest or demonstration shall not infringe upon the rights or privileges of students not in sympathy with it. Thus, all students are assured that the idea or desires of others shall not be inflicted upon them and that they will be allowed to exercise the right of free choice.

Finally, the freedom to demonstrate on the campus shall be limited to members of the campus community only.

Many people have asked what the university will do if a demonstration on this campus were to occur that is not responsibly conducted and that is therefore disruptive. Except under extreme conditions, a committee made up of members of the administration, faculty and student body will be consulted. The university will attempt to deal with such a disruptive demonstration by internal means if at all possible. Internal sanctions include probation, suspension and expulsion. In any university judicial action which might ensue, the Constitutional freedoms and rights of students, including due process, will be maintained.

However, if it becomes evident that a disruptive demonstration cannot be dealt with internally, the university may have to seek outside aid, probably through the injunctive processes of the courts. And if a demonstration becomes destructive of property or threatens life or limb, the university may have to request immediate assistance from law enforcement officials outside the university.

The integrity of the campus community is primary and the normal functioning of the university must not be impaired.

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. This includes the distribution of leaflets and petitions, as well as demonstrations or protests involving speaking, discussion or the distribution of information.

All persons are permitted to distribute printed material, offer petitions for signature, make speeches and conduct other similar activities outside university buildings.

The only limits on these activities are the rights of the members of the university community and the maintenance of the normal functioning of the university. No activities which 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.

HIV/AIDS Policy

Policy Statement

Carnegie Mellon University recognizes the serious nature of the public health problems of Acquired Immune Deficiency Syndrome (AIDS) and the threat it poses to the campus community. Carnegie Mellon views AIDS as it does any other chronic illness and therefore does not approve of and will take action against cases of discrimination or harassment based on a person's actual or suspected Human Immunodeficiency Virus (HIV) status. Carnegie Mellon will exercise full, reasonable care to protect the health and safety of faculty, staff and students and will offer on-going education and support services as part of this commitment. This policy is consistent with and acts in conjunction with applicable federal, state and local laws as well as university policies relating to harassment, discrimination, workplace accommodation and related university services.

It may be revised as more facts about the disease are learned.

Reason for the Policy

This policy was developed to make known the university's position on treatment of actual AIDS occurrences and related issues within the Carnegie Mellon environment and address the needs of afflicted individuals. Current medical knowledge indicates that those individuals infected with HIV pose no threat to other students or employees in an academic setting because the virus is not transmitted through casual contact: it is transmitted only through the exchange of certain bodily fluids. The university is committed to an educational campaign designed to influence behaviors, especially relating to safer sexual practices and the use of condoms, in order to limit spread of the virus.

The United States Centers for Disease Control have repeatedly affirmed that there is no recognized risk of infection created by casual kissing, contact with skin not contaminated with blood or living in the same house as, eating food handled by, being coughed or sneezed upon by or swimming in a pool with, an infected person. These facts, derived from the best epidemiological data available, serve in concert as the basis for this policy.

Definition of Terms

Carnegie Mellon adopts the following AIDS-related medical definitions:

Acquired Immune Deficiency Syndrome (AIDS) is a serious, progressive illness caused by Human Immunodeficiency Virus (HIV) which reduces the immune system's capability to fight disease and allows for infection by a variety of serious opportunistic diseases. At the present time, there is no known cure, vaccine or fully satisfactory treatment for AIDS.

Human Immunodeficiency Virus (HIV) is the virus which causes AIDS. It is possible to carry the virus for many years without noticing symptoms. Transmission of the virus occurs through intimate sexual contact with an infected individual, the sharing of needles, contaminated blood and blood products and from an infected mother to her infant during pregnancy or birth.

Penalty for Violation

Any faculty, staff or student found to have violated the university's policy on AIDS or found guilty of discriminating or harassing an individual afflicted with AIDS, will be subject to existing disciplinary mechanisms and procedures, including possible suspension, termination or expulsion. Any faculty, staff or student with HIV infection who believes that s/he is being discriminated against or harassed, knows or suspects the occurrence of AIDS discrimination

or harassment or desires counseling for coping with potential harassment, is strongly urged and encouraged to immediately contact one of the persons listed in the advisors listed in the Student Handbook.

Educational Awareness

An educational program is central to addressing HIV infection on the Carnegie Mellon campus. Increased awareness and education not only help prevent further spread of the virus, but also reduce the potential for various forms of discrimination against individuals infected with HIV by providing factual information to dispel unwarranted fears.

The university will continue to offer comprehensive educational programs about HIV infection and AIDS. Such programs will include information on the nature of the disease and transmission factors, the proper use of condoms, testing and treatment options and legal rights and responsibilities. Effective educational programs will require

substantial outreach regularly. Updated informational materials will be available at the Student Health Service office, residence halls and other designated areas on campus.

Health Services

In support of offering factual information on the disease, Student Health Service will offer medical care, counseling, referrals, risk assessment, education on safer sex practices and HIV pre-test and post-test counseling to all students upon request. Initial phone contact may be made anonymously until the caller is comfortable with the ramifications of revealing his/her identity.

The university expects that its employees will independently seek appropriate health care through their off-campus providers. However, Student Health Services will provide referrals to any individual upon request.

HIV Testing

Carnegie Mellon will not conduct a mandatory screening program to determine the HIV status of faculty, staff or students. However, Student Health Service will be familiar with testing sites and will make referrals. Pre-test and post-test counseling will be available at the Student Health Service office for students only; employees will be referred to testing sites if mandated by local testing programs.

Confidentiality

The university will comply with federal and state laws, regulations and policies that protect the confidentiality of medical and educational records and with the disease reporting requirements of the Allegheny County Health Department and Pennsylvania Department of Health. Student Health Service will not release medical information of any kind to any person, group, agency, parent, family member, insurer, employer or institution without the prior, specific, written informed consent of the individual involved unless required by law or court order. No faculty or staff member will enter information that a student or employee has AIDS into non-medical, employment or education records without the knowledge and consent of the student or employee involved.

Administrators of the Student Health Service, Counseling and Student Development Center, Housing Office, Department of Human Resources and Office of the Dean of Student Affairs must make all personnel aware of the need to protect confidential information. Each unit will have procedures in place for the maintenance of secure confidential records. Any purposeful or accidental breach of the security of confidential information on the part of unit personnel will be met by prompt, effective action in accordance with university personnel policies.

Impact on Students

Admission – The university will not discriminate in accepting and/or enrolling applicants on the basis of actual or suspected AIDS status or require any applicant to take an HIV test or provide any information concerning AIDS for the purposes of acceptance, enrollment or continuing enrollment.

Classroom – Reasonable accommodations for students with AIDS will be provided consistent with the university's policy on making reasonable accommodations for any student medical condition.

Housing – The Housing Office will not discriminate in room assignment procedures involving a student who has AIDS.

Impact on Employees

Casual contact with persons who have AIDS does not place co-workers at risk for the illness. Therefore, in compliance with current federal and state laws, the university will not prevent an employee with AIDS from continuing in the workplace, so long as the employee can physically and mentally meet existing performance standards.

Consistent with current law, Carnegie Mellon will not ask employment applicants if they have AIDS, make a hiring decision based on the suspicion that a person has AIDS or require anyone to test for HIV antibody status as a condition of employment.

Reporting AIDS Status

If an individual discloses the illness to a supervisor or department head, the supervisor or department head should, without revealing the individual's identity, contact the director of human resources to obtain information on support and accommodations the university can provide to that individual.

In all cases of illness or disability, including AIDS, the university will not request or require a diagnosis of illness, except as required for evaluating work accommodation requests or processing disability claims. The faculty or staff member may be asked to provide physician certification about his/her ability to work, work limitations and/or length of convalescence. In the event the employee is not able to continue working, s/he is eligible to use Paid Time Off and/or short-term disability and long-term disability, as provided by current university policy.

To protect the health of employees identifying their AIDS status, the director of human resources, in appropriate consultation with the chairman or the department head, director of environmental health and safety and director of student health services, should notify the supervisor if the work environment is believed to be one with greater than normal risk of exposure to infectious agents and advise appropriate actions, if any, to be taken. Any employee identifying his/her AIDS status and holding a position which might involve a high risk of contamination of infectious diseases will be educated to take the precautions necessary to ensure his/her own health.

Impact on Internationals

The university will provide equal access to information, counseling and health services for faculty, staff and students who are not United States citizens. Available information includes current United States laws and regulations with respect to non-citizens and AIDS, particularly in matters relating to visas, work permits and the ability to enter, remain and work in the country. University personnel responsible for providing information and counseling about the legal and medical aspects of AIDS are to ensure that cultural and language barriers do not prevent the clear communication of facts.

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. (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.)

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 the 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 University.

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 the libraries and offices), nor does extensive use of a specialized facility for routine tasks. Use will be considered "extensive" and facilities will be considered "major" if similar use of similar facilities would cost the creator more than $5000 (five thousand dollars) in constant 1984 dollars if purchased or leased in the public market. Creators wishing to directly reimburse the University for the use of the facilities usage for a particular intellectual property becomes substantial. (This provision is not intended to override any other department or University policy concerning reimbursement for facilities usage.)

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

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

3. Policy Provisions

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

3-1. Externally Sponsored Work

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

Procedural Provisions: It is the responsibility of the University's Office of Sponsored Research 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 acknowledgement of such provisions by any person working on externally sponsored projects. A summary of external sponsorship agreements limiting the intellectual property rights of potential creators will be maintained by the Office of Sponsored Research and will be available to the general University community.

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

3.2 Internally Sponsored Work

Ownership Provisions: When the University provides funds or facilities for a particular project to the extent of substantial use, it may also choose to designate itself as sponsor of that work. The University may declare itself the owner of intellectual property resulting from said work. In such cases the University must specify in advance the disposition of any intellectual property rights arising from the project. If the University declares itself to be a sponsor, but does not declare itself the owner of the intellectual property, ownership shall be determined in accordance with 3-6-4 below.

Procedural Provisions: It is the responsibility of the University's Office of Sponsored Research 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 acknowledgement of such provisions by any person working on internally sponsored projects. A summary of work for which University sponsorship limits the intellectual property rights of potential creators will be maintained by the Office of Sponsored Research and will be available to the general University community.

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

3-3 Individual Agreements

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

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

3-4 Intellectual Property Created within Scope of Employment

Ownership Provisions: Intellectual property created by University employees who were employed specifically to produce a particular intellectual property shall be owned by the University if said intellectual property was created within the normal scope of their employment.

Faculty are presumed not to be hired to produce a particular intellectual property. On the other hand, computer programs written on the job by staff computer programmers would fall under this provision.

3-5 Public Dedication

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

Procedural Provisions: Creators wishing to place their intellectual property in the public domain are responsible for ascertaining that the right to public dedication of that intellectual property is not limited by any external agreement, University sponsorship arrangement, or terms of employment as described in Provisions 3-1, 3-2, or 3-3. The University Provost will provide such a determination in writing upon request by the creator. It is also the creator's responsibility to ensure that disclosure does not include valuable intellectual property owned by others. (This provision does not release the University from its general obligation to notify creators of limitations to intellectual property rights specified in Provisions 3-1 and 3-2.)

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

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

3-6. In General

Unless governed by subparts 3-1, 3-2, 3-3, 3-4, or 3-5 above, ownership of intellectual property created at the University shall be determined as follows:

3-6-1. Traditional Rights Retained

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

Procedural Provisions: The types of intellectual property listed in the preceding paragraph share the attribute that they display information or visual or auditory appearances which are fully revealed to the purchaser or consumer. Thus, for example, source code listings would also be considered within this category. On the other hand, most computer software and data bases do not share this attribute; they are characterized by their capacity to perform tasks. Because of their utilitarian nature, ownership rights with respect thereto are governed by 3-6-3 or 3-6-4. Educational 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, and it may be modified only by a specific prior agreement between the creator and the University. The use of University-owned computers and other facilities in the preparation of books and similar works does not alter this provision, though other University policies may limit such use or require reimbursement to the University. Similarly, the use of externally sponsored resources does not alter this provision, unless the creator is effectively notified in advance of such limitations to his rights in accordance with 3-1.

3-6-2. No substantial Use of University Facilities

Ownership Provisions: The creator owns all intellectual property created without substantial use of University facilities, including intellectual property rights in computer software and data bases.

3-6-3. Substantial Use of University Facilities — No External or Internal Sponsorship

Ownership of intellectual property created with substantial use of University facilities, but not directly arising from externally sponsored work, or from work for which the University has declared itself as sponsor, shall be determined as set forth hereinafter depending on whether the creator or the University develops said property.

3-6-3-1. Development by Creator

Ownership Provisions: The creator originally owns intellectual property created with substantial use of University facilities but no external or internal sponsorship, and retains said ownership by commercial development of said property subject to the following: (i) the University shall receive 15% (fifteen percent) of the net proceeds to the creator above $25,000 (twenty-five thousand dollars) in constant 1984 dollars from all sources (in the case of patents and copyrights, this provision shall be limited to the life of the patent or copyright), and (ii) the University shall receive a perpetual, non-exclusive, non-transferrable, royalty free license to use said intellectual property. In the case of software, this license includes access by specified University personnel to the source listings, and the University shall require each person to whom a disclosure is made to execute in advance a binding confidentiality agreement in favor of and enforceable by the creator. If the intellectual property is created solely by a student or students, the creator is exempt from the obligation to pay to the University a fraction of his net proceeds, but not from the provision of this paragraph for a non-exclusive license to the University.

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

3-6-3-2. Development by the University

Ownership Provisions: When intellectual property is created with substantial use of University facilities, but not directly arising from sponsored research, the creator will originally retain the rights to the property, provided that he desires to commercially develop the property himself or to make it available to the public. If, however, the creator elects not to commercially develop same or fails to show diligence in pursuing such development, then the ownership rights to that property may be acquired by the University. Intellectual property acquired by the University in this fashion will be treated as in 3-6-4-1 below.

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

3-6-4. Substantial Use of University Facilities — External or Internal Sponsorship

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

3-6-4-1. Development by University

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

3-6-4-2. Development by Creator

Ownership Provisions: When intellectual property is created with substantial use of University facilities provided by external or internal sponsorship, the University will originally retain the rights to the property, provided that it desires to commercially develop the property or to make it available to the public. If, however, the University elects not to commercially develop same or fails to show diligence in such development, the ownership rights to that property may be acquired by the creator. Intellectual property acquired by the creator in this fashion will be treated as in 3-6-3-1 above. This assignment of rights to the creator may be prohibited by the terms of an external sponsorship agreement with the University or by an internal University sponsorship declaration, but in such cases the creator must be notified in advance, as in Provisions 3-1 and 3-2.

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

3-6-5. Consulting Agreements

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

Procedural Provisions: Under University policy consulting work must not make substantial unreimbursed use of University facilities except by explicit prior agreement. Any member of the University community who is engaged in consulting work or in business is responsible for ensuring that provisions in his agreements are not in conflict with this policy of the University or with the University's commitments. The University's office for technology licensing 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 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 Chairman 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 Chairman) will be appointed for two-year terms of office, 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 Chairman will be appointed by the Chairman 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 of his design. At all times at least one of the faculty members will have had significant practical experience with intellectual property development and exploitation. The faculty members appointed by the President of the University will be selected from a list of nominees prepared by the Faculty Senate or its designated committee, and nominees with experience in intellectual property development will be identified as such by the Faculty Senate. The staff representative will be selected from a list of nominees prepared by Staff Council, and the administration representative will be named directly by the President of the University or his designee. The graduate student representative will be 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 creator is currently bound. Similarly, members of the University working under contracts signed before the effective date of this policy who do not choose to accept this policy will remain bound by the patent policies that already apply to them.

With respect to intellectual property developed during the course of employment at the University, this policy shall continue to be binding on any person whose relationship with the University becomes terminated.

The University should take all administrative steps necessary to ensure that employees and students sign, upon initial employment, registration, or at other appropriate times, forms that indicate their acceptance of this policy.

7. Amendments of the Policy

Amendments of this policy may be proposed by the Faculty Senate, Staff Council, or University Administration. Proposed amendments must be approved by a two-thirds majority of votes in the Faculty Senate and subsequently approved by a simple majority of votes cast in a referendum administered by the Faculty Senate that is open to all members of the faculty as defined by this policy and to the exempt staff, provided that this majority constitutes at least 25% (twenty-five percent) of those eligible to vote. This referendum must be preceded by an opportunity for public discussion open to all interested faculty, administration, staff, and students. Amendments that are supported by the faculty and staff must then be approved by the President of the University and adopted by the University Trustees. Once adopted, amendments will become binding on new faculty, administration, and staff when hired, on existing faculty and staff when they sign new employment contracts, and on graduate and undergraduate students when admitted. Other University personnel, including tenured faculty, and current staff and students may choose to become bound by this policy for future and pending intellectual property by voluntary written consent. Intellectual property that is already developed or under development at the time that an amendment to the policy is ratified will not be bound by the terms of the amendment without the voluntary written consent of both the creator and the University.

Non-Discrimination Policy

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.

In order to assure adherence to this policy, Carnegie Mellon will not permit any student or other organization to operate on campus which either by affiliation with a national organization or by its own constitution, by-laws or established selection procedure or practice, discriminates against race, color, creed or national origin in the selection of its members.

Social and professional organizations, including student social groups such as fraternities and sororities, exist at Carnegie Mellon with the consent of the university. They exist because of the value which they provide to the academic community. Carnegie Mellon cannot assign sole responsibility for reviewing the operation or the practices of such organizations to any group exterior to the campus. The primary responsibility for reviewing the activities and practices of campus groups has been assigned by the university to its Division of Student Affairs.

No student organization or chapter of a national organization may exist on the campus without the ability of its officers to report directly to the administrative officers of the university on matters properly concerned with university policy.

Political Activities

The university applauds and encourages the interest of individuals and groups who wish to work as citizens through political channels for betterment of society. However, the university as a university is and must remain neutral on political issues.

In the light of active political concerns of the members of the university community, guidelines have been developed to avoid the improper use of the institution's resources and facilities for political purposes. This is vital for two reasons: (1) to preserve the university's neutrality on political matters and its function as a center for freedom of thought, and (2) to assure that its tax-exempt status is protected.

All individuals and groups in the university community who wish to pursue political activities should follow the principles established by Organization Announcement 228-A, Separation of Individual's and Institution's Interests, December 12, 1969, which is reprinted annually in the Student Handbook.

Privacy Rights of Students

Annual Notification of Rights

It is the policy of Carnegie Mellon to notify graduate and undergraduate degree candidates, on an annual basis, of their rights under PRIVACY OF PARENTS AND STUDENTS, Section 438 of the General Educational Provisions Act, Title IV, of Public Law 90-247, as amended (Buckley Amendment). It is the usual practice to notify graduate and undergraduate degree candidates of these rights during the registration process by publishing a summary of these rights in the Schedule of Classes.

Additional copies of the policy statement may be obtained in the Office of the Registrar, Warner Hall.

Student Reports and Records

On August 21, 1974, Public Law 93-380, entitled "The General Education Provisions Act" became effective. The law provides for: (a) inspection of records by a student; (b) the opportunity through a hearing for a student to challenge the content of the records; (c) the permission of the student for release of the records and maintaining a record of all persons, including the student, who inspect the file. The university supports the intent of the law and to the best of its ability will provide the rights and privileges specified by the law.

Confidentiality

Student records, both academic and personal, are confidential records to be released only to appropriate faculty, administrative officers and parents or guardians. Release of these records to other persons such as other colleges, employers, prospective employers, governmental and legal agencies shall occur only upon approval of the student or graduate or upon subpoena.

Membership

No member of the staff of the Division of Student Affairs may maintain a file listing the members of student organizations unless requested to do so by the organization involved. Only the names of officers may be maintained in records of the division.

Recruiting

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 policies pertaining to citizenship requirements, drug testing and sexual orientation.

Research

The primary purpose of research at the University is the advancement of knowledge in all fields in which the University is active. Research is regarded as one of the University's major contributions to society and as an essential element in education, particularly at the graduate level, and in faculty development. The University emphasizes fundamental inquiry. It recognizes, however, that a part of the function of education is to assist in the translation of scientific, technical and social knowledge into new processes, products, techniques and approaches. Hence, both basic and applied research which relate to the educational programs of the University and contribute to graduate education or faculty development are considered appropriate activities.

Policy on Restricted Research

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

There exists, therefore, a tension between the university's goal of disseminating knowledge freely and the desire on the part of some of its members to conduct restricted research on important problems. The university intends to guarantee the academic freedom of all faculty

members to do research in their own manner on topics of their own choosing, provided that such research is consistent with the overall purposes of the university.

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

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

Definitions

research
all projects and investigations involving the creation of new knowledge of a theoretical or practical nature. The term research as used here encompasses both "research" and "development" as they are commonly defined.

classified research
research, the free dissemination of the results of which is deemed to jeopardize National security. The federal government controls access to the environment in which such research is performed, restricts discussions about the work in progress to individuals with clearance and a "need to know", and limits publication of research, results or access to data needed to verify results, for a specified period of time.

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

publication
oral or written dissemination.

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

semi-autonomous units
units of the University specifically so designated by the President, after consultation with the University Research Council and the Faculty Senate, currently the Carnegie Mellon Research Institute and the Software Engineering Institute.

non-autonomous units
all university entities other than semi-autonomous units

Restricted Research in Non-Autonomous Units

It is the policy of Carnegie Mellon that restricted research is inappropriate and therefore not permitted within its non-autonomous units.

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

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

A sponsor may request a delay of up to six months in publication so that steps may be taken to secure intellectual property rights to inventions or ideas developed under the contract.

A sponsor may require a delay of thirty days for review of publications for removal of proprietary information which was provided for the conduct of the research.

Considerations for faculty/researchers:

The university recognizes that problems arise in both restricted research and research that is not itself restricted but that involves access to classified or propriety information or materials (hereinafter, restricted materials). Researchers may also have access to restricted materials when serving as consultants. Access to restricted materials gives rise to concerns about limitations on researchers' freedom to communicate. In such instances, researchers must exercise 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 students:

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.

Human Subjects in Research

The University is committed to the protection of the rights and welfare of human subjects in research investigations conducted under the jurisdiction of the University. The University believes that review independent of the investigator is necessary to safeguard the rights and welfare of human subjects of research investigations. A subject is considered to be any human being exposed to any research procedure whether carried out by a University employee or others, for the purpose of contributing to research investigations conducted under the jurisdiction of the University.

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

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

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

Required Withdrawal

The university may require a student with serious health problems, including mental health problems or whose use of drugs is potentially self-destructive in the psychiatric sense, to withdraw from the university until the problems have been solved through appropriate treatment. Such a withdrawal will be required only after a thorough case review by a committee consisting of the dean of student affairs, the dean of the student's college and such medical, psychological or psychiatric consultation as is necessary.

Safety, Environmental Health & Safety

The university endeavors to provide for the campus community an environment adequately free from hazards to life, limb and property. A major expression of its concern for the safety of faculty, staff, students and visitors is the Environmental Health and Safety Program operating through the director of campus services and the Environmental Health and Safety Committee.

Each person should be aware that safe practices are the responsibilities of the individual as well as the institution; any unsafe condition should be reported to a person's supervisor or the Environmental Health and Safety Office. Each person planning to operate any kind of equipment or use any material with which s/he is not familiar is expected to obtain instruction from his or her supervisor or instructor.

Decisions relative to construction, renovations, alterations and occupancy of university facilities and the conduct of some of the activities of the institution require that building permits and occupancy classifications be obtained and posted by the administration. Plans for construction must be reviewed in accordance with structural building policy. Fire and Safety Code and the permitted occupancies should not be violated by individuals. It is expected that all members of the university community will appreciate that a safe environment can be achieved only through safe practices and procedures.

Any questions about safe practices should be directed to the university's director of Environmental Health and Safety.

Sexual Assault Policy

The Carnegie Mellon University community is committed to the standard that all members of the community shall be able to pursue their interests free from non-consensual sexual contact. Therefore, it is a violation of Carnegie Mellon's community standards to have sexual contact with any member of the community without the clear, freely chosen consent of those involved.

Persons bringing action under this policy are encouraged to pursue the incident through the criminal justice system and/or the university disciplinary system. No disciplinary or other action is taken in such cases without the clear, informed agreement of the individual bringing the charge forward. The university provides advice and emotional support to assist any individual in better understanding and pursuing the matter through one or both of these judicial systems. In addition, the university provides direct medical treatment and counseling, referral to additional medical and counseling support where appropriate and other support to any individual involved in such an incident.

These cases are dealt with in a confidential, supportive and discrete manner. Any individual involved in such an incident may contact the Campus Police 24 hours a day at x8-2323. The university has a panel of sexual assault advisors available to assist any individual involved in such an incident. These advisors include students and staff and may be contacted through the Campus Police, through the Office Student Affairs at x8-2073 or through the Counseling and Student Development Center at x8-2922. (Students contacting any of these offices should simply tell the receptionist that they would like to discuss a sexual assault and will immediately be put through to the appropriate advisor.) Students should contact one of these advisors at any time to discuss an incident or a concern relating to sexual assault.

All members of the university community are encouraged to take every measure available to eliminate rape and sexual assault on this campus.

In addition to campus educational efforts, peer influence will be central to protecting members of the community from assault. Any student aware of a sexual assault on the campus is encouraged to contact the Campus Police, the Office of Student Affairs or one of the sexual assault advisors immediately.

Sexual Harassment Policy

(NOTE: This policy is under revision; new policy statements will be issued during the Fall of 1994.)

Carnegie Mellon University seeks to maintain a learning and work environment free from sexual harassment. Carnegie Mellon is dedicated to the free exchange of ideas and the intellectual development of all members of the community. For this exchange and development to take place, the environment must promote the confidence to work, to study, to innovate and to perform without fear of harassment.

Sexual harassment is specifically prohibited by Carnegie Mellon University. Any faculty member, staff employee or student found to have violated the University's policy against sexual harassment will be subject to immediate and appropriate disciplinary action, including possible suspension, termination or expulsion.

Carnegie Mellon University adopts the basic definition of the Equal Employment Opportunity Commission (EEOC) regarding sexual harassment as any unwelcome sexual advances, requests for sexual favors or other verbal or physical conduct of a sexual nature when:

1. Submission to such conduct is an explicit or implicit condition of employment or evaluation or advancement of a student.

2. Submission to or rejection of such conduct is used as the basis for employment, evaluation or advancement decisions.

3. Such conduct has the purpose or effect of unreasonably interfering with an individual's work performance or creating an intimidating, hostile or offensive work environment.

Under Federal, State and City laws, employers have an affirmative duty to investigate claims of sexual harassment and develop appropriate sanctions for such behavior. These laws require that employers affirmatively address the issue of sexual harassment in the workplace and devise and adopt appropriate procedures for maintaining a working atmosphere free of sexual pressure or intimidation.

In support of its commitment to maintain an environment free of sexual harassment, the university attempts to make reporting of such incidents and advising about sexual harassment as widely available as possible. To that end, the university has assigned special responsibility to trained advisors who are available to talk with members of the community who have concerns or questions about sexual harassment. They also can provide information about established guidelines and procedures for dealing with matters of sexual harassment and will help any individual pursue an effective course of action. In their consultation, they will maintain the greatest possible degree of confidentiality consistent with their responsibilities as university officers.

Any student, faculty or staff member who feels s/he is sexually harassed, knows of or suspects the occurrence of sexual harassment or desires counseling on coping with potential harassment is strongly urged and encouraged to contact immediately, in person, one of these advisors. Because of the sensitivity of sexual harassment issues, an advisor will promptly and thoroughly review the case to determine whether sexual harassment has occurred and will take the appropriate action. All reviews will be designed to protect the privacy of and minimize suspicion toward all parties concerned. Should an informal review of an allegation of sexual harassment not result in a satisfactory outcome, the matter may be pursued formally through the appropriate grievance procedure. (Faculty, see Faculty Handbook; staff, see Staff Handbook/One; students, see Student Handbook, Initiating the Disciplinary Process.)

No person will be reprimanded or retaliated against in any way for initiating an inquiry or complaint in good faith. The university will also protect the rights of any person against whom a complaint is alleged.

Supervisors observing any form of sexual harassment identified above, regardless of whether or not a complaint is made, should address the matter immediately and take corrective action. Supervisors are responsible for maintaining an environment that is free of sexual harassment and for referring to an adviser all charges of sexual harassment brought to their attention. Supervisors are considered to be agents of the university and as such, act on behalf of the institution. The university can be held liable for any actions supervisors may or may not take in this area.

Staff and faculty members also are expected to do all that they can to prevent and discourage any sexual harassment from occurring. In addition, faculty are expected to exercise responsibility for developing an academic atmosphere in which students are able to express candid opinions unintimidated by inappropriate sexual conduct or reference.

Student Activities Fee

By action of the Board of Trustees, a required Student Activities Fee of $50.00 per semester (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.

No student enrolled at Carnegie Mellon may on the basis of race, color, sex, creed, age, handicap or national origin be barred access to an activity, program, facility or service, publication or enterprise provided by such fees. No use made of the fees described above may be intended to violate or circumvent the policies of the university or the laws of the land. All Carnegie Mellon students shall have access without hindrance to the functions and services provided by the fee.

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 Senate has dedicated a specific portion of graduate students' activities fees to the Graduate Student Organization to be used at their discretion.

Student's Rights

The primary right of students is to pursue their education so long as they maintain their eligibility to remain a member of the community by meeting its academic standards and so long as they observe the regulations imposed by the university for the governance of the academic community.

The second right of students is to be recognized as members of the student body, with all the privileges pursuant thereto as to use of physical plant, university services and facilities.

Every student has the constitutional rights and responsibilities of any citizen under the law. Conversely, a responsibility of any student is to respect these rights of any other member of the university community.

A student has the right to expect that academic and professional processes should be flexible and periodically open to review and to participate constructively with faculty and administration in those processes by which the university community maintains the excellence of the standards of its curriculum and methods of instruction and the viability of its total educational program.

The student has the right to recourse through due process against unreasonable academic action.

Undergraduate Academic Regulations

Undergraduate Academic Regulations

Advising and Registration

Advising and registration is the process of selecting courses for the upcoming semester, reviewing those selections with an academic advisor and obtaining the written approval (signature) of that advisor.

Registration for entering freshmen is accomplished with the assistance of deans and department heads during the summer. Academic placement and elective choice information is collected by mail questionnaires during June and July. Freshmen receive their schedules and enrollment information from the Office of the Registrar after each academic office has entered their freshmen schedules in the Student Information System.

Enrolled students select their courses for the upcoming semester during Registration Week, prior to the end of each semester. A Schedule of Classes is published before Registration Week, listing available courses and relevant information (course numbers, meeting times, instructors). The university reserves the right to make changes in the schedules of hours, units or instructional staff when such changes seem necessary or advisable. 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 subjects for which credit has not yet been earned 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-enroll 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. Unless the prerequisites are satisfied or special approval is obtained when the student enters the course, no credit can be allowed for the course. Exceptions to this may be authorized by the head of the department offering the course in question.

Students are not allowed to schedule a course until they have a passing grade in the course prerequisite to the course desired. Exceptions to the rule may be granted only upon the recommendation of the College Council concerned.

Changes, either addition or elimination, to a student's schedule must be made with the approval of the faculty officer (advisor) designated by the dean (see the section on "Change in Schedule" for more information).

Undergraduates may seek to transfer from one academic unit to another within the University. Information on procedures and criteria is available through the Dean's Offices of MCS/CIT and H&SS, through department offices in the College of Fine Arts, and through the undergraduate departmental offices in Computer Science and Industrial Management.

Auditing

Auditing classes is defined to mean presence in the classroom without academic credit. The auditor may take part in class discussion and take examinations, subject to the agreement of the instructor. Auditing courses will be permitted, without additional charges, to all students who are already paying full tuition and fees. Part-time and special students who are permitted to audit will be charged tuition for the audited course at the regular rate. To register, a student must pick up a "Course Audit Approval Form" in the Office of the Registrar (Warner Hall 201), obtain permission to audit from the instructor and then follow the normal procedure for registration. The decision to audit a class must be made by the official university or college deadline for adding a course, and is irreversible thereafter. No audit will be placed on a student's final record unless the instructor reports an audit on the final grade sheet. The audit policy applies to all students.

Change in Schedule (Add/Drop)

If, after registering, a student wishes to change his/her schedule, the following procedure applies:

- The student requests a Registration/Add/Drop (RAD) form from his/her department office, college office or from the Office of the Registrar, obtains necessary approvals and submits the form to the Office of the Registrar.
- Scheduling changes must be made within the period in the semester as established in the University calendar. Changes after this period must be authorized by action of the College Council of the student's college.

A student cannot withdraw from the university or 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 Leave of Absence (see the section on "Withdrawals and Leaves of Absence" for more information).

All adding and dropping of courses must be initiated as follows:

- freshmen in Fine Arts and Industrial Management: through the head of the student's department;
- freshmen and sophomores in the College of Humanities and Social Sciences: through the Assistant Dean of H&SS (in the H&SS Academic Advisory Center);
- freshmen in the Carnegie Institute of Technology, Mellon College of Science, or School of Computer Science: through the appropriate office of the Associate Dean of the college;
- upperclassmen in all colleges: through the head of the student's department.

The tuition charged each student will be reduced only when an approved Registration/Add/Drop form has been submitted to the Office of the Registrar by the 10th regularly-scheduled class day (refer to the specific date noted in the University calendar as the "last day to add courses") and the reduction in the number of units justifies computing the tuition charge on the unit rate. The tuition charged will be increased whenever the number of units added justifies tuition charges greater than those paid for by the student at the time of fee settlement. 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 action of the College Council of the student's college.

In no case will any portion of the tuition assessed at the time of fee settlement be reduced if the change in schedule takes place after the official refund deadline.

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

Conduct of Classes

Once a student has satisfied the requirements for enrollment, the student is entitled to attend 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 faculty are expected to be alert to absenteeism that is

detrimental to a student's performance, and to call all such cases to the attention of the appropriate faculty advisor or dean.

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:

- As with all other absences, 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(s) of class(es) missed. 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 ten minutes before leaving.

Any form of cheating, including plagiarism, is to be referred through the instructor's department head to the Committee on Discipline. It is the duty of each department to define for its students the extent and manner in which sources may be used legitimately.

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

The purpose of cross-registration is to provide opportunities for enriched educational programs by permitting students enrolled at any PCHE institution to take courses at any other PCHE institution. PCHE members are: Carnegie Mellon University, Carlow College, Chatham College, Community College of Allegheny County, Duquesne University, LaRoche College, Pittsburgh Theological Seminary, Point Park College, Robert Morris College and University of Pittsburgh. Cross-registration is available to all full-time students enrolled in a PCHE college or university. Part-time students are normally not permitted to cross-register. If valid circumstances exist, the appropriate home school academic administrator may grant a waiver of the Cross Registration Guidelines.

1. Each college or university accepts registration from the other institutions; however, first priority is given to students of the host college, and not all departments or schools in all institutions are able to participate in this program.

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 at any of the institutions, including the spring term at the University of Pittsburgh. However, taking courses at other institutions during those terms is facilitated by "temporary transfer student" procedures separately agreed to by the PCHE colleges and universities.

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 time frame.

13. "PCHE Cross Registration Request" forms are available in the Office of the Registrar, Warner Hall 201.

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. 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.

Enrollment

Enrollment is the process whereby each eligible student notifies the Registrar that they will be attending the University and the Registrar acknowledges that all requirements for registration and for payment of tuition and fees have been satisfied by validating the student's ID card. An enrolled student is one who is academically registered and financially cleared by the Cashier's Office. Most students complete the enrollment process by mail, thereby avoiding late enrollment, late fees and lines.

Students who do not or cannot enroll by mail must enroll in person on the appropriate Late Enrollment Day for that semester. (Note: there is a special Enrollment Day each Fall for freshmen.) Enrollment must be completed before beginning classes and before using university facilities.

Instructions for registration, payment of fees and enrollment are distributed prior to each semester from the offices of the Cashier and the Registrar. Scholastic credit will not be allowed for students who fail to meet registration, enrollment or financial obligations to the university. Enrollment deadlines are available from the Office of the Registrar.

Students who do not settle financially with the Cashier's Office by the payment deadline and who enroll on or after Late Enrollment Day are assessed a Late Enrollment Fee of $10 per class day to a maximum charge of $250, which is assessed by the Office of the Registrar.

Grading

Final grades identifying the quality of work are awarded to each student, in each subject scheduled, at the end of the semester or summer session. In general, each instructor takes into consideration the student's performance in classwork, homework and examinations.

Mid-semester grades are given at the middle of each semester, to indicate to students their scholastic standings for the first part of their courses. Mid-semester grades are not reflected on the official academic transcript.

A permanent (final) 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 their department. 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 in bestowing honors, if applicable. Both grades, however, are recorded on the official academic transcript and are calculated in the University Quality Point Average index.

When students are absent from a final examination and are not entitled to an "I" (incomplete) grade, they are given an "R" (fail) grade.

The recording of dropped courses for undergraduates is as follows:

- On or before the university deadline to drop: the course is removed and does not appear on the official academic transcript.
- After the university deadline to drop: "W" (withdrawal) grade is assigned and appears on the official academic transcript.

Students can pick up copies of their grades in their department or college office. Final grades are also mailed to the address indicated on a student's Biographical Update Form as "Mailing Address for Grades". Copies of Fall and Spring mid-term and final grades are also mailed to parents of freshmen.

At the end of each academic year, copies of each student's complete record are sent to the student's department head and the dean of the student's college. Students should consult their departments concerning their progress and should report apparent errors or inconsistencies to the Registrar.

Grading Practices

The symbols used in recording academic performance for undergraduates at the university are:

Grades	Meaning	Quality Points
A	Excellent	4
B	Good	3
C	Satisfactory	2
D	Passing	1
R	Failure	0
P	Pass (In a course in which the student has permission to be graded pass/fail)*	
O	Audit	No academic credit or quality points
W	Withdrawal	0

Conditional Grades

I	Incomplete**	0
X	Conditional Failure***	0

Conditional grades, (I) Incomplete and (X) Conditional Failure, revert to (R) Failure at the end of the semester following the one in which the course was taken unless the reason for the conditional grade is eliminated and a permanent grade is substituted. If the instruction or facilities for completing the work are unavailable, permission may be given by the College Council to continue the conditional grade.

When a conditional grade is given, the instructor should stipulate the time when and the manner in which the work is to be completed.

**Incomplete — A grade of I (Incomplete) may be given when, for unpredictable reasons (e.g., illness), the student has been unable to complete the work of the course, provided that the work completed in the course is passing and that provisions to make up the work missed do not burden the instructor unreasonably.

***Conditional Failure — A grade of X (Conditional Failure) may be given to a student when it is deemed that by some further work not amounting to retaking the course the student can achieve a passing level of performance. The highest grade that can replace an X is a D. The Department of Industrial Management does not issue the conditional grade of X.

Pass/Fail Grading

An undergraduate student may elect to receive a pass or fail grade in any non-major or non-minor course, or in a free elective course, under conditions stated below:

- A non-major course is defined as a course outside of the requirements of the student's major area. A free elective course is defined as any course not required for a particular program in a department or college. For example, a technical elective or an elective in an optional field or a required Humanities and Social Science elective are not courses in which the student may elect a pass or fail grade.
- Two permissions are required: the first, of the student's department head or departmental adviser, and the second, of the instructor in the course.
- The decision to take a course pass/fail must be made before the end of the third week of the term and is irreversible thereafter.
- The instructor of the course or the head of the department in which the course is offered is the final judge of the student's qualifications to take the course.
- The student must perform all work, including examinations, term papers, etc., required of all students in the course. The instructor determines what constitutes "pass" and "fail" for the course (i.e., a "pass" may require a better quality of work than a "D" grade does).

Graduation Fee

A graduation fee of $30 is charged to every bachelor's and master's degree candidate for each diploma awarded; doctoral candidates are charged $65. The fee is payable during the enrollment period preceding the commencement when the degree is to be awarded.

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 and/or recommendations of the faculty.

Students who are awarded their degrees with University Honors will be listed as such in the Commencement program, and their diplomas will carry the distinction "With University Honors".

Overloads

Freshmen and first semester transfer students are limited to a normal schedule of units in their first semester of attendance. For other students, exceptions to the following rules can be made only by action of the College Council of the student's college.

Students are not permitted to carry an overload of courses until they have demonstrated their ability to carry a normal load successfully. An academic advisor or department head may approve, at the time of scheduling, excess units (not to exceed 12) provided the student's QPA for the preceding semester is 3.00 or better. The scheduling of more than one excess course or more units than provided for by the above formula must be approved by College Council action.

The normal load in the College of Humanities and Social Sciences is 45 units per semester. The normal load in all other colleges is between 45-54 units, depending upon the curriculum. Students who violate the overload policy— i.e. students who did not achieve a 3.00 QPA in the previous semester and register for an overload or students who register for an overload of more than 12 units— will have courses dropped from their schedules. This reduction begins arbitrarily, and continues until the total units have reached policy limits.

Refund Policy

Students who give written notice of voluntary withdrawal or leave of absence (i.e. submission of an Application for Withdrawal or Leave of Absence) will receive a tuition credit as follows:

- Within the first 10 class days of the semester, the full tuition charged will be credited with the exception of $200. Part-time students will be credited full tuition less $100.
- After the first ten days of a semester, but prior to mid-semester, students who withdraw or take a leave because of personal illness or illness in the immediate family (as verified by the University Health Service) will be credited one-half of the tuition fee charged.

- After mid-semester, no tuition is credited for withdrawals or leaves of absence.

- Students called to active military duty from reserve status will be refunded full tuition. Students who voluntarily enlist after the semester has started will be refunded tuition on a pro-rated basis for the unexpired portion of the semester.

Tuition credits will be based on the largest number of registered units during the period of enrollment. The student activities fee is not refundable for any reason.

Refunds for Housing and Dining Service will be based upon a schedule on file in the appropriate offices.

Students dismissed at any time for unsatisfactory academic standing or infraction of regulations will not be credited tuition and related fees or housing charges in whole or in part, except that at the end of the term the student may request a refund of housing charges in the event of subsequent re-rental.

It is the student's responsibility to complete a "Request for Refund" form at the Cashier's Office and to make arrangements with the Cashier for receiving the refund.

Students or parents who believe that their individual circumstances may warrant an exception from the published tuition refund policy may submit a written appeal to the Office of the Registrar, Warner Hall 201.

Required Withdrawal

The university may require a student with serious health problems, including mental health problems or whose use of drugs is potentially self-destructive in the psychiatric sense, to withdraw from the university until the problems have been solved through appropriate treatment. Such a withdrawal will be required only after a thorough case review by a committee consisting of the dean of student affairs, the dean of the student's college and such medical, psychological or psychiatric consultation as is necessary.

Residence Requirement

A candidate for the bachelor's degree shall complete, at the university, a minimum of two semesters of full-time study or four semesters of part-time study, comprising at least 90 units of work. The minimum residence requirements must be met by full-time work of the senior year or by work of equivalent or higher level.

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.

Returning to the University (Readmission)

Most undergraduates who have withdrawn or who are on a leave of absence from the university are eligible to return to the university without reapplying for degree candidacy through the Office of Admission. Undergraduates who *must* re-apply through the Office of Admission are in the following categories:

- Undergraduates who become full-time students or degree candidates elsewhere (these students must re-apply to the university as Transfer Student candidates);

- Undergraduates whose period of withdrawal or leave of absence has lasted for more than four years.

Graduate students who have withdrawn must reapply to their departments for admission.

All students who are on voluntary leaves of absence and wish to return to the university must complete and file an "Application for Return from a Leave of Absence." Students who are on involuntary leaves of absence (i.e. on academic or disciplinary suspension) must initially request clearance to return from their college (for academic suspensions) or from the dean of student affairs (for disciplinary suspensions), by obtaining an Application for Return From a Leave of Absence. The application must be submitted to the Office of the Registrar at least 90 days prior to the late enrollment period for the semester or summer session of return. NOTE: financial aid applications are due four months prior to the start of the academic year during which students propose to return. Forms and additional information about deadlines should be requested directly from the Office of the Registrar and the Financial Aid Office.

The Application for Return from a Leave of Absence may be obtained from the Office of the Registrar and should be submitted upon completion to the Office of the Registrar. The application requests general information about the student: when s/he plans to return, when s/he was last enrolled at the university and how time was spent while on leave. If courses were taken at another institution, the student must have an official transcript from that institution sent to the Carnegie Mellon Office of the Registrar. Failure to fully report information about courses taken elsewhere results in no transfer of credit for said courses and possible subsequent disciplinary action.

Upon receipt of the Application for Return from a Leave of Absence, the Office of the Registrar checks the student's enrollment status on the Student Information System to determine whether s/he is eligible to return (e.g. has suspension ended) and to check if there are any "holds" or special conditions on the student's record. Suspended students may generally apply for readmission one year after the semester of suspension; for example, a student suspended at the end of spring 1994 may apply for readmission for fall 1995. If the student is not eligible to return for some reason and/or if there are any "holds" on the record, the Office of the Registrar notifies the student in writing and sends copies of the notification to the student's department and Dean's Office.

If the student is eligible to return, the Office of the Registrar forwards the Application for Return to the student's Dean's Office, who obtains department approval, adds dean's approval, notes any conditions that apply to the student's return and returns the form to the Office of the Registrar. If the student is in the Registrar's Office at the time, s/he is given the student copy of the application; otherwise, the Office of the Registrar keeps the student's copy. The Registrar's Office then responds to the student in writing confirming clearance to return and sends a copy of the letter to the student's department and to the Financial Aid Office.

Graduate students who have *deferred* their acceptance and then decide to attend the university must have their department submit a Graduate Student Data Sheet prior to their first semester of attendance. The department must write "DEFERRAL" clearly across the top of the Graduate Student Data Sheet; if the Office of the Registrar is not notified of the student's deferral status, the student will be required to submit an Application for Return from a Leave of Absence. This procedure applies to *all* deferred graduate students, regardless of the duration of the deferral.

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.

Major Terms

Degree

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

Multiple Degrees

More than one degree granted by the University, whether simultaneously or sequentially. While working towards more than one bachelors degree, one of the departments (and if necessary colleges) to be designated as home unit. 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).

Joint Degree

Degree program offered between two or more colleges/departments or offered in conjunction with an outside University.

Examples: M.S. in Colliods, Polymers, and Surfaces (Chemistry and Chemical Engineering); M.S. in Information Networking (CIT/GSIA/SCS)

Major
Field(s) 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.

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 double major.

Examples: Civil Engineering (Biomedical Engineering Option) Physics (Computer Science Option)

Minor
Secondary field of study, generally represented by a set of department-determined courses of **no less than** 45 units.

Examples: Film Studies; Industrial Management; History of Ideas

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

A specific area of study generally associated with a major or double 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
Definition: One diploma, stating the degree and the major field of study. Currently, the Statute of Limitations on earning an undergraduate degree is eight years (See p. 71).

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

Multiple Degrees
Definition: 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; Master of Science in the field of Physics

Requirements: **Multiple bachelors degrees**

To recieve multiple bachelors 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 (cited on p. 73) 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.

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.

Graduates: upon admittance OR upon submission of the Graduate Student Data Sheet OR by the end of the semester preceding the expected graduation date.

Certification: Home college, home department

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

Additional Majors
Double Major
Definition: One diploma/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.

Eg. For 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)

Note: Non-CIT students cannot pursue (an) additional major(s) in CIT.

CIT students may pursue (an) additional major(s) in other colleges but are limited within CIT to a double major only in Engineering and Public Policy. Undergraduates can only double major in EPP — it is not offered to them as a major.

The Biomedical Engineering option available to CIT students is now a minor.

Triple Major
Definition: One diploma/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.

Eg. For a History student, this degree is valid: B.A. in History with additional majors in Professional Writing and in Spanish

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: Home college, home department

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

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

Note: Non-CIT students cannot triple major in CIT.

Minor

Definition: One diploma/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).

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: Home college, home department

Minor department or program (minor college only needs notification)

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.

Major - Additional Major -Minor Declaration Process

Major

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 to the Office of the Registrar on the Graduate Student Data Sheet.

Additional Majors/Minors

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.

For graduates, all variations on a student's sought degree and major field must be declared by the end of the semester preceding the expected graduation date.

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

The Declaration of Additional Major or Minor form should be completed for all students who wish to pursue additional majors and/or minors; the form requires various authorizing signatures and should provide the student with a detailed curriculum for attaining the desired degree. Upon receipt of the Declaration of Additional Major or Minor form, the Office of the Registrar will update the Student Information System and subsequently transfer that information to the Commencement System. This procedure ensures that when a student is expected to graduate, all degree/major information is immediately accessible, the correct diploma is ordered and certification of the degree is simplified.

Process for Creation of New Degrees, Majors, Minors

All diploma notations (new degrees, majors, minors, options) must be:

- Recommended by the department/college
- Approved by college council
- Approved by the university through the Provost's office

All other transcript notations must be:

- Recommended by the department
- Approved by the department's college council

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.

Tuition

The tuition charge for 1994-95, $17,900 per year, is for all full-time undergraduate students. A full-time student is one registered in a degree program and carrying a schedule of not less than 36 units per semester. An undergraduate student enrolled for 35 units or less per semester will be charged tuition on a unit basis of $249 per unit. A student activities fee of $50 per semester (in addition to tuition) is charged to all students who enroll for 19 units or more.

Undergraduate students who are enrolled in a full-time program of off-campus work (e.g. Argonne National Laboratory, WQED, drama practicum in repertory companies, etc.), for which the university must assign a grade, shall be assessed tuition at the rate of $125 per unit up to a maximum of 24 units per semester for a maximum of two semesters. Units in excess of 24 per semester will be assessed at the regular tuition rate of $249 per unit.

Exceptions to the above policy are undergraduate students enrolled in:

- off-campus work which has been scheduled for more than two semesters or
- both on-campus and off-campus work or
- the Washington Semester program or
- the CMU-EPFL program.

These students are charged at the regular tuition rates.

Private music instruction is available and can be arranged for non-Music students through the Music Extension Program. This private instruction for non-Music students is not included in the basic full-time tuition charge.

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, making a 9-unit subject. Mathematics might require 3 hours of recitation plus 3 hours of preparation for each recitation, making a 12-unit subject.

Final grades are given "Quality Point Values" as follows:

- •A (excellent) = 4
- •B (good) = 3
- •C (satisfactory) = 2
- •D (passing) = 1
- •R (failure) = 0

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

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

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

Total Units = 48

Total Quality Points = 98

Quality Point Average (98 divided by 48) = 2.04

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

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

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.

Withdrawals/Leaves of Absence

Students who leave the university after enrolling and prior to graduating fall into one of two categories:

- Students who have withdrawn from the university.
- Students who have taken a leave of absence from the university.

A **withdrawal** means leaving the university with no intention to return.

A **leave of absence** means leaving the university temporarily, with the firm and stated intention to return.

If a student finds it necessary to withdraw from the university, an "Application for Withdrawal or Leave of Absence" must be filed at once with the Registrar. This application may be obtained from the dean of the student's college. A student cannot withdraw from the university by simply notifying the instructor(s) or by ceasing to attend class(es).

Leaves of absence fall into two categories: involuntary and voluntary.

- *Involuntary* leaves of absence usually result from academic or disciplinary suspensions, return from which must be cleared through the student's college (for academic suspensions) or through the Office of Student Affairs (for disciplinary suspensions).
- ALL students taking *voluntary* leaves of absence are required to file an "Application for Withdrawal or Leave of Absence" with the Office of the Registrar. Failure to do so will automatically result in subsequent classification as a "withdrawal," making return to the university possible only by reapplication through the Office of Admission.

The Application for Withdrawal or Leave of Absence requires information about the student, the request he or she is making (i.e. for withdrawal or leave), the reasons prompting the request and additional comments pertaining to the request. Signatures are required of the student, his or her academic department, his or her Dean's Office and (if the student is under 18 years of age) his or her parent or guardian. 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. The completed application is to be submitted to the student's Dean's Office, who will then transmit the application directly to the Registrar for processing and distribution of copies.

The process of withdrawing or taking a leave of absence is not complete until all necessary signatures on the Withdrawal/Leave form are obtained by the student and until all outstanding bills are paid. If the withdrawal or leave is to take effect during a semester of the academic year, it will go into effect as of the date indicated next to the signature by the student's Dean's Office, UNLESS the form reaches the Registrar more than one week beyond said date. In such cases, the date of the withdrawal or leave is the date the form is received in the Office of the Registrar.

Withdrawals or leaves taken while school is in session (through the last day of classes) result in "no academic penalty" for the student — that is, no permanent grades are recorded for courses taken during that semester. Recording of courses and grades for students who withdraw or take a leave of absence is as follows:

On or before the university deadline to drop courses: all courses are removed and do not appear on the academic record.

After the drop deadline but on or before the last day of classes: "W" (withdrawal) grades are assigned to all courses and appear on the academic record. (The "W" grades apply to undergraduates only.)

After the last day of classes: permanent grades are recorded as assigned by instructors and appear on the academic record.

Students must remain cognizant of deadlines that affect eligibility for refunds (see the section on "Refund Policy" for more information). If a student feels that a refund is warranted even if stated deadlines have passed, s/he should state the reasons for this claim in the "Comments" section of the "Application for Withdrawal or Leave of Absence" and fill out a "Request for Refund" form at the Cashier's Office. Students who have been dropped or suspended or who have withdrawn are required to absent themselves from the campus (including residence halls and fraternity/sorority houses) within a maximum of two days after the action and to remain off the campus for the duration of the time specified. Enrollment in part-time or summer courses is not permitted for the duration of withdrawal or suspension.

University Services

Academic Support

Advisory Services

Preparation for a life devoted to a professional career is both a complex and a developing process. The university wishes to ensure that experience at every level in the academic community contributes to that process. Because of the range of those experiences, however, it is important that there be constant access to advice or assistance whether it be for personal, academic or professional reasons. The Division of Student Affairs, assigned responsibility by the university for a total of the student experience, works regularly with all other divisions to ensure that the services students need are available and effective.

Advisory services about academic matters are primarily the responsibility of the undergraduate colleges and are handled differently in each college. Freshmen in the College of Humanities and Social Sciences begin under the guidance of their Academic Advisory Center and at the end of the sophomore year are assigned to academic advisors chosen by their departments. Freshmen in Carnegie Institute of Technology and Mellon College of Science begin their freshman year with the advice of the associate dean of their college. After departmental majors have been selected in the spring semester, they are assigned advisors in the department of their choice. Academic advising in the College of Fine Arts is ordinarily the responsibility of the department head, although in some departments responsibility will be delegated to an assistant. Freshmen find that the close, one-to-one relationship between instructor and class often results in an advisory and counseling relationship with the instructors of their courses.

Assistance for Students with Learning or Physical Disabilities

Everett Tademy, Director, Equal Employment Opportunity
143 North Craig Street (Whitfield Hall)

Marcia Wratcher, Learning Services
University Teaching Center, HBH 239

Carnegie Mellon offers services that help individuals with physical or learning disabilities meet their needs as students on campus.

Public Law 94-142 defines a physical disability as a permanent disorder of varying severity which may limit a student in a variety of ways. This includes visual, motor, hearing and speech impairment.

Both physical and learning disabilities take many forms. Learning disabilities affect a student's ability to receive, comprehend and express information. Other forms of learning disabilities occur in listening, thinking, talking, reading, writing, spelling and mathematical computation disorders. Learning disabilities do not include problems due to developmental delay, visual, motor or hearing impairment, mental retardation, emotional disturbance or environmental disadvantage.

Qualified students are entitled to special academic support under the guidelines of reasonable accommodations. The Equal Employment/ Affirmative Action (EEO/AA) Office serves as a link for students with physical or learning disabilities and the campus community. We urge individuals with physical and learning disabilities to contact these offices before enrolling at Carnegie Mellon. Verification of a disability will be required. Letters of introduction and requests for accommodations are distributed to the relevant college dean and the student's professors.

Examples of reasonable accommodations could include notetaking services, books on tape or untimed exams. Accommodations are determined on a case by case basis.

Carnegie Mellon Action Project

Director: Gloria P. Hill
Office: The Student Center, Suite 125

The Carnegie Mellon Action Project (CMAP), was founded at Carnegie Mellon in 1968. It was established originally to aid the university in recruiting African-American students, to provide them with academic and supportive services to assure their progress toward graduation. In the fall of 1991, Hispanic and Native-American students became a part of CMAP's target population. CMAP provides a wide range of academic and non-academic activities including a five week summer program, academic tracking and monitoring, and a comprehensive tutoring program. Attention is paid to students personal development through a variety of special programs, and assistance is provided in securing summer and permanent job placements. But, perhaps, the most important aspect of CMAP is that it is a place where minority students can "cool out" . . . a place where people care about you as a unique human being. CMAP is not a "remedial" program nor is it just for "students who need help". It is an organization committed to meeting the needs of Carnegie Mellon African-American, Hispanic, and Native-American students, whether these needs are academic, personal or social.

Recruitment and Admissions

CMAP works in cooperation with the Office of Admission to identify talented African-American, Hispanic, and Native-American youth who wish to pursue degrees in any of the University's disciplines. CMAP assists in the recruiting process by visiting counselors and students at high schools, participating in college fairs, conducting interviews and answering inquiries about the project and the university. Once admitted students become a part of the academic mainstream and are expected to perform at the same level the University requires for all students.

CMAP Summer Program

A key component of CMAP is the five week residential Summer Program. It is academically rigorous, intensive and challenging. The Summer Program is designed to acquaint incoming freshmen with the level of competition, the quantity, and the caliber of work they will encounter in the Fall. The course work aids in the development of study skills and self-discipline, tests motivation, and prepares students for a smoother transition to the freshman year. Students will also have the added advantage of becoming familiar with college teaching styles and expectations, since instructors are university faculty and graduate students. Engineering and Science students attend classes in calculus, physics and English. While Humanities and Social Science students attend classes in calculus, economics, and English. Fine Arts students will participate in a unique program through their departments as well as participate in the CMAP Summer program. Participants are strongly encouraged/sometimes required to attend this summer session.

Academic Advising

CMAP advisors, working in cooperation with academic departmental advisors, assist students with course selection and sequencing to meet their major requirements. Their input enables CMAP to monitor student performance throughout the school year. The primary objective is to assure that students are making consistent progress towards graduation.

Tutorial Services

Tutoring is available Sunday through Thursday on a walk-in basis. There is also the opportunity for tutoring by appointment as the need arises. In addition to tutoring, CMAP also sponsors workshops on study skills and time management to help students better utilize and manage their time.

Personal Counseling

A full time counselor is available to address the personal, emotional, and social needs of African-American, Hispanic, and Native American

students. Student/counselor sessions cover a multitude of topics. CMAP's goal in providing counseling for our students is to aid them in their development toward maturity by helping them to define and examine their problems, and consider all possible choices so that they are able to move in a direction that will lead to a reduction of tension and a resolution of the problem using all resources at their disposal.

Job Placement

Because Carnegie Mellon University and CMAP recognize that trained students need practical as well as theoretical experience, assistance is available in securing summer and permanent job placements. CMAP sponsors career seminars which furnish students with firsthand information on developments and opportunities in their fields of interest. Additional workshops focus on job search strategies, interviewing techniques, resumes, and career planning.

Summary

CMAP exists to assure that African-American, Hispanic, and Native-American students do, in fact graduate from Carnegie Mellon. It's primary purpose is to provide a supportive environment where student talent is guided and reinforced. The program interfaces with all major administrative, academic and student service departments to assure the retention effort is an integral part of the campus community. The focus remains on viewing and treating minority students as individuals with goals, talents and abilities . . . as individuals that can be successful at Carnegie Mellon.

Computing Services

Vice President for Computing Services: William Y. Arms
Office: Cyert Hall 105

The Computing Services division is responsible for providing the campus with central computing and communications services. These services include system software development, application and maintenance; voice and data communications; system hardware and operations support; applications acquisitions, installation and consulting; education and training; and computer cluster facilities and support.

The Andrew Distributed Computing Environment. The main computing services are centered on Andrew, a distributed computing environment. The Andrew system consists of three major components: the network, network clients, and network services. The key network services are the Andrew File System (AFS), the Andrew Message System for electronic mail ("email") and bulletin boards ("bboards"), and distributed printing. These services are accessible directly by a variety of UNIX workstations and indirectly, via intermediate servers, by PCs and Macintoshes.

Personal Computing (PCs and Macintoshes). Computing Services has developed software to integrate PCs and Macintoshes into the Andrew environment. The main products used are MacMail, EzMail, and the EzFax service. The MacMail package allows Macintosh users to access the Andrew Message System with a Macintosh-style user interface. EzMail is an interface designed for PC users. EzFax allows authorized people to fax documents from EzMail, MacMail, or Messages, the Andrew Message System interface for UNIX workstations.

The following are descriptions of groups and services within the Computing Services division.

Applications Software

Hamburg Hall, Third floor

The Applications Software group provides a collection of Macintosh, MS-DOS/Windows and UNIX software for use by faculty, staff, and students. The software is available in the division's public computing clusters or from the central UNIX file servers. This collection includes operating systems, productivity tools such as word processing, spreadsheet and general purpose graphics and CAD software, and cross-curricular software such as compilers, statistics packages, symbolic computation software and utilities. Questions about software licenses can be addressed in electronic mail to software+@andrew.cmu.edu.

Computer Repair

Cyert Hall A-64

Computer Repair offers repair services for a wide range of products including those sold through the Computer Store. These services are available to any member of the Carnegie Mellon community. Repairs are completed within two to three working days for parts that are in stock. When parts must be special-ordered, Computer Repair makes the arrangements and quotes prices and turn-around time. Other services include pick-up and delivery to academic buildings on campus, shipping equipment to the manufacturer, backing up hard drives, upgrades, equipment evaluation, and extended warranty contracts. Acceptable forms of payment are check, cash, departmental charge, MasterCard or Visa.

Computer Store

Cyert Hall A-Level

The Computer Store is a source of many services regarding the latest computing products. The Computer Store sells Apple, IBM, and Dell hardware and educational software at reduced prices to members of the Carnegie Mellon community. Peripherals and supplies such as disks, paper, magnetic tape, modems, and printers are also available. If an item is not in stock, it can be ordered. Free literature about the Computer Store's products is available in the Computer Store. Acceptable forms of payment are check, cash, departmental charge, MasterCard or Visa.

Cluster Services

Hamburg Hall, Third floor

The Cluster Services group supports 16 public computing clusters on campus, several of which are open 24 hours a day. Together the clusters contain about 350 computers, including: Macintoshes, DOS/Windows, and UNIX workstations. Clusters are used mainly by students; however, departments reserve certain clusters for classes or presentations. Some clusters are staffed with consultants. For information on cluster schedules, see the official.computing-news electronic bboard and *Cursor*, the Computing Services newsletter.

Computer Accounts

Cyert Hall, 111-113

The Computer Accounts group handles computer accounts and user IDs on the university's central computing systems. This work includes creating user accounts, setting disk quota, changing passwords, and billing. User IDs remain active as long as the individual remains affiliated with the university.

User IDs on the Andrew System are available to all members of the Carnegie Mellon community. Most students receive an Andrew user ID upon entering Carnegie Mellon. Additionally, user IDs for faculty, staff and graduate students are established by their departmental account administrator prior to, or upon, their arrival on campus. Undergraduates without user IDs may bring their valid Carnegie Mellon ID cards to the accounts office and complete application forms. Faculty, staff or graduate students without user IDs should contact their departmental account administrators to complete application forms.

Computer Education

Hamburg Hall, Third floor

The Computer Education group offers hands-on courses on using the university's computing technology. In addition, self-paced videotape courses can be checked out. Both are available to any member of the campus community. A catalog is sent by campus mail to all full-time faculty and staff. For more information, send email to computer-education+@cmu.edu.

Computer Operations

Cyert Hall, A-level

Computer Operations provides around-the-clock support for the campus' centrally-located computers. This work includes central printing, file backup and restoration, after-hours support for the campus network, and support for the various file server machines.

Computing Services Media Lab

Cyert Hall Cluster

The Computing Services Media Lab is a technology resource center equipped with several different computing platforms, peripheral tools, and associated software. The lab is available to any member of the campus community by appointment only. Contact the Help Center, 268-HELP.

Data Communications

Cyert Hall

Computing Services provides the networking hardware and software to interconnect the central campus computers, the Andrew file servers,

and personal computers (including workstations) in various configurations. Some of the keys to this service include:

A campus-wide internet running the TCP/IP, AppleTalk, and Novell IPX protocols

A dialup modem pool for access by telephone Ethernet, Token Ring, and AppleTalk through the IBM cabling system

A campus-wide asynchronous terminal network

Computing Services installs and maintains approximately 120 networks and over 7000 connections across campus. These connections are made through the IBM cabling system (the oddly shaped outlets in virtually every room on campus). Three types of network connections are supported on campus: IBM Token Ring, LattisNet (Ethernet through the IBM cabling system) and PhoneNet (AppleTalk through the IBM cabling system). Starting in fall 1994, IBM Token Ring will only be available in academic buildings.

The university's primary connection to external networks is through the Pittsburgh Supercomputing Center, which is one of the major hubs on the NSFNet backbone.

Telecommunications

Hamburg Hall, Third floor

Telecommunications provides telephone services to students, faculty, and staff including lines, equipment, maintenance, and long distance. Other services include voice messaging, video conferencing, and satellite transmissions. Telecommunications manages the centrally-provided cabling facilities for voice, data, and video.

User Services

Cyert Hall

The Help Center. The Help Center is a comprehensive service for members of the Carnegie Mellon community who have questions about computing on campus. A Computing Services consultant is available weekdays from 9:00 am to 5:00 pm. Contact the consultant by phone (268-HELP) or in person at the center's location, Cyert Hall A-51.

Advisor. Advisor is an email system for answering questions. Send questions by private email to advisor+@andrew.cmu.edu. A Computing Services consultant will respond directly to you, also by private email.

Consulting. Computing Services professional consultants are available in addition to the services of the Help Center and Advisor. These consultants evaluate new technologies and assist departments and individuals in selecting hardware and software to meet various needs. Contact a consultant through the Help Center, 268-HELP.

Other Sources of Information about Computing Services

Computing Services publishes a newsletter, *Cursor*, seven times during the academic year. Full-time faculty and staff members automatically receive copies in campus mail; students can obtain free copies in the clusters. The division also publishes documentation and other instructional materials on software and services developed by Computing Services. For daily information about activities and the status of central computing, subscribe to the division's electronic bboards:

official.computing-news
official.cluster-reservations
official. computer-store-and-repair
official.software

Educational Technology

Director: Gregg Mathis
Office: Hamburg Hall

The Educational Technology Department's mission is to encourage and enable the appropriate use of technology in education. The department includes the Computing Skills Workshop and Instructional Technology.

Computing Skills Workshop

Baker Hall (BH) 140A

Administered by Educational Technology, Computing Skills Workshop (CSW) is a university core course that teaches basic computing skills on Andrew and the Macintosh. CSW meets twice a week for one hour, each class introducing an operating system and/or a software application. Teaching assistants (TAs) present an instructional video and monitor a lab session where students get hands-on experience with a new application. Students who have mastered the material covered in CSW may choose to place out of the course early. Homework and projects are assigned and two exams are given to exercise students' knowledge of the material. Students may choose from the standard CSW course, an advanced version of CSW, or the special IBM PC course. CSW also offers adjunct workshops in popular software applications used on campus that may not be covered in the regular CSW courses.

Instructional Technology

Hunt Library, Lower Level

Instructional Technology (IT), a department of Educational Technology, is responsible for providing media equipment and support for the Carnegie Mellon community. Instructional Technology includes Classroom and Presentation Services, Academic Videotaping Services and the Slide and Video Collections.

Classroom and Presentation Services

The Classroom and Presentation Services group of Instructional Technology (IT) is responsible for providing media support for the Carnegie Mellon community. Equipment is provided free of charge for courses scheduled by the Registrar. If an IT operator is requested or required, a labor fee is charged. All other service orders are charged an equipment rental fee plus any operator labor fee. Classroom and campus services include pickup and delivery of computer projection systems, sound systems, video display systems, 35mm slide projectors, and 16mm film projectors. Most common computers are supported: IBM PS/2, Macintosh, Andrew UNIX workstations and portable computers. Computers are not provided without projection devices.

Classroom and Presentation Services has installed computer projectors in fourteen classrooms and has also equipped all Registrar controlled classrooms and lecture halls with storage cabinets. Some cabinets are equipped with video play back equipment, slide or film projectors, and microphones for sound systems. All cabinets contain overhead projectors and an extra supply of chalk and erasers. Faculty can obtain keys to the cabinets from Instructional Technology, Hunt Library, lower level.

Slide and Video Collections

Video Collection: The Video Collection contains over 2800 VHS videotapes and over 650 laserdiscs, including U.S. and foreign films, documentaries, and instructional programs. Faculty members may schedule showings of video collection holdings for Carnegie Mellon credit courses only. Videos also can be viewed by one or two people at a time in the Viewing Carrel Area upon presentation of a valid Carnegie Mellon ID. The Viewing Carrel Area contains nineteen VHS videotape players, one Beta videotape player, one 3/4" tape machine, one closed-caption video player for the hearing impaired, eleven laserdisc players (two of which are interactive), two MacIntosh interactive laserdisc stations and a Caramate slide viewer/audiotape player.

Also offered is a film rental service to faculty members who wish to use 16mm film or videotapes available through other institutions.

Slide Collection: The Slide Collection includes more than 150,000 slides, primarily in the fine arts fields. Slides of maps and historical subjects are also included. Four light tables, one slide projector, and one Caramate slide viewer/audiotape player are available for on-site use. Other slide projectors are available for loan through Classroom and Presentation Services.

Spoken-word Audiotape Collection: The Spoken-word Audiotape Collection includes recordings of literature and instructional materials. Tapes circulate to Carnegie Mellon students, faculty and staff.

Academic Videotaping Services

University Teaching Center: Academic Videotaping Services has an ongoing mission to aid the University Teaching Center in improving the quality of education at Carnegie Mellon. Academic Videotaping Services handles all video services for the University Teaching Center, including videotaping faculty and graduate students for critique of teaching quality.

Student Edit Cluster: The Student Edit Cluster, similar in function to a computer cluster, provides students with the equipment necessary to edit videotapes. Located in the College of Fine Arts, third floor, the cluster contains three VHS video tape bays, one Super VHS videotape bay, one Hi8 editing bay and a format converting setup for editing. Use

of the cluster is free of charge, however one free two-hour training session is required of all first time cluster users. Bays may be reserved for course projects on a case-by-case basis.

Video Camera Loan: Through Academic Videotaping Services, faculty members can authorize free loan of Instructional Technology's video cameras to their students. Video cameras may be borrowed rent free for course related projects only, Written notification from a faculty sponsor is required.

Intercultural Communication Center

Bridging Language Gaps

The Intercultural Communication Center equips non-native speakers of English with the skills they need to succeed in their academic programs. Our program is designed for students who are too advanced for traditional ESL programs. In addition to the English language, students study the culture and customs of the American classroom. The center offers:

- A Writing Clinic with individual appointments for both bilingual and non-native speakers who want to improve the writing skills required for their academic work.
- Individual tutoring in specific areas such as speaking, listening, fluency, listening comprehension, grammar, and TA skills.
- Workshops in Presentation Skills, Reading Skills, Job Interviewing for Non-Native Speakers and International TA Skills.
- Diagnostic language testing in listening and speaking skills for all incoming students as part of the Freshmen Orientation.
- Screening Tests for prospective TAs (teaching assistants) who are non-native speakers of English.

For more information contact: The ICC, Warner Hall 418, Carnegie Mellon University, Pittsburgh, PA 15213-3890, (412) 268-4979.

Undergraduate Research Initiative

Director: Jessie B. Ramey
Office: Warner Hall 429

The Undergraduate Research Initiative supports students in all disciplines at the university through a number of programs and services designed to complement those already in place in the departments and colleges:

Information Services

The Undergraduate Research Initiative maintains information on university and off-campus research opportunities including summer internships, conferences, grants, fellowships and research positions. The Director is also available to discuss research ideas, help you find a project advisor, and assist you in preparing grant proposals. Further information may be found on the "official.research.undergrad" b'board on andrew.

The Research Directory

The Research Directory lists all Carnegie Mellon faculty and their research interests. This document is an excellent resource for students seeking advisors or simply looking for knowledgeable faculty to discuss project ideas. Copies of the Directory are available in each department, the libraries, the Information Desk, the Career Center and the Undergraduate Research Initiative. The Research Directory is also available on the Library Information System.

Undergraduate Research Associates Program [URAP]

All undergraduates conducting a research or creative project are eligible for university recognition through the Undergraduate Research Associates Program (URAP). Students may submit a completed Participation Form at any time during the semester. Participants receive invitations to a number of events including the "Celebration of Undergraduate Research"; announcements of research, grant and fellowship opportunities; parental notification (if you wish); hometown newspaper notification (if you wish); URAP Honor Roll listing in each department; and the opportunity to have your work displayed on campus. Upon completion of the project, participants receive official Research Associate status; a certificate of completion; special listing in the commencement program; and publication in the *Undergraduate Research Abstract Book*.

Small Undergraduate Research Grants

All undergraduate degree candidates in good academic standing are eligible to apply for a Small Undergraduate Research Grant [SURG]. SURG grants are awarded up to $500 and may be used to purchase supplies, pay subjects for an experiment, rent equipment, or even supplement a student stipend. There are two grant periods each year: a proposal must be submitted in the Spring for Summer and Fall projects and in the Fall for Spring projects.

Travel Awards

Undergraduates whose work has been accepted for presentation at an academic conference are eligible to apply for a limited number of Travel Awards. There is no deadline, but a completed application must be submitted to the Director of the Undergraduate Research Initiative. Awards will cover 75% (up to $250) of the total cost of attending the conference. Approximately eight awards are made each semester.

University Libraries

University Librarian: Charles B. Lowry
Office: Hunt Library

The University Libraries' collections include more than 828,000 volumes and 3,700 periodical subscriptions housed in three locations: Hunt Library (humanities, fine arts, social sciences and business), the Engineering & Science Library (engineering, mathematics, physics, computer science and robotics), and the Mellon Institute Library (chemistry and biology). Facilities include group study areas, reserve areas, study carrels, and quiet study areas.

Several specialized collections distinguish the University Libraries. At Hunt, the Fine & Rare Book Rooms offer unique materials in literature, the arts, the history of science, and other subjects. The University Archives trace the history of the university from its beginning as Carnegie Tech to the present, and the Architecture Archives document the history of architecture in Western Pennsylvania. Both archival collections are located in Hunt Library. The Engineering & Science (E&S) Library maintains a notable collection of technical reports in computer science.

Reference staff at Hunt, E&S and Mellon will help you find information and learn to use the University Libraries. Reference librarians are subject specialists who can provide in-depth research assistance, if you should need it. Publications designed to acquaint you with library collections and services are also available at the reference desks.

The libraries continually apply new technologies to improve services. The Library Information System (LIS), for example, is a collection of databases which can be accessed from any network-connected terminal or personal computer, in the libraries or elsewhere. This innovation extends library use to offices, computer clusters, dorm rooms and other locations. You can search or browse the catalog of Carnegie Mellon library materials on LIS. Other databases on LIS include *INSPEC*, *ABI/INFORM*, *Business Dateline*, *Periodical Abstracts*, *Newspaper Abstracts*, the full text of the *Academic American* encyclopedia, the *American Heritage* dictionary, and Who's Who at CMU (an online directory of students, faculty and staff). Additional databases are shared among the three libraries on a CD-ROM network. Reference staff can facilitate your access to many other databases throughout the world. Some database searches are free; others are fee-based.

An online management system, available in all three libraries, not only provides catalog information about library collections but also indicates whether items are checked out and when they are due to be returned.

The University Libraries maintain reciprocal borrowing agreements with libraries at other colleges and universities in the area. These arrangements give Carnegie Mellon students personal access to a wide variety of regional library resources. In addition, the libraries provide daily courier service from the University of Pittsburgh Library System and the Carnegie Library of Pittsburgh (the public library). PITTCAT and Caroline—the online catalogs of these nearby libraries—are among the databases on LIS.

Campus Services

Carnegie Mellon Dining Services

Roger Heydt, Director
Office: Student Center, Room A03

Dining Services is dedicated to providing exemplary service and the highest quality product at the lowest cost. This dedication leads us to make changes each year to better serve our customer, the student. In the coming years we will continue working to meet our students' changing needs.

Facilities

Highlander Cafe

Located on the first floor of Resnik House, the Highlander Cafe is open seven days per week and is the focal point of our full service meal plans. It's where you can always get a full course breakfast, lunch, or dinner, and the most value for your dining dollar - whether you participate in a pre-paid meal plan, utilize a declining balance account, or simply use cash.

In addition to a variety of entrees each meal (including vegetarian), this facility also features "food court" menu items such as hamburgers, baked potato bars, frozen yogurt, pizza, bake-it-yourself Belgium waffles, wok-it-yourself stirfry, a 20-foot salad bar, and much more. All selections offer unlimited seconds, but "take-outs" are not permitted. All menu selections must be consumed on the premises.

Morewood Court

The Morewood Court, located by the main entrance to the Morewood Gardens Residence Hall, is also open seven days per week. A sampling of the menu offerings include: fresh baked pastries, made-to-order deli sandwiches, ethnic specialties, homemade soups, pizza, and hot sandwiches. All items are available a la carte, so you can dine in or take out, and "mix and match" based on your personal preferences.

Cart Cafes

Carte Cafes are open Monday through Friday, and are located in Wean Hall, GSIA, Hamburg Hall, and Mellon Institute. Each location has its own unique menu and its own personality. Whether it's a cup of cappuccino or a serving of General Tsao's Chicken, there's something to suit everyone's taste. In addition to more "exotic" alternatives, the Carte Cafes provide made-to-order deli sandwiches, homemade soup and chili, hot entrees, and Continental breakfast selections. All locations are open for breakfast and lunch, with some also providing dinner and early evening service.

Hours of Operation

Individual unit operating schedules vary throughout the academic year. As such, schedules are posted at the entrance to each location, on bulletin boards around campus, in the "8 1/2 x 11 News", on the computer BBoard: Official.CMDS, and on our "Menu Line" - 268-MENU (6368).

Meal Plan Options

Meal plan enrollment forms and information regarding current dining programs are mailed to all students during the summer. Additional copies or other information may be obtained from the Dining Services office.

Meal plans are financially attractive because the cost is discounted from the per-meal cash prices. Meal plans also offer the security of not having to manage cash to pay for meals.

All meal plans are a combination of the following components:

Constant Pass - Provides unlimited access to the Highlander Cafe during normal (posted) serving days and times.

Block Meals - Each "block" constitutes one meal - either one entrance to the Highlander Cafe, or a cash credit in Morewood Court. Block Meals may not be used on the Carte Cafes.

DineXpress - This is a declining balance account which may be used exclusively in Dining Service facilities, i.e., Highlander Cafe, Morewood Court, and, beginning in the fall of 1994, on the Carte Cafes.

CampusXpress - This is also a declining balance account, which, in addition to being used in dining facilities, may also be used in other campus locations; such as the book store or art store.

ID Cards

All meal plan options are supported by your ID card. You should always carry your ID card. For security purposes, only YOU may use your ID card.

How the process works:

In the Highlander Cafe, present your card and then go though the serving area. In Morewood Court and at the Carte Cafes, select your food items and then present your card to the cashier.

When your card is presented to the cashier, depending on which meal plan option you have selected, the register will display the number of meals remaining in your block plan, or the balance remaining in either your DineXpress or CampusXpress account. When using an "Xpress" account in a dining location, the registers are programmed to utilize your DineXpress account first (if you have both a DineXpress and CampusXpress account). If you would like to utilize your CampusXpress account, simply inform the cashier at the time of your purchase.

Lost ID Cards

You should act quickly if you lose your ID card. You are responsible for the unauthorized use of your ID card until it is reported missing. During normal business hours, report your lost ID card the CardXpress office in Room 28B, Warner Hall. At night, or over the weekend, report your loss to Campus Police. They will provide you with a temporary ID and prevent unauthorized use of either your meal plan or "Xpress" account.

Change and Refund Policies

Meal plans are extremely flexible. Students are permitted to change from one meal plan to another without a fee or penalty throughout the academic year. Unused block meals and DineXpress balances carry over from one semester, and one academic year to the next, and may be applied as a credit to future meal plan purchases. Upon graduation, remaining balances are refunded in full.

While there are no penalties or fees to change meal plans, the amount of a credit (or charge) will vary based on the plans you are changing. For example, Constant Pass plans are valued on a daily basis - so the amount of a credit, or charge will vary based on the particular date you make the change; whereas a Block Meal plan costs the same, regardless of when you purchase it.

First year students applying for university housing and who are not assigned to a room with cooking facilities are required to enroll in a meal plan. Upperclass and transfer students are not required to participate in a plan. Students enter into a contract upon enrollment in a meal plan, and therefore penalties may be assessed if students choose to drop out. If you request a credit for a balance which is carried over between academic years, or if you wish to cancel your meal plan, or if you wish to convert a DineXpress account to a CampusXpress account, you will only receive 85% of the current value of your Constant Pass, Block Meal, or DineXpress accounts.

Full Refund (or Full Conversion) conditions:

1) Marriage
2) Special Diet - documented by either a medical professional or religious official
3) Leave of Absence
4) If you join a Greek organization, which has a dining program, and if you live in the Greek housing system
5) Graduation

Under most other circumstances, as previously mentioned, you will only receive 85% of the value of your combined accounts (excluding CampusXpress) . However, Dining Services does recognize that there may be special circumstance whereby a student should be entitled to a full refund. If you would like to discuss your situation, feel free to call the Dining Service office at X8-2127. A representative will review your request.

Refund Process

When Dining Service authorizes a refund (as described above), the money is reflected as a credit on your Student Account. If this transfer results in a credit balance on your account, you may then request a refund from the Cashier's office.

Choosing a Meal Plan

Choosing a meal plan that's right for you requires some consideration. Carefully evaluate the available options described in the Dining Service brochure. Your selection should be based on the number of meals that you eat in a week and where you live. After assessing your personal dining habits and budget, select the option that seems correct - and don't forget that you can always change.

Many students open CampusXpress accounts in addition to having a dining plan so they don't have to carry cash, and they are able to use it at the various campus stores. You receive the greatest value for your dollar, however, when you select the pre-paid dining plan with the number of meals which most closely matches your dining preferences, and then supplement that with either a DineXpress or CampusXpress account.

Choose your meal plan carefully, so that you can take advantage of the convenience and flexibility that Dining Service has to offer. If at any time you have questions or concerns, do not hesitate to call Dining Services and speak with a manager.

Housing/Residence Life

Dave Potter, Director of Housing
Office: Morewood Gardens, E-Tower

Timothy Foster, Director of Residence Life
Office: Morewood Gardens, First Floor Lobby

Students have varying preferences for types of accommodations. Carnegie Mellon University responds to those preferences by offering living arrangements that include traditional single-gender residence halls, coeducational residence halls, apartments, houses and fraternity and sorority living areas.

The university's housing facilities are within walking distance of the academic buildings and the neighborhoods of Oakland, Squirrel Hill and Shadyside, well-known cultural and shopping areas in the city of Pittsburgh. Additionally, there are four apartment buildings in the Oakland-Shadyside neighborhood. These units are within 10 to 15 minutes walking distance of campus and are served by the university's shuttle bus.

The university provides each resident student with a bed, desk and chair, bookcase, dresser and closet or wardrobe unit. Students supply such items as pillows, bed linens, bedspreads, curtains, area rugs and desk lamps.

Residence hall room rates include utilities, maintenance and centrex telephone equipment. Students pay separately for room and public area damages and for telephone usage (beyond a maximum local calling allowance) which is billed directly by the telephone company.

Room Types

The types of rooms are divided into three categories at Carnegie Mellon: residence hall rooms, apartments and houses.

Residence hall rooms (with no in-room cooking facilities) are grouped and priced by occupancy and room type classifications. Occupancy (single, double, triple or quad) is the number of students assigned to a fully occupied room. Room type classification is primarily based on the level of bathroom privacy:

- students in standard rooms share a large, central bathroom facility;
- students in prime rooms share private or semi-private bathrooms for five or fewer students;
- students in suite-style housing share a common living room as well as a semi-private bathroom.

Apartments (with cooking facilities) are grouped and priced by occupancy, by location and by the number of bedrooms. **Houses** (also with cooking facilities) are grouped and priced by occupancy and by location.

Residence Halls

Primary Housing for First-Year Students

The majority of first-year students live in the residence halls and apartments listed in this section. Percentages of first-year student occupancy are listed at the conclusion of each description.

Donner Hall is the largest of the residence halls in what is known as "The Hill" area. It houses 254 students on four floors in large standard double rooms with central baths. Donner, coed by wing, contains a central lounge and meeting area on the entrance level, and a recreation area and laundry room on the floor below. Sixty-four percent of Donner was occupied by first-year students during the 1993-94 school year.

Hamerschlag House, a large Hill residence hall, houses 174 men and offers standard doubles with central baths. Hamerschlag (not to be confused with Hamerschlag Hall, an academic building) has two wings connected by a large central lounge. Hamerschlag also has a kitchen next to the lounge and a basement laundry room. Ninety-three percent of the students in Hamerschlag in 1993-94 were first-year students.

Morewood Gardens, the largest residence hall, is a six-story building that once was a gracious apartment complex for affluent Pittsburghers. Today, the four towers of the original building—A, B, C and D towers—house 476 students in a variety of prime single, double and triple rooms with private or semi-private baths. Two central lounges on each of the upper floors serve the residents as meeting, socializing and study spaces. The first floor includes a formal lounge, mail room, television room, reading room and computer cluster. Two laundry rooms are located in the basement area. A and B towers are coed by room. Thirty-one percent of the students in these two towers during the 1993-94 school year were first-year students. C and D towers are for women only. Forty-five percent of C and D towers were occupied by first-year female students in 1993-94.

Morewood E-Tower is a newer, separate residence hall connected to the original Morewood Gardens by a facility that includes a dining room and recreation room. E-Tower has standard double rooms with central baths and houses 220 students on its third through seventh floors. (One floor is for women only. Four floors are men's floors.) In 1993-94, 78 percent of the students in E-Tower were first-year students.

The entire Morewood Gardens area houses 732 students including 36 students who live in the E-Tower apartments located on the second floor of E-Tower. There are floor lounges and laundry rooms available throughout Morewood E-Tower. The Morewood complex is also the location of the Residence Life Office, the Housing Office, the Health Service and the Counseling and Student Development Center.

Mudge House is a mansion originally built by the Mudge family. After its donation to the university, the two upper floors were converted to student rooms and the handsome living, dining and parlor rooms on the first floor were converted to study lounge areas. Mudge House now has two additional residence hall wings that overlook the garden courtyard. Most Mudge residents live in prime doubles or singles in which two rooms share a semi-private bath and a common entrance off the main corridor. Laundry facilities in Mudge are in the basement of one of the towers. Mudge House is a coed residence hall that accommodates 306 students. In 1993-94, 45 percent of the residents were first-year students.

Scobell Hall is a four-story building that houses 96 students. Scobell is an all-male Hill residence hall that offers a mix of standard and prime (larger) singles and standard double rooms, all sharing central baths. There is a laundry room on the ground floor in Scobell and each floor has a study lounge. In 1993-94, 64 percent of the residents in Scobell were first-year male students.

Boss and McGill Halls are identical residence halls facing each other across a courtyard entrance. Each building houses 77 male students in standard or prime single, double and triple rooms with semi-private bathrooms. (Note that there are standard rooms in this complex even though bathrooms are semi-private. In this configuration, six students share bathrooms where a triple, double and single room are connected; this number exceeds the "five-or-fewer students sharing a bathroom" designation for a room to be prime.) The main lounges, which have a recreation area and a television room, are located on the

first floor of each building. Each floor also has a study lounge. A laundry room was added to Boss/McGill during the 1993-94 year. Thirty-two percent of Boss and McGill was occupied by first-year male students during 1993-94.

Doherty Apartments (which also have an academic building namesake, Doherty Hall) accommodate 155 students in two- and three-person apartment units. The building has a large basement laundry room, recreation room and television lounge. This year, 38 percent of the residents in Doherty were first-year students.

Primary Housing for Upper-class Students

Only a limited number of first-year students live in the residence halls and apartments listed in this section.

Oakland-Shadyside Housing The university offers a variety of student accommodations in apartment buildings in the nearby Oakland and Shadyside neighborhoods. Both areas are popular among the students of several local colleges. The university owns or, in most cases, rents apartments units in these buildings. Carnegie Mellon students living in these locations receive all the services of university-owned housing and at the same time experience living in an urban residential environment with easy access to a variety of neighborhood shops and public transportation, plus the choice of a convenient Carnegie Mellon shuttle bus trip or a 10-15 minute walk to classrooms or the library.

In Oakland, one block north of Carnegie Mellon's Mellon Institute, the **Shirley Apartments** house 41 students in 22 one-bedroom and efficiency units. Thirty-nine percent of the residents of Shirley during 1993-94 were first-year students.

About a block closer to campus, the university leases approximately 35 one-bedroom, two-occupant units in the large **Fairfax Apartment** building.

In the Shadyside neighborhood, the **Cathedral Mansions Apartments** will be home for the first time for university housing students (this building has been a popular choice for some time for students living on their own). Efficiencies for two occupants, one-bedroom units for two occupants and two-bedroom units for three-occupants are heavily selected by upper-class students.

Also in Shadyside, the university offers housing for 36 students in 18 efficiency units for two students each in the **Marybelle Apartments** at 618 Clyde Street, just one half block north of Fifth Avenue, very near the Mudge House. Twenty-five percent of Marybelle's residents were first-year students during 1993-94.

Henderson Hall, the smallest of the Hill area residence halls, is a two-story fieldstone building housing 40 students. Next to Henderson is **Welch Hall,** a three-story, tan brick building that houses 54 students. These coed buildings have prime double rooms connected by semi-private baths. The basements include recreation rooms, study areas and laundry facilities.

Resnik House and West Wing, our newest residence complex, houses 300 students in two wings. This building contains suites (with bedrooms, bathrooms and living rooms) for five to eight students, as well as a number of prime single and double rooms. This facility also contains a 400-seat dining hall, a mail room, a computer cluster, television room, recreation room, lounges on each floor and a large laundry facility.

Woodlawn Apartments house 30 students in three- or four-person units. The building also has a basement laundry room and a student-run art gallery with a separate entrance on Forbes Avenue.

Roselawn Terrace is a short private street with three groups of four-unit, two-story row houses. The 5-person houses have three bedrooms, a bath, living room, dining, room, kitchen and basement with laundry facilities.

Spirit and Tech Houses are larger houses operated as co-op facilities for up to 10 students each. In these arrangements, students provide for their own living needs as two small, independent residential communities. The university provides standard room, kitchen and living area furnishings and basic administrative assistance. The houses receive additional university services upon request.

The Margaret Morrison Apartments (also sharing its name with an academic building, Margaret Morrison Carnegie Hall), consist of 20 two-bedroom apartments for four students each and four townhouse apartments that have four bedrooms for eight students. These townhouses are available to students in special interest groups who submit written proposals explaining how their collegiate experience will be enhanced by these special living arrangements.

At the sidewalk level of the Margaret Morrison apartments is an area known as the Margaret Morrison Plaza, where all students have access to a women's center, a computer cluster, a laundromat with an on-campus dry-cleaning pick-up/delivery service and a convenience store featuring delicious deli sandwiches made to order.

Residence Life

The staff of the Residence Life Office focuses on a number of goals related to the quality of student life outside the classroom. They are:

- to foster a sense of community in the residence halls
- to promote the personal and academic success of residents
- to enhance the leadership development of residents

A professional staff of Coordinators of Residence Life lives in University housing and is available as advisors to students. They offer both guidance and referrals for students seeking help with academic, social or administrative questions.

Carnegie Mellon's housing program also provides a staff of student Community Advisors and Resident Assistants who organize a wide range of activities and provide assistance for residence hall students, under the supervision of their Coordinator. Student staff members are selected based on their exemplary academic, leadership and personal qualifications. Their job is to help other students benefit from their collegiate and resident experiences and to insure the orderly operation of each residence hall.

The director of residence life and the residence life staff work closely with the dean and professional staff of the Student Affairs Division, and with members of the Student Dormitory Council, elected representatives of residence hall students, in sponsoring various residence hall activities and programs.

Fraternities and Sororities

Many students choose to move to fraternity and sorority houses following their experience in the campus residence hall system. The organizations in the Greek system each set their own requirements for members to live in the houses. The Coordinator of Residence Life for Greek Affairs and the Fraternity Maintenance Supervisor, a Housing Office staff member, work with members of the Greek community on a wide range of quality of life issues.

Other Living Arrangements

Most first-time college students who are not living at home live in university housing. First-time freshmen who wish to live in a residence other than that of their parents or within the university housing system must request permission from the dean of student affairs.

Students who receive this permission, students who move into a fraternity or sorority house and students who leave housing (except to participate in an academic program away from the Pittsburgh area) should know that their opportunities to move back to Carnegie Mellon housing may be very limited at the start of the next fall semester. Students who wish to return to Carnegie Mellon housing join a waiting list for spaces remaining after all returning residents and incoming freshmen and transfer students have been housed.

Community Housing

The Housing Office in Morewood Gardens provides an off-campus housing advisory service. The Community Housing Coordinator maintains up-to-date information on available apartments, houses and rooms in private homes for rent and on students who are looking for roommates.

Housing Reservations

Application Procedures:

Returning Students who plan to live in university housing during the next academic year must pay a $100 deposit during February of the current academic year in order to participate in the room reservation process. Room reservations proceed in two phases: First, students draw numbers to determine, within their academic class, their order of room selection, and based on that numerical rank, may decide either to retain their current rooms or to participate in the selection of another room. Second, students who decide to participate in room selection rather than retaining their current rooms, choose from among the available rooms in order by the numbers they drew, beginning with the next year's seniors, then juniors, then sophomores.

At the end of this process, every returning student who participated has signed an Agreement to live in housing for the next academic year. Returning students who change their minds before May 15 may release their housing reservations and receive refunds of their $100 deposits.

By June 15, returning students who still plan to live in university housing in the coming academic year must pay a second $100 deposit. At that time, the total deposit of $200 becomes non-refundable.

Entering Students who plan to live in university housing in their first academic year at Carnegie Mellon must send a $400 admissions deposit to the Office of Admission, postmarked on or before the first business day in May of that year. (Please consult the Office of Admission about deposits for students who do not plan to live in university housing.) The $200 housing portion of the deposit is refundable (as a credit on the student's account with the university) only if the Housing Office is unable to offer an accommodation to an entering student.

At the beginning of May, entering students whose $400 deposit has been received by the university will receive a mailing from the Housing Office containing Housing Application information. The procedures and information needed to complete these forms, and the address and date for returning these materials, will be enclosed with the mailing.

The Housing Office uses the application form to collect information not available elsewhere that is used for room and roommate assignments. In addition, because we believe the living experience in the first year away at college is important to a student's academic career, we also ask entering first year students to complete a profile questionnaire for use by the Housing Office in a matching approach that Carnegie Mellon and other universities have used in the roommate assignment process.

Entering undergraduates (i.e., first-time freshmen and transfer students) who apply for housing are required to register for a dining service contract. Returning students and graduate students may find it convenient to hold dining service contract meal plans, but may choose not to. The dining service staff uses the registration forms to plan the locations and staffing of the contract meal program for the next academic year. The dining service section of the catalog gives further information about contract meal plans.

Assignment Procedures:

Undergraduates: After returning students reserve their rooms, remaining accommodations are then assigned to entering first year and transfer students. (A transfer student is one who has previously matriculated at another school as a first-time freshman even if he or she now will be a freshman for the first time at Carnegie Mellon.) Most freshmen are assigned to rooms with their classmates, but it is possible for freshmen to share rooms with upper-class students. Transfer students will be considered for housing in the same assignment process with first-time freshmen.

Requests from entering students for specific types of rooms, if available, are honored according to the date in the acknowledgment letter for the $400 admission deposit. If the requested accommodations are not available, entering undergraduates are assigned to alternate spaces. Standard doubles and triples are most likely to be available, along with some apartment spaces. Further, if two students request each other as roommates, their request usually will be honored. Finally, as previously stated, in a building that is co-educational, rooms that share a bath may be reserved only by, or assigned only to, students of the same gender.

Graduate Students: Accommodations in the university housing system are not available to graduate students. The Community Housing Service in the Housing Office is available to assist graduate students who seek accommodations in the local area.

Housing Terms and Conditions

Housing License Agreement: Once the Housing Office makes a student's room assignment, it confirms the offer by preparing and signing a standard Housing License Agreement, and forwarding it for signature by the student or guardian. The document has the student's name, the housing assignment (by room number and building), the telephone and mail box numbers, the dates of occupancy for the room, and the room rate and payment terms of the Agreement. Also it states the terms and conditions of occupancy by which the student and the university intend to be legally bound. The university advises the student and parents or guardian to read the Agreement carefully before signing and returning it to the Housing Office. THE HOUSING LICENSE AGREEMENT IS FOR TWO FULL TERMS, BEGINNING WITH THE FALL SEMESTER.

Housing Charges: The housing room charge is billed in two separate amounts. After crediting $200 as the housing deposit toward these charges, the university bills students for the balance of their academic year housing charges in two separate, equal amounts on their invoices for the fall and spring semesters.

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 that Agreement 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 on the leases negotiated through June of 1995).

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, administered by the Cashier's Office. Refund amounts are based on the number of full weeks remaining after the student completes the entire withdrawal procedure, which includes both filling out the Withdrawal from Housing form and returning the room key to the Housing Office.

Other Housing Services and Policies

Computing Services: The university has installed voice and data communications wiring in each building for each student in university housing. This wiring system provides for the use of computers in student rooms on a network that connects with computers in other rooms on campus, and with the university's central computers. This wiring also has the ability to handle telephone service for the entire university, including student housing. Beginning in the 1994-95 academic year, all Carnegie Mellon-owned residences will be serviced by 10Base-T Type Ethernet.

In addition to a number of public computer clusters in the academic buildings, Computing Services provides personal computer workstation clusters for student use in the residence halls. These clusters are located in Morewood Gardens, the Margaret Morrison plaza and in the West Wing.

Cooking: Cooking is permitted in the residence halls only in areas specifically equipped by the university for that purpose. An exception to this policy is that the use of microwave ovens ("compact" units or those under 600 watts) is permitted in residence hall rooms.

Guests: The Housing License Agreement provides accommodations only for the student. Guests are permitted only under regulations promulgated by the Housing Office to protect the interests of each occupant of a residence hall room, apartment or house.

Mail Service: The Post Office, located in the Student Center, provides a full range of U.S. postal services, including stamp sales, parcel post, Post Office box rentals, and regularly scheduled mail pick-ups. United Parcel Post Service is available at this location.

Students in university housing receive mail addressed to them on campus through mailboxes at distribution points located Donner, Morewood Gardens, Mudge House and Resnik House. A mailbox is assigned to each resident and in a few cases is shared with other students in the room. A student's Housing License Agreement shows the resident's assigned mailing address on campus.

Maintenance Service: The residence halls receive custodial, grounds, repair, and maintenance services from the university's Facilities Management Services (FMS). The Housing Office coordinates student requests for routine maintenance with FMS through the Housing Office, located on the first floor in Morewood Gardens E-Tower. Emergency maintenance services are available to housing residents twenty-four hours a day.

Personal Property: Students are responsible for their personal property as well as for the property of groups to which they belong. If insurance is desired against loss, theft or damage occurring to such property in the residence halls or elsewhere on campus, coverage must be arranged by students or their parents through an insurance agent or company.

Pets: No pets of any kind are permitted in the residence halls.

Telephones: A university-owned telephone is provided in each living unit. For its telephone system in the residence halls, the university has

an agreement with one of the long distance telephone companies for service to resident students. (Long distance services are available from other companies by dialing the local numbers and codes that connect subscribers to those services.) The Carnegie Mellon service provides a way for each resident to receive their own individual bill for long distance calls.

In its provisions for student telephone service, the university has included an arrangement for a maximum number of local calls (approximately 50), before the local telephone company charges for those calls. Another feature of the student telephone system is that there is no charge at all for calls from a student room phone to any other phone in the university telephone system.

All the occupants of a residence hall room, apartment or house are responsible for paying bills from the telephone or long distance service company for message unit and long distance calls made from or charged to the telephone in that unit. The cost of telephone equipment, dial tone access, and the allowance for local area calls for each unit, is included in the housing room charge.

Additional Policies: Information on additional university and housing policies is found in the Student Handbook and Residence Halls Handbook.

Security

Director: James J. LaPaglia
Office: Student Center Room 100

The Department of Security consists of 21 Sworn Police Officers, 25 Security Guards, two Traffic Monitors and five Communications Dispatchers. Security 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 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 Security are located both inside and outside of buildings at 34 locations around the campus.

The Office of Safety and Security is prepared to assist students who have suffered theft of personal property in the following ways: If there is a reason to believe that the theft has occurred within the campus community, it will undertake a thorough investigation to recover stolen property. It will also assist students in reporting the theft to the Pittsburgh Police to insure that every effort is made by civil authorities to recover the property.

Safety and Security undertakes a program of registration of articles of high value, including such things as computers, bicycles, stereos sets, and camera equipment, to assist in recovery of articles.

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 the students or their parents through an insurance agent.

Student Services

Department of Athletics and Physical Education

Dr. John H. Harvey, Director
Office: 204 Gymnasium

Carnegie Mellon strives for 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 endeavors after graduation also benefit from university experiences as a student-athlete.

Carnegie Mellon sports teams have competed intercollegiately since the early 1900s, and in the past 14 years the program has experienced an explosion of success. The Tartans have won 62 conference championships and competed in over 66 national championships since 1976. This success was achieved while operating within the academic constraints of the university and within the rules of amateurism.

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 22 sports including 12 for men and 10 for women. UAA members include Brandeis University, Case Western Reserve University, Carnegie Mellon University, Emory University, Johns Hopkins University, New York University, the University of Chicago, the University of Rochester and Washington University in St. Louis.

Carnegie Mellon, like the other eight UAA members, is a member of the the National Collegiate Athletic Association (NCAA). Its intercollegiate teams compete on the Division III level, which prohibits athletic scholarships and operates under the true meaning of amateurism. Student-athletes who play at the varsity level are students first and athletes second. All students, both athletes and non-athletes, are treated equally with regard to admission and financial aid policies. Carnegie Mellon fully supports a policy of equity in resources and opportunities for women and men .

The university fields competitive teams in 17 sports. The Tartans compete in football, men's and women's soccer, men's and women's cross-country, men's and women's tennis, women's volleyball, men's and women's basketball, men's and women's swimming, men's and women's indoor and outdoor track and field, and golf.

Carnegie Mellon's intercollegiate program has consistently produced winners. The Tartans' football team has won ten conference championships 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 has won 12 straight conference championships, and holds the NCAA Division III record with 109 consecutive dual meet victories. The women's basketball team, which has won two conference crowns recently, set a school record with 21 victories and advanced to the national tournament during the 1990-91 campaign.

To provide excellence in the athletic program the department employs full-time coaches. 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 possessing athletic skills in any of the above mentioned sports are welcome to become members of the team. Participation is open to all students. Inquiries should be directed to the:

Department of Athletics, Gymnasium Building
Carnegie Mellon University
Pittsburgh, PA 15213
(412) 268-2211

Intramurals

Earl J. Birdy Jr., 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 4,200 students. Men and women, both graduate and undergraduate, compete in one or more of over 40 indoor and outdoor sports, ranging from touch football and basketball to table tennis, water polo, and ultimate frisbee.

The Intramural Department is under faculty direction, but four student-run organizations (the Intramural Board, the Managers' Club, the Womens' 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 other 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	Winter	Spring
Touch Football	Basketball	Co-Rec Table Tennis
Tennis	Faculty/Grad. Volleyball	Table Tennis-Singles
Golf	Floor Hockey	Table Tennis-Doubles
Co-Rec Volleyball	Pinochle	Team Call Pool
Cross-Country	Handball	Individual Call Pool
Water Polo	Wrestling	Swimming
Chess	Water Basketball	Weight Lifting
Soccer	Co-Rec Badminton	Indoor Soccer
Volleyball	Team Badminton	Softball
Bowling	3-on-3 Basketball	Fencing
Racquetball	Foul Shooting	Frisbee Golf
Team Table Tennis	3-Point Shoot Out	Ultimate Frisbee
Darts		Track & Field
3-Person Volleyball		Triathlon
Backgammon		
Bridge		

Fitness and Health

Donna Morosky, Director
Office: 200 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 '90s and beyond.

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. For more information contact the university's Fitness and Health Director, Donna Morosky at (412) 268-8140.

Recreation

Dr. John H. Harvey, 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 recently completed East Campus Project has provided a new football, soccer, and intramural field, as well as a new outdoor track. These facilities are lighted for night play.

The Gymnasium, which has facilities for basketball, volleyball, badminton, racquetball, weight lifting and aerobicycling, is open Monday through Friday, as well as weekends. The swimming pool, located in the Gymnasium, is available to any student, faculty or staff person with a valid Carnegie Mellon ID. For pool and Gymnasium hours, please contact the Athletic Office at (412) 268-2211.

New tennis courts, located between Skibo Hall 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. John H. Harvey, Head
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 approximately 25 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.

Faculty

DR. JOHN H. HARVEY, Director of Athletics and Physical Education — Ph.D. Boston College; Carnegie Mellon, 1989—.

EARL J. BIRDY JR., Director of Intramurals/Senior Physical Education Instructor — M.Ed., University of Pittsburgh; Carnegie Mellon, 1951—.

TERRY BODNAR, Assistant Football Coach/Instructor — M.S., Indiana University of Pa.; Carnegie Mellon, 1985—.

JIM CUTRONE, Head Men's and Women's Swimming Coach/Instructor /Aquatics Director— M. PH. Emory University; Carnegie Mellon, 1991—.

DARIO DONATELLI, Head Women's Cross-Country and Track Coach/Instructor — B.S., Carnegie Mellon University; Carnegie Mellon 1987—.

RICHARD ERDELYI, Assistant Football Coach and Head Golf Coach/Instructor — B.A., University of Pittsburgh; Carnegie Mellon; 1986—.

NICK GAUDIOSO, Head Soccer Coach/Instructor — B.S., University of Maine; Carnegie Mellon, 1981—

KEITH GORSE, Athletic Trainer/Instructor — B.S., University of Pittsburgh; M.Ed., University of Pittsburgh; Carnegie Mellon, 1986—.

HEATHER HOLLANDS, Head Volleyball Coach/Instructor - B.S., University of Pittsburgh; M.A.T., University of Pittsburgh, Carnegie Mellon 1993-.

RICHARD LACKNER, Head Football Coach /Instructor — B.A., Carnegie Mellon University; Carnegie Mellon, 1979—

JOAN MASER, Associate Athletic Director/Instructor — M.S., University of Pittsburgh, Carnegie Mellon, 1981—.

MIKE MASTROIANNI, Assistant Director of Intramurals and Club Sports Coordinator/Instructor — M.S., Slippery Rock University of Pa.; Carnegie Mellon 1986—.

GARY L. MECKLEY, Head Men's Cross-Country and Track Coach/Instructor — M.Ed., University of Pittsburgh; Carnegie Mellon, 1966—.

DONNA MOROSKY, Director of Fitness and Health/Instructor — M.Ed., University of Pittsburgh; Carnegie Mellon, 1975—

PETER MOSS, Head Men's and Women's Tennis Coach/Instructor - B.S., Allegheny College; Carnegie Mellon, 1990-.

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

JULIE SHACKFORD, Department Assistant/Instructor /Head Women's Soccer Coach— B.A., College of William and Mary, Carnegie Mellon, 1990—.

TONY WINGEN, Head Men's Basketball Coach/Instructor — M.S., Springfield College; Carnegie Mellon, 1990—

Division of Student Affairs

Dean of Student Affairs: Michael C. Murphy
Office: Warner Hall third floor

The Division of Student Affairs encompasses the following offices:

- Career Center
- Counseling & Student Development Center
- Housing Office
- Residence Life Office
- Student Activities
- Student Health Services
- Office of International Education
- Office of Student Affairs

The staff of the Division of Student Affairs stands ready to help undergraduate and graduate students. The staff is concerned with students and their studies, social growth, well-being and future. Students with concerns, suggestions or problems, or who are simply looking for someone to talk to can always turn to Student Affairs for assistance.

The Office of Student Affairs helps to orchestrate a number of specific programs and services, including liaison with academic units, personal development programs, class activities, community service outreach, leadership development, outreach to parents, peer tutoring and academic support and emergency student loans.

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

The ability of an academic community to serve its many constituents and to provide vital learning in a period of rapid change requires constant planning and reevaluation. Students participate in the process at every level. Student Senate provides both legislative self-government and counsel to the Division of Student Affairs and to the President. Students serve on the councils of Faculty Senate and participate with them in planning and analysis of university operation. Students regularly serve with trustee committees and as members of all other special university committees convened to deal with particular problems.

Career Center

Office: Warner Hall 19-C

The thoughtful selection of a satisfying career path and the subsequent preparation needed to attain this goal is a prime concern to 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 placement 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 this office includes workshops and seminars designed to equip students with important career exploration and career decision making skills, regular advisor-advisee contacts and the availability of state of the art interactive computer based career interest inventory and other professionally administered techniques to aid in this process.

To complement these, workshops focusing upon practical job hunting skills including interviewing, resume preparation, strategies and related topics are offered to enable students to compete effectively in the job market. A very important resource available in the Career Center is the career library collection which features an extensive assortment of career planning and career choice selections, occupational monographs, job hunting releases, business and professional directories, graduate study directories and employer information, recruiting brochures and video tapes featuring most of 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 or parttime internships or that first job after graduation.

Because the name of Carnegie Mellon has come to be regarded as synomous 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, nearly 1300 employers sought to hire these students and 220 firms sent representatives to the campus during that time to meet with interested job candidates. Nearly 4500 interviews were conducted on these occasions. Average starting salaries offered Carnegie Mellon graduates in most fields consistently rank above national norms.

Carnegie Mellon Interfaith Council

Contact: Fr. Bryan Summers, (412) 681-3181

The Carnegie Mellon Interfaith Council is composed of representatives of the Jewish, Catholic, Orthodox, Episcopal and Protestant faiths, and representatives of the Church of Jesus Christ of Latter Day Saints, the Islamic Center of Pittsburgh and the Church of Reconciliation. The Interfaith Council believes that ministry to higher education is unique in many ways from ministry to local parishes because of the spirit of free inquiry essential to the learning community. Thus, one of the major goals of campus ministry is to enable students to reconcile faith with knowledge and to realize personal wholeness and integrity of life. In addition, this affiliation with the university enables the synagogue and church to be present on campus, not as a building but as a living body of believers. Religious services and programs are frequently conducted on campus, thus making it convenient for students. These programs include worship, Shabbat, Mass, fellowship, Bible class, retreats, outreach programs, personal counseling and others.

In order that students maintain their religious ties and receive additional information about the campus ministry, entering freshmen are given an opportunity to identify their religious affiliation. This information is directed immediately to the Interfaith Council. The goal is to assist students as they come into a new and unfamiliar environment and to help them in enhancing the quality of their lives.

Brochures about the Interfaith Council are available at the Student Center Information Desk, the Admission Office, the Counseling Center or by contacting one of the Council's officers.

Information concerning other religious communities that are not members of the Interfaith Council but are present on the Carnegie Mellon campus or in the Greater Pittsburgh area is available from Bryan Summers at (412) 681-3181.

Counseling and Student Development Center

Sandra Kryder, Director
Office: Morewood Gardens E-Tower

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 personal therapy and periodic group workshops.

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 Student Development Center office is open weekdays, and there is a professional on call for emergencies during evenings and on weekends.

Discipline

The university is committed to a strong community supported by the adherence to a set of standards of mutual respect for all individuals. The disciplinary process includes university students, faculty and staff, and is administered by the Student Affairs office. The university reserves the right to dismiss students for serious infractions of regulations, improper behavior or unsatisfactory academic standing. Dismissal for disciplinary reasons does not take place without a hearing designed to ensure the right of the student to due process. In case of dismissal, fees and dormitory charges will not be refunded in whole or in part. All disciplinary procedures are outlined in the Student Handbook.

Freshman Orientation

Contact: Kimberly DiDonato, Coordinator of Residence Life for First Year Programs

The Division of Student Affairs is responsible for the planning of programs to assist students in making the transition from secondary school to the university. Orientation, which occurs immediately before the fall enrollment, is required of all new students (first year students and transfer students), and is sponsored through the Residence Life Office. This time is designed to help entering freshmen get to know the services and programs provided for them as well as to offer an opportunity for them to become acquainted with their peers and get a sense of the campus community before classes begin.

Office of International Education

Foreign Scholar Advisor: Judith M. Udavcak
Foreign Student Advisor: Linda Melville
Study Abroad Advisor: Eva Mergner, Interim Advisor
Office: Warner Hall 219

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 Scholars

OIE advises departments on immigration matters and preparation of visa documents for visiting professors and researchers who come to Carnegie Mellon from abroad. The foreign scholar advisor meets with all visitors upon arrival to check their immigration documents, provide orientation data, and answer any questions they may have relating to immigration matters and adjustment to life in the Pittsburgh area and more specifically, at Carnegie Mellon. OIE advises and assists departments in making certain that all visitors maintain a valid immigration status while they are at Carnegie Mellon.

Service to Foreign Students

OIE coordinates two orientation programs each August which are designed to help all international students who come to Carnegie Mellon. There is a week-long program for international graduate students and a day-long program for international undergraduates. During the orientation, OIE introduces students to university life, public transportation, campus security, health care, health insurance, social security, cultural adjustment, etc. Assistance with finding housing is also provided to graduate students. Special support is offered to spouses and partners of foreign students by the International Spouses and Partners Organization. During orientation and all through the year, the foreign student advisor serves as a liaison to the university for foreign students and advises them on person, immigration, academic, and social issues. Seminars on career opportunities, income tax preparation, and other matters are held at appropriate times. The foreign student advisor also serves as an advisor to the International Student Organization.

Student Activities

Student Center

Anne Witchner, Assistant Dean of Student Affairs and Director of Student Activities
Office: Student Center 211

The Division of Student Affairs centers its support of campus activities through the office of Student Activities in the Student 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 helps with many aspects of student organizations, runs the campus-wide Information Desk and oversees the Student Center, the student activities center on campus. Student Activities is committed to assisting student-run organizations on campus and provides leadership training seminars and workshops for student groups. Over 200 student organizations exist at Carnegie Mellon and more are created each semester.

The student activities fee, administered by the Student Senate, 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

coffeehouses 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.

Most importantly, however, 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.

Through the office of Student Activities and the office of Student Affairs, the division also tries to ensure that students have an opportunity to broaden their social, occupational, spiritual, sexual, physical, intellectual, cultural, and emotional understanding by means of an extensive series of programs designed to complement curricular learning opportunities.

Student Guidebook

The Student Guidebook includes the Word, the Student Handbook, the Residence Hall Handbook and the Freshman Pic Book. The Student Guidebook is published each year by the Division of Student Affairs. The Student Handbook includes a statement of general university policies, general university regulations affecting student and community life and updated academic regulations. It also contains a complete description of the disciplinary policies followed by the university. The Word offers advice and information about all aspects of student life. The Word and Student Handbook are sent to entering students during the summer; the Pic book is distributed during freshman orientation.

Student Health Service

Anita Barkin, Director Health Center
Morewood Gardens E101

The Health Service provides the same level of service available at a family doctor's office. Services include: general medicine, gynecological care and contraception, allergy injections, first aid and on-site pharmaceuticals.

Appointments to see the physician, nurse practitioners and register nurses can be scheduled by calling the office Monday through Friday during normal operating hours. Walk-in emergency appointments are also provided. All examinations 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.

Entering students are asked to submit the health history form found in the admissions packet. Immunization information must be completed on the back of the form. Proof of two vaccinations against measles or proof of having had the disease is required.

If a student has a medical emergency when the office is closed, he/she should call CAMPUS SECURITY at x8-2323 for transport to Presbyterian University Hospital Emergency Room.

Health Insurance

The university offers three health insurance plans through Blue Cross/Blue Shield of Western Pennsylvania for students who are not covered by their parent's policy. The three plans, designed with the help of students, provide catastrophic, moderate, and high levels of coverage depending on the plan chosen. All students, whether on one of these plans or not, need to inform the Health Service of their insurance coverage. Students can enroll for insurance coverage and payroll deduction at the Health Services Office.

Reserve Officers' Training Corps (ROTC)

Department of Aerospace Studies (Air Force ROTC)

The Air Force Reserve Officer Training Corps (AFROTC) is open to all Carnegie Mellon students. A student may take courses for information purposes/academic credit or, if eligible, to obtain a commission as an officer in the United States Air Force. There is both a four-year program and a two-year program.

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 begins by attending a six-week summer training program prior to 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 one hour 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 all costs of tuition, incidentals and lab fees, books, plus pay each recipient $100 per month.

General Military Course (GMC)

The subject matter for the freshman and sophomore years is developed from an historical perspective and focuses on the scope, structure, and history of military power with emphasis on the development of air power. The freshman courses explore the role of U.S. military forces, and the Air Force in particular, through a study of the total force structure, strategic offensive and defensive forces, general purpose forces, and support forces. The sophomore courses include an introduction to the history of air power with emphasis on the development of concepts and doctrine governing the employment of U.S. air power.

Professional Officer Course (POC)

The Professional Officer Course, taken during the cadet's junior and senior years, concentrates on three main themes: the concepts and practices of management, leadership, and national defense policy. During the first term of the junior year the course concentrates on a study of the management functions: planning, organizing, coordinating, directing and controlling. Basic and advanced management techniques, as found in the military and industrial environment, are explored. The second term deals with the application of general concepts of leadership to Air Force situations. As a basic study of human behavior, human relationships, and professional ethics, the course emphasizes the similarities between the problems encountered in the military and civilian environment. The first term of the senior course concentrates on selected elements of the U.S. government and national security process engaged in producing national strategy as well as various elements of U.S. military forces, doctrine, and employment capabilities. During the second term, the course concentrates on the strategic options available to the U.S. and on the manner in which policy choices are made. The course also includes a review of the military justice system. For details about the two programs as well as information on the courses, scholarships and flying programs, interested students are encouraged to contact the Air Force ROTC detachment in Room A200 of Hamburg Hall, (412) 268-8747, or write to the Professor of Aerospace Studies, Air Force ROTC, Carnegie-Mellon University, Pittsburgh, PA 15213.

Faculty

RICHARD N. COMPTON, Professor of Aerospace Studies - MS, University of Arkansas, Carnegie Mellon 1992-

TIMOTHY E. FISK, Assistant Professor of Aerospace Studies - MS, Air Force Institute of Technology, Carnegie Mellon, 1992-.

JEFFREY E. THIERET, Assistant Professor of Aerospace Studies - MPA, Golden Gate University, MA Natl Security & Strategic Studies, USNaval War College, Carnegie Mellon, 1992-.

GARY M. WOLBERT, Assistant Professor of Aerospace Studies - MPA, Golden Gate University, Carnegie Mellon 1992-

Department of Military Science (Army ROTC)

Clint Long, Lieutenant Colonel, U. S. Army
Office: Cathedral of Learning, 29th Floor, University of Pittsburgh

The study of military sciences at Carnegie Mellon University dates back to 1918. Since then more than 2,000 students at the university have been commissioned as officers in the Armed Forces through the university's Reserve Officers Training Corps (ROTC), and at least 30 Carnegie Mellon graduates have attained General Officer rank in the Armed Forces. The university is one of over 700 extension centers offering a military science program to undergraduate students to qualify them as reserve or regular officers in the United States Army.

The ROTC program is a cooperative effort mutually and contractually agreed to by the Department of the Army and the university as a means of producing well-educated young men and women with leadership potential for service as officers in the Active Army, Army Reserves, or Army National Guard. The department is under the supervision of an Active Army officer who is detailed as Professor of Military Science and is assisted by a staff of commissioned and non-commissioned officers and civilian assistants from the Department of the Army.

The Curriculum

The complete instructional program for Army ROTC consists of three parts: the academic major in a recognized degree field, university courses of particular interest and value to the military science, and courses in military science. Only full-time students may enroll. It is a goal of Army ROTC to provide the nation with officers who have succeeded in the college world, since such people also offer the greatest potential for success as Army leaders and managers. The ROTC program is designed to complement the student's civilian goal of acquiring a baccalaureate or graduate degree in a course of study of his or her choosing. The curriculum does not provide technical training in a job specialty, nor does it emphasize vocational training; rather, it provides a broad military education emphasizing basic military skills and leadership development.

The military science curriculum consists of a four-year program and a two-year program.

The Four-Year Program

Army ROTC at the university is primarily a four-year program, divided into two phases - a freshman/sophomore phase (basic course), and a junior/senior phase (advanced course).

Freshman/Sophomore Phase

The Army ROTC basic course is available for all qualified students during their freshman and sophomore years. Membership in Army ROTC is voluntary throughout this period with right of withdrawal available at any time (except sophomore scholarship students). One course taught by the Military Science Department and a Leadership Laboratory comprise the curriculum each semester, requiring about four hours per week. The basic ROTC courses are shown below in sequence. Students may enter the program at the beginning of any semester during freshman and sophomore years. Leadershiip Laboratory is available only to ROTC Cadets.

Freshman Year

MS I 30-101 Self Development and Military Skills I - Fall Semester
MS I 30-102 Self Development and Military Skills II - Spring Semester
All - Leadership Lab/Seminar - Both Semesters
(Freshmen courses are taught at the University of Pittsburgh)

Sophomore Year

MS 30-201 - Challenges in Modern Leadership I - Fall Semester
MS 30-202 - Challenges in Modern Leadership II - Spring Semester
All - Leadership Lab/Seminar - Both Semesters

Successful completion of these courses and attainment of Army physical standards enable students to enter the junior/senior phase.

Junior/Senior Phase

The junior/senior phase of ROTC covers the student's final two years at the university and is offered only to students contracted to the Army. It includes a six-week Advanced Camp that is held during the summer between the junior and senior years. While attending Advanced Camp, students are paid approximately $600 and travel expenses to and from camp. Uniforms, quarters, medical care, and meals are furnished by the United States Army during the camp period. While enrolled in the junior/senior phase, the student will receive a $100 per month allowance for up to the number of the months the school is in session.

Junior Year

30-301 - Tactics and Strategies I - Fall Semester
30-302 - Tactics and Strategies II - Spring Semesters
Leadership Lab/Seminar - Both Semesters
Advanced Camp - Summer

Senior Year

30-401 - Transition to Professional Leadership I - Fall Semester
30-402 - Transition to Professional Leadership II - Spring Semester
Leadership Lab/Seminar - Both Semesters

Two-Year Program

The two-year program consists of the junior/senior phase offered in conjunction with Basic Camp.

The Basic Camp consists of six weeks of training conducted during the summer at Fort Knox, Ky. It is designed for transfer students, graduate students, or other non-ROTC students with at least two years of full-time education remaining prior to graduation. While attending Basic Camp, students are paid approximately $670. Travel expenses to and from camp, uniforms, quarters, rations and medical care are furnished by the United States Army during the camp period. The Basic Camp is normally scheduled after a student's sophomore year or during the summer preceding the student's four remaining semesters at the university. There is no commitment by attending Basic Camp.

Prior to commissioning as an officer in the Armed Forces, three professional military education courses are required in the following areas: written communication skills, human behavior, and military history.

Courses already in the college's curriculum have been identified to meet these requirements.

Other recommended professional military education courses are in the areas of management and national security studies.

Financial Assistance Program

The Army offers a scholarship program designed to provide financial assistance to outstanding men and women. Each scholarship provides for 80% or $8000 whichever is higher for tuition and a $450 allowance for books and supplies, in addition to $100 per month for the number of months the school is in session. These benefits are for the duration of the scholarship. Scholarships may be awarded for periods of two and three years. Four-year scholarships, by discipline, are awarded to selected high school applicants who plan to attend a university offering Army ROTC. Applicants must apply during their senior year in high school, no later than December 1st each year.

Two-year and three-year scholarships are awarded to either enrolled or non-enrolled freshmen and sophomores who meet the qualifications for entry into the advanced course of ROTC.

A special Reserve Component Service Scholarship is available for students more interested in Army Reserve or Army National Guard service. This scholarship guarantees service in the reserve forces.

Active Duty and Reserve Obligations

Recipients of Army ROTC scholarships agree to serve on active duty as commissioned officers for two to four years followed by the remainder of the eight year commitment in reserve forces duty or eight years of reserve forces duty which includes a three to six month period of active duty for initial training in your branch specialty.

Students commissioned through the Army ROTC program request the branch which best suits their career goals. Active duty students will enter the service within a year after graduation or may request an educational delay for graduate or professional schooling. Reserve Forces officers may begin serving in their unit immediately upon commissioning.

Cadet Organization

The Panther Battalion is the student organization within the Military Science Department at both Carnegie Mellon and the University of Pittsburgh which exists to complement the overall ROTC class curriculum. Most Leadership Laboratory classes, as well as numerous additional activities such as enrichment seminars, social events, intramural sports, and civic service projects are student organized and executed. The cadet organization allows students to meet challenges, earn cadet rank and excel in leadership experience.

Voluntary Extracurricular Activities

The following activities are available to university students:

Ranger Unit - An elite Ranger-type unit which exists to complement classroom theory with challenging field application. The training is physically and mentally rigorous and includes mountaineering, patrolling, individual military skills, land navigation and compass techniques in difficult terrain.

Social Functions - Departmental formal social and informal functions are held throughout the school year and include such functions as the Military Ball and the Dining-In.

Faculty

CLINT LONG, Lieutenant Colonel, Professor of Military Science - M.S., Pittsburg State University; Carnegie Mellon, 1994-.

BEVERLY ERTMAN, Major, Assistant Professor of Military Science - M.Ed., Edinboro University, M.Ed., Slippery Rock University, Carnegie Mellon, 1990-.

Department of Naval Science (Navy ROTC)

Director: Captain Joseph D. Mazza, USN
Office: A-217, Lester A. Hamburg Hall, (412) 268-5109

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 to the weekly drill class. NROTC students are active in all facets of university life; many are in positions of leadership in student government, on varsity and intramural sports teams, in campus clubs, and other student organizations. The NROTC program seeks students who are bright, ambitious, enthusiastic leaders whose lives are enriched by their education at Carnegie Mellon and by their involvement in NROTC.

Four-Year Scholarship Program

The four-year scholarship program provides full tuition, fees, textbooks, uniforms, and a $100 per month tax-free subsistence allowance to students selected through nationwide competition. Midshipmen must complete the university approved curriculum of their choice, including courses in calculus and calculus-based physics, 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. A limited number of full scholarships may be awarded by the NROTC unit on campus. 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.

Three-Year Scholarships

Three-year scholarships are available on a competitive basis to those qualifying college program (non-scholarship) students who have demonstrated leadership and academic excellence during their freshman year and are nominated for the scholarship by the Professor of Naval Science. Active duty obligation is four-years upon commissioning.

Two-Year Scholarship Program

The two-year scholarship program provides the same benefits as the four-year program for a period of 20 months. The program is available to students who have completed their sophomore year of undergraduate study. 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.

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 $100 per month. A paid summer training period is provided between the junior and senior year. College program students may also compete for a limited number of merit scholarships.

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 two-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

ROBERT O. FRASCA, Assistant Professor of Naval Science — B.S., Rochester Institute of Technology; Carnegie Mellon, 1992—.

DOUGLAS J. KUSH, Assistant Professor of Naval Science — B.A., Kenyon College; Carnegie Mellon, 1993—.

SCOTT W. MALLOY, Assistant Professor of Naval Science — B.S., U. S. Naval Academy; Carnegie Mellon, 1992—.

JOSEPH D. MAZZA, Professor of Naval Science — M.S., U.S. Naval Postgraduate School; M.A., Naval War College; Carnegie Mellon, 1991—.

DONALD E. ROCKWELL III, Associate Professor of Naval Science — M.S., George Washington University, Carnegie Mellon, 1992—.

MICHAEL M. WEBER, Assistant Professor of Naval Science — B.S., Florida Institute of Technology; Carnegie Mellon, 1991—.

Naval Professional Academic Courses (Naval Science Courses)

Course #	Title	Year Taken	Required of	Units
32-101	Introduction to Naval Science	Freshman	All	6
32-102	Naval Ships Systems I (Engineering)	Junior	Navy Option	9
32-201	Naval Ships Systems II (Weapons)	Senior	Navy Option	9
79-275	History of Modern Warfare	Freshman	All	6
32-301	Navigation	Sophomore	All	9
32-302	Naval Operations	Junior	Navy Option	9
32-310	Evolution of Warfare	Junior	Marine Option	9
32-401	Naval Resource Management I	Sophomore	All	6
32-402	Naval Resource Management II	Senior	Navy Option	6
32-410	Amphibious Warfare	Senior	Marine Option	9
32-100-400	Naval Laboratory	All	All Entrants	3

Undergraduate Options

Undergraduate Options

Bachelor of Humanities and Arts Degree

The Bachelor of Humanities and Arts (BHA) degree is a unique interdisciplinary program that combines depth of training in the fine arts with a liberal/professional education in the humanities, behavioral and social sciences. The BHA program is offered jointly by the College of Fine Arts and the College of Humanities and Social Sciences. The program is very flexible, with many combinations of concentrations to provide an individualized curriculum. In addition to a general education requirement (72 units), students take a minimum of 108 units from the College of Fine Arts and 54 units from the College of Humanities and Social Sciences. See page 74 for more details.

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 Department of Electrical and Computer Engineering's five-year Integrated Master's/Bachelor's program offers students superior technical preparation for careers in industry. Also, 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 may lead to a Master of Science degree.

College of Humanities and Social Sciences

The Department of Philosophy offers two bachelor's/master's degree options: the Bachelor's/Master's degree in Computational Linguistics, and the Bachelor's/Master's degree in Logic and Computation.

2-3 Masters Program in Secondary School Teaching

Students interested in secondary school teaching may consider a Master of Arts degree and Pennsylvania teacher certification in English, French, History, Spanish or Psychology. These programs are offered jointly with Chatham College.

H. John Heinz III School of Public Policy and Management 3-1-1 Program and Master of Arts Management Program

The Heinz School's 3-1-1 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 3-1-1 program leads to a Master of Arts Management degree.

Graduate School of Industrial Administration 3-2 Program

Students who are interested in business management may wish to consider the Graduate School of Industrial Administration's 3-2 program. Qualified undergraduate students may earn their master's degree in Industrial Administration in addition to their bachelor's 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.

Double Majors/Double Degrees

Students interested in pursuing more than one area of study are encouraged to consider a double major or double degree. Students who double major will earn a single degree in two areas. Generally, it is possible to fulfill the requirements of both majors in four years by taking the course requirements of the second major in the elective spaces allowed by the first major. Students in Carnegie Institute of Technology may elect to double major in Engineering and Public Policy, which is offered only as a second major.

Double degree programs allow students to earn two degrees. Students who are interested in a Double Major or Double Degree are encouraged to review the specific possibilities with their academic advisors.

Health Professions Program

Director: Amy L. Kennedy
Office: Scaife Hall 115

The Health Professions Program (HPP) is an advisory service for all students interested in entering medical school, dental school, or other graduate programs/careers in the health professions. Carnegie Mellon does not have a separate pre-med major. The courses that a student needs in order to be prepared for a career in the health professions can be included in the schedule of study in any of the science or engineering departments, or in the college of humanities and social sciences. A student chooses a major and becomes knowledgeable in that subject, while also developing credentials geared toward a career in the health professions. The Health Professions Program helps a student to clarify career goals, to be well-informed about requirements and opportunities, and to develop as a strong candidate for post-baccalaureate education.

If you are interested in the health professions, you should talk with the HPP Director and also pick up the HPP Student Handbook. This Handbook is intended as a guide for your undergraduate years. It discusses what courses a student needs in order to fulfill medical school requirements, to develop strong academic credentials and to prepare for the Medical College Admission Test (MCAT). Pre-med/pre-dental requirements include biology, general chemistry, organic chemistry, physics and English. Advisors from departments in MCS, CIT, and H&SS work closely with the HPP and will help you combine work in your major department with the courses you need as a health professions student.

The HPP sponsors activities to help students become well informed about careers in the health professions. The student health professions club, the DOCS (Doctors of Carnegie), brings speakers to campus to discuss current issues in various health fields. Students are also encouraged to do meaningful volunteer work in Pittsburgh's numerous health care facilities. In cooperation with Shadyside Hospital, a special Preceptorship Program is available for qualified upperclassmen. In this program, students are assigned to "shadow" resident physicians on their rounds. This affords Carnegie Mellon students the opportunity to observe first-hand the work of medical professionals in diverse clinical specialties.

The HPP office has an information center with catalogues, application forms, information regarding financial aid, professional journals and magazines, videotapes, and a listing of summer opportunities. The HPP Handbook discusses the process of applying to medical school and also describes a number of different health-related professions and the requirements for entering each of them.

The Program assists students who are applying to medical school by providing a committee letter of recommendation for each applicant and by informing the medical schools about Carnegie Mellon's grading standards, the level of scholastic competition at this institution, and the

caliber of the student body. Historically, students from Carnegie Mellon have had a very good performance record on the MCAT and a high rate of acceptance to medical school.

Minors

Minors offer students an excellent opportunity to supplement their major program of study with an additional concentration. Minors available at Carnegie Mellon are as follows:

Carnegie Institute of Technology:

Engineering Studies

Designated Minors (open only to CIT students)

Biomedical Engineering
Electronic Materials
Engineering Design
Environmental Engineering
Manufacturing Engineering
Mechanical Behavior of Materials

The College of Fine Arts:

Architecture
Architectural History (available also to B.Arch. candidates)
Architectural Representation and Visualization
Architectural Technology
Art
History of the Arts
Jazz Performance
Music
Product Design
Theatre Arts
Visual Communications

Minor open only to B. Arch. candidates:

Building Science

Minors open only to students majoring in Music:

Accompanying
Conducting
Jazz Performance

The College of Humanities and Social Sciences

Computational Linguistics
English
Environmental Studies
Ethics
European Studies
Film and Media Studies
French
Gender Studies
German
Health Professions (in cooperation with the Mellon College of Science)
History
Information & Decision Systems
International Affairs
Japanese
Logic and Computation
Minority Studies
Philosophy
Political Science
Psychology
Public Management
Religious Studies
Second Language Acquisition
Sociology
Spanish
Statistics
Teacher Certification (Early Childhood, Elementary, or Secondary; in cooperation with Chatham College)
Teaching English to Speakers of Other Languages

Graduate School of Industrial Administration

Industrial Management
Management (for Students in CFA)

Mellon College of Science

Biological Sciences
Chemistry
Mathematics
Physics

School of Computer Science

Computer Science

Pre-Law Advising Program

Director: Joseph Devine, Associate Dean, College of Humanities and Social Sciences
Office: H&SS Academic Advisory Center, Baker Hall 161

"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 consciously 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/ae 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.

Study Abroad

For students who would like to work or study abroad, the Office of International Education (OIE) has a reference library of hundreds of available programs. There are opportunities for studying abroad in western and eastern Europe, the Middle East, Australia, New Zealand, and most countries in Asia, Africa, and Latin America. Any student with good academic standing can study abroad as long as he/she receives home department approval. Most Study Abroad programs are designed for students in their Junior year; however, with careful planning, it can be done at other times. The length of the programs varies from just a summer, to a semester, to an entire academic year. Students interested in study abroad should start planning at least one year in advance.

University Exchange Programs

Carnegie Mellon University has a number of university-wide undergraduate exchange programs. Students who participate in exchange programs pay CMU tuition and receive their regular financial aid package. Students are responsible for room, board, travel and miscellaneous expenses.

EPFL/Exchange program with the Ecole Polytechnique Federale de Lausanne in Lausanne, Switzerland. The full year program is open to third year engineering and science majors (not biology) and fourth year architecture majors. Prior French study is preferred but not required. A three month intensive French language program is included at no additional tuition cost. Students who are fluent in French may opt to participate in an internship at EPFL instead of the language program. Students must apply to the program in November of the year before they plan to attend. Up to twenty Carnegie Mellon students may participate each year.

ITESM/Exchange program with Instituto Tecnologico y de Estudios Superiores de Monterrey in Monterrey, Mexico. This semester or full year program is open to all Carnegie Mellon undergraduates. Students must have completed two years of college level Spanish or the equivalent to participate. A six week long intensive Spanish language program is included at no additional tuition cost. Students must apply to the program in the year before they plan to attend. Up to twenty Carnegie Mellon students may participate each year.

KEIO/Exchange program with Keio University in Tokyo, Japan. This one year program is open to all CMU undergraduates. Students must consider that they will only study Japanese language and culture and may lose track for graduation. Prior Japanese study is preferred. Students must apply to the program in November of the year before they plan to attend. Only one to two Carnegie Mellon students may participate per year.

ETH (planned for 1995-1996 - applications available Fall 1994)/ **Exchange program with Eidgenossische Technische Hochschule in Zurich, Switzerland**. The full year program will be open to third year engineering and science majors (not biology) and fourth year architecture majors. Prior German study is required. A three month intensive German language program is included at no additional tuition cost. Students must apply to the program in November of the year before they plan to attend. Up to ten Carnegie Mellon students may attend each year.

Departmental Exchanges

The departments of Art and Design have established a number of exchange programs for their own students. GSIA also has a number of exchange programs and will allow undergraduate Industrial Management and/or Economics majors to participate in some of the programs. Only one to two students may attend each program, and most programs are for one semester. Students should contact the departments or college for additional information. Departmental exchanges work exactly like university exchanges; students pay Carnegie Mellon tuition and receive their normal financial aid package. Students are responsible for room, board, travel and miscellaneous expenses.

University Sponsored Programs

The university has designated a few study abroad programs as sponsored programs. On these programs, students will pay regular Carnegie Mellon tuition, room, board and fees. Carnegie Mellon will pay the tuition to the study abroad sponsor/organization/university and distribute stipends to the students for room, board, travel and miscellaneous expenses. Applications and information are available in OIE. Carnegie Mellon will begin the recruitment process for these programs in the academic year 1994-95.

Institute for American Universities (IAS) in Aix-en-Provence or Avignon, France/In Aix-en-Provence, the Marchutz School of Painting and Drawing complements a general studies program of French (at all levels), history, business, literature, philosophy, psychology, art history, political science and international relations. Many of these courses are taught in English. The Centre d'Etudes Francaises in Avignon has attracted many French majors and minors. All courses are taught in French. Students may attend either program for a semester or a year. Applications should be submitted in October for the following spring semester and April for the following fall or full year program. There is no limit on the number of Carnegie Mellon students who may participate on the IAU programs.

University of Regensberg, Regensberg, Germany/At the University of Regensberg, students spend the early part of the year or the first few months of the spring semester in an intensive language program. Upon completion of the course, all students must take a language examination. Once students pass the examination, they may directly enroll in University of Regensberg courses. Practically all beginning and intermediate courses are open to program participants. Places in laboratory science courses are very limited and cannot be guaranteed. Applied music instruction is also available to qualified participants. Students may attend for a full year program (Sept. to July) or a spring semester program (Jan. to July) Students must apply in early October for the spring semester and March for the full year program. Prior German language study is required. Space is limited on both options.

Non-Carnegie Mellon Programs

Students may also decide to participate in a program sponsored by another university or another study abroad organization. If the student's home department approves the program and its course offerings, the student may participate. Students will be paying 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. Semester and full year programs are available. Information may be obtained in OIE.

University Choice Program:

a freshman year full of exploration and flexibility

From electrical and computer engineering to literary and cultural studies, Carnegie Mellon is rich in a variety of programs you may find intriguing. Though many students are reasonably sure of what they want to study when they come to Carnegie Mellon, others are attracted to a number of programs and would prefer not to choose only one of our colleges upon admission. To enable these students to explore their broad, intellectual interests, Carnegie Mellon has created the University Choice Program. This program allows a select group of students to design an individualized freshman year course of study directed toward their particular interests, while deferring the choice of a major within one college to the sophomore year. Alternatively, following the freshman year, a student may design a self-defined major with the help of a faculty advisor.

All University Choice students participate in a special seminar that focuses on issues in science, technology and society, and examines policy issues from an interdisciplinary perspective. In this small, interactive class, students also find plenty of opportunities to sharpen their skills in discourse and argument. Through the seminar and contact with faculty advisors, students clarify their own interests and objectives and head into the sophomore year with a sound academic plan for the next three years.

If you're interested in more than one college at Carnegie Mellon and wish to be considered for participation in the University Choice Program, simply complete the application form, (available from the Office of Admission) marking the colleges that interest you. Students who exhibit exemplary qualifications for more than one college at the time of admission will be considered candidates for the University Choice Program. If selected, you'll be notified at the time of admission to the university.

The Bachelor of Humanities and Arts Degree (BHA)

Bachelor of Humanities and Arts Degree

Interdisciplinary Program - The College of Humanities and Social Sciences/The College of Fine Arts

Carnegie Mellon University offers a degree that uniquely combines the strengths of the College of Fine Arts (CFA) and the College of Humanities and Social Sciences (H&SS). The degree, called the Bachelor of Humanities and Arts (BHA), provides depth in the arts and well rounded exposure to the humanities and to the social and behavioral sciences. The BHA program enables a student to receive broader exposure to the humanities and liberal arts than is generally possible through CFA's Bachelor of Fine Arts degrees, while at the same time obtaining deeper and more substantial training in the fine arts than is generally possible through H&SS's Bachelor of Arts or Bachelor of Science degrees. Students get 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 and cultural studies. The program also provides enough flexibility to allow students to explore other areas of interest.

The BHA curriculum combines an eight-course General Education Program with a wide range of concentration areas. Three of the General Education courses are specific course requirements in the following areas: Writing; Statistics; and World Cultures. The remaining five courses are chosen from a set of "menu electives" in languages, science, history, literature, the social sciences, philosophy, statistics, and psychology.

Along with the General Education Program, students in the BHA program choose a concentration in the fine arts, and a concentration in the humanities and/or social/behavioral sciences. There are three types of concentrations listed below (each of which includes a minimum of 108 units in the fine arts, and six courses [minimum of 54 units] in H&SS). Courses for the H&SS concentration may be chosen from an existing H&SS major or minor, or (subject to approval) may be self-defined.

• Departmentally-focused concentration: Students complete CFA units from one CFA department (Architecture, Art, Design, Drama, or Music), plus the complementary H&SS course set.

• Interdepartmentally-focused concentration: Students combine course work across fine arts disciplines, plus the complementary H&SS course set.

• Self-defined concentration: Students design a curriculum in consultation with their advisors and approval from the BHA oversight committee.

In addition to the General Education Program and the concentration requirements in CFA and H&SS, BHA students have approximately thirteen free electives in their undergraduate curriculum.

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 in this area. A student in the junior year may apply to the 3-1-1 program with the H. John Heinz III School of Public Policy and Management. In this program students will 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.

Each BHA student will receive extensive advising support from both CFA and H&SS. Interested students should contact or visit the H&SS Academic Advising Center, Baker Hall 161.

The Curriculum

A. General Education Program — 72 units (min.)

NOTE: The BHA General Education program is an abbreviated version of the H&SS General Education program, a full description of which is presented in the H&SS section of this catalog (see pages ***). For BHA General Education courses to be chosen from designated "menus," refer to course lists presented in the H&SS General Education program description.

BHA students are required to fulfill the following General Education requirements:

• Wnting. Choose one of the following:

76-100	Introduction to English: Argument
76-101	Introduction to English: Interpretation

• World Cultures.

79-104 Introduction to World History

• Cognition, Choice and Behavior. Choose one course from the "Cognition, Choice and Behavior" distribution category course list in the H&SS General Education Program.

• Economic, Political and Social Institutions. Choose one course from the "Economic, Political and Social Institutions" distribution category course list in the H&SS General Education Program.

• Two language courses. These must be (a) courses taught in a foreign language, by the Modern Languages Department, and (b) at least intermediate-level courses (or elementary sequences in Japanese, Russian, or Chinese).

• Science and Technology. Choose one course from the "Science and Technology" distribution category course list in the H&SS General Education Program.

• Statistical Reasoning.

36-201 Statistical Reasoning

NOTE: This course is offered in both Fall and Spring semesters. Generally, BHA students will take this course in the Spring semester. Exception: BHA students with H&SS interests that require the follow-up course to 36-201 (36-202). These BHA students will, if possible, be accommodated in 36-201 in the Fall semester.

B. Concentrations

CFA Concentration: **(min) 108 units**
H&SS Concentration: **(min.) 54 units**

1. Departmentally Focused Concentration.

Students take a minimum of 108 units in a CFA department and six courses (minimum 54 units) in H&SS. The six H&SS courses may be an H&SS minor, although students may also devise a more varied and customized H&SS course combination, subject to approval.

The courses listed below can be considered a guide for the BHA student pursuing a departmentally-focused concentration. Each BHA student will be assigned a departmental advisor from the appropriate CFA department to assist in finalizing the program.

Architecture

A student might approach a concentration in architecture by simply earning two minors from the list of minors that appears in the CFA section on interdisciplinary programs or follow the 108-unit depth sequences listed below.

Required Courses (54 units)

48-100	Arch. Design and Drwg or 48-096,7	18 units
48-140	Introduction to Architectural History	9 units
48-2xx	Arch. History Lecture	9 units
48-2xx	Arch. History Lecture	9 units
48-330	Perspective Drawing	9 units

Complete one of the following elective sequences:

Electives in General Education in Architecture (54 units)

48-035	Computer Modeling	18 units
48-220	Fundamentals of Architectural Geometry	9 units
48-2xx	Arch. History Lecture	9 units
48-4xx	Arch. History (Prereq. Two 48-2xx Arch His.)	9units
48-4xx	Dept. Elective (Prereq. various)	9 units
33-108	Physics for Bldg Sci. (Prereq. 21-121, 33-106)	9 units
48-210	Statics (Prereq. 33-103)	9 units
48-215	Building Structure I (Prereq. 48-210)	9 units
48-310	Building Structure II (Prereq. 48-215)	9 units
48-315	Environmental Design	9 units
48-320	Psychology of Habitation	9 units
48-325	Design Econ. (Prereq. 73-100, 36-209 or 211)	9 units
48-425	Design Decision Mkg (Prereq. 36-209 or 211)	9 units

Elective Focus in Architectural History (select six - 54 units)

48-xxx	Architectural History	9 units
48-xxx	Architectural History	9 units
48-xxx	Architectural History	9 units
48-xxx	Architectural History	9 units
48-xxx	Architectural History	9 units
48-xxx	Architectural History	9 units

Elective Focus in Architectural Representation and Visualization (54 units)

This sequence is for candidates who intend to develop particular skills in architectural representation

48-035	Computer Modeling	9 units
48-220	Fundamentals of Architectural Geometry	9 units
48-335	Color Drawing	9 units
48-435	Architectural Rendering	9 units
48-745	Geometric Mod (Prereq. 48-711, 713, 750)	6 units
48-747	Shape Grammars (Prereq. 48-711, 713, 750)	6 units
48-744	Graphics (Prereq. 48-711, 713, 750)	6 units
48-72x	Lighting and Bldgs. (Prereq. 21-121, 33-106)	6 units

Elective Focus in Architectural Technology (54 units)

This sequence is for candidates who intend to develop intellectual links to the technical aspects of the profession.

Prerequisite Courses (19 units)

21-121	Calculus	10units
33-106	Physics I	10 units
33-103	Physics for Building Sciences (or 33-107)	9 units

Elective Courses (Choose six) (54 units)

48-210	Statics (Prereq. 21-121, 33-106, 33-103)	9 units
48-215	Building Structure I (Prereq. 48-210)	9 units
48-310	Building Structure II (Prereq. 48-215)	9 units
48-315	Environmental Design	9 units
48-410	Acoustics and Lighting (Prereq. 33-103)	9 units
48-415	Indoor Environmental Controls	9 units
48-4xx	Designated Dept. Technical Elective	9 units

Art

Concept Studios (30 units)

Required:

60-101	Concept Studio I (Fall)	10 units

Choose Two:

60-102	Concept Studio II (Spring)	10 units
60-201	Concept Studio III (Fall)	10 units
60-202	Concept Studio IV (Spring)	10 units

Media Studios (30 units)

Choose three from the following:

60-150	2-Dimensional Studio I (Fall)	10 units
60-151	2-Dimensional Studio II (Spring)	10 units
60-250	2-Dimensional Studio III (Fall)	10 units
60-251	2-Dimensional Studio IV (Spring)	10 units
60-130	3-Dimensional Studio I (Spring)	10 units
60-230	3-Dimensional Studio II (Fall)	10 units
60-110	Electronic Media Studio I (Fall)	10 units
60-210	Electronic Media Studio II (Spring)	10 units

Advanced Studios (30 units)

Choose Three (courses available either semester):

60-41x	Advanced Electronic and Time-Based Work (ETB)	10 units per semester
60-43x	Advanced Sculpture, Installation and Site Work (SIS)	10 units per semester
60-45x	Advanced Painting, Drawing and Printmaking (PDP)	10 units per semester

Art History/Theory (18 units)

Required

60-610	The Arts, Time and World Civilization I (Fall)	9 units
60-611	The Arts, Time and World Civilization II (Spring)	9 units

Design

Choose from:

51-114	Design Studio I (Fall)	9 units
51-115	Design Studio II (Spring)	15 units
51-126	The Human Experience in Design (Fall)	9 units
51-134	Design Drawing I (Fall)	9 units
51-135	Design Drawing II (Spring)	9 units
51-160	Learning to Look (Fall)	9 units
51-161	Introduction to Design Thinking (Spring)	9 units
51-212	Design History (Fall)	9 units
51-204	Basic Typography (Fall)	9 units
51-220	Photography for Graphic Design (mini-Fall)	4.5 units
51-208	Generation of Forms (Fall)	9 units
51-213	Color and Communications (Spring)	9 units
51-218	Human Factors (Spring)	9 units

Drama

Required Classes (42 units)

54-183	Fundamentals of Drama (Fall)	6 units
54-184	Fundamentals of Drama (Spring)	6 units
54-281	History of Drama (2 Fall minis)	6 units
54-282	History of Drama (2 Spring minis)	6 units
54-161	Production Preparation (Fall)	9 units
or 54-261	Production Run (Fall)	
54-162	Production Preparation (Spring)	9 units
or 54-262	Production Run (Spring)	

Performances Emphasis Classes (56 units)

Choose from:

62-151	Acting Elective (Fall)	9 units
62-152	Acting Elective (Spring)	9 units
62-130	Ballet Elective (Fall)	6 units
62-131	Ballet Elective (Spring)	6 units
54-107	Movement (Fall)	4 units
54-108	Stage Combat (Spring)	4 units
54-213	Elementary Dance (Fall)	3 units
54-214	Elementary Dance (Spring)	3 units
54-123	Dance I (by audition -Fall)	3 units
54-124	Dance I (by audition -Spring)	3 units
54-197A	Phonetics	
54-103	Theatre Studies Acting Workshop (by audition - Fall)	6 units
54-104	Theatre Studies Acting Workshop (by audition - Spring)	6 units
54-409	Theatre Lab- New Play Workshop (Fall)	6 units
54-410	Theatre Lab- New Play Workshop (Spring)	6 units
54-803	Text to Stage (Fall)	4 units
54-804	Text to Stage (Spring)	4 units

Design Emphasis Classes (56 units)

Choose from:

54-197B*	Basic Design (mini- Fall)	6 units
54-198B*	Basic Design (Spring)	6 units
54-246	History of Clothing (Fall)	6 units
54-246	History of Clothing (Spring)	6 units
54-239	History of Architecture and Decor (Fall)	6 units
54-240	History of Architecture and Decor (Spring)	6 units
54-151	Introduction to Stage Lighting (Fall)	6 units
54-152	Introduction to Stage Lighting (Spring)	6 units
54-161	Technical Production I (Fall)	6 units
54-162	Technical Production I (Spring)	6 units
54-237*	Scene Painting I (Fall)	4 units
54-239*	Scene Painting I (Spring)	4 units
54-231*	Stage Design (Fall)	9 units
54-232*	Stage Design (Spring)	9 units
54-341*	Costume Design I (Fall)	9 units
54-342*	Costume Design I (Spring)	9 units

Possible selections for either emphasis:

54-187A	Introduction to Playwriting (mini - Fall)	3 units
54-188A	Playwriting I (Spring)	6 units
62-153	Introduction to Playwriting, Non-Dramats (Fall)	9 units
62-154	Introduction to Playwriting, Non-Dramats (Spring)	9 units
62-155	Advanced Playwriting (Fall)	9 units
62-156	Advanced Playwriting (Spring)	9 units
54-283*	Fundamentals of Directing (Fall)	4 units
54-284*	Fundamentals of Directing (Spring)	4 units

*These courses require the permission of the instructor.

If a student has a specialized interest particular courses could replace a similar course above, in agreement with faculty, advisors and head of Drama.

Music

Required Classes (39 units)

57-151	16th Century COunterpoint (Fall)	6 units
57-152	Harmony I (Spring)	6 units
57-181	Solfege I (Fall)	6 units
57-182	Solfege II (Spring)	6 units
57-161	Eurhythmics I (mini -Fall)	3 units
57-162	Eurhythmics II (mini-Spring)	3 units
57-173	Survey of Western Music History (Fall?)	9 units

Required Performance (36 units)

Students must audition and be accepted into one of the departmental major ensembles. Membership in a major ensemble is required for six of the eight semesters in residence.

Choose from:

57-417	Concert Choir (Fall and Spring)	6 units per semester
57-430	Philharmonic Orchestra (Fall and Spring)	6 units per semester
57-419	Repertory Chorus (Fall and Spring)	6 units per semester
57-418	Wind Ensemble (Fall and Spring)	6 units per semester

NOTE: Private studio instruction is available, if desired, for an additional fee.

Studio instruction is not required of students in the BHA Program.

Elective Classes (33 or more units)

57-107/108	Studio for Non-majors	3-9 units
57-153	Harmony II (Fall)	6 units
57-154	18th Century Counterpoint (Spring)	6 units
57-183	Solfege III (Fall)	6 units
57-184	Solfege IV (Spring)	6 units
57-163	Eurhythmics III (mini - Fall) (must also take IV if elected)	3 units
57-164	Eurhythmics IV (mini - Spring)	3 units
57-203	Medieval, Renaissance and Baroque History (Fall)	9 units
57-204	18th and 19th Century Music History (Spring)	9 units
57-205	20th Century Music History (Fall)	9 units
57-337	Sound Recording I (Fall)	6 units
57-338	Sound Recording II (Spring)	6 units
57-347	Electronic and Computer Music I (Fall)	9 units

2. Interdepartmental Concentration.

Students combine a minimum of 108 units from two or more fine arts departments, with a complementary 6-course (minimum 54-unit) H&SS concentration. This approach allows the BHA student to combine courses in the arts with courses in the humanities and social and behavioral sciences to develop a curriculum designed to suit the student's background and interests. Areas which might be considered include:

Arts and Society, combining fine arts departmental studies and related work in cultural history and anthropology; focusing on the role of the arts in a wider cultural context.

Visual and Verbal Communication, combining courses from design, creative writing and professional writing to encompass several facets of effective communication.

The Arts and Organizations, familiarizing the student with the arts through the introductory courses in all the areas, then emphasize courses in organization theory and management. This could lay the groundwork for a career in arts management.

Performance and Theory, promoting an understanding of the interaction between the creative act and the critical perspective. This might involve studies in at least two of the arts.

Comparative Arts, focusing on courses from a number of the fine arts departments, plus perspectives derived from arts histories and cultural history.

3. Self-Defined Concentration.

Somewhat similar to the interdepartmental concentration, the Self-Defined option allows BHA students to propose their own 108-unit CFA/54-unit H&SS combination. Students choosing this option design a concentration in consultation with their advisors and approval from the BHA committee.

Degree Requirements (summary)

General Education requirements	(min.)	72 units
CFA concentration	(min.)	108 units
H&SS concentration	(min.)	54 units
Free Electives	(max.)	126 units
Degree Requirements	**(min.)**	**360 units**

Carnegie Institute of Technology

Carnegie Institute of Technology

Stephen W. Director, Dean
Robert P. Kail, Associate Dean for Undergraduate Studies
Undergraduate Office: Scaife Hall 110

Carnegie Institute of Technology, the engineering college of the university, has three main activities — undergraduate education, graduate education, and research. Its continuing goal has been to maintain excellence in all these activities. The degree to which this goal has been achieved is attested to by the demand for its graduates, the success of its alumni, the quality of its students and faculty, the adoption elsewhere of its innovations, and the national and international recognition it receives in educational and research activities.

The college offers the degree of bachelor of science in chemical engineering, civil engineering, electrical and computer engineering, mechanical engineering, and materials science and engineering. All of these programs are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. It is also possible for a student to pursue a minor in one of the CIT designated minor programs, or a double major in engineering and public policy, or to design either double-major or double-degree programs with other non-engineering departments.

From its earliest days Carnegie Institute of Technology (CIT) has considered undergraduate education to be the key element in the development of future leaders. In this regard, CIT has adopted a plan for education which is designed to equip students with the capacity to learn and to continue the process of self-education throughout their lives. The present curriculum incorporates this philosophy by providing the opportunity for both breadth in a number of engineering and science areas as well as depth in a major area of concentration. To achieve these goals the curriculum has been designed to help each student acquire:

A thorough and integrated understanding of fundamental knowledge in fields of a student's major interest and the ability to use this knowledge;

Skill in quantitative analysis, particularly with the widespread use of computers which, in all engineering disciplines, increases the applicability and impact of modern computational methods;

A genuine competence in the orderly way of thinking, which professionals and scientists have always used in reaching sound, creative conclusions, with the goal that after graduation the student can, by such thinking, reach decisions both as a member of a profession and as a citizen;

An ability to learn independently with scholarly orderliness, so that after graduation the student will be able to grow in wisdom and keep abreast of the changing knowledge and problems of the profession and the society in which he or she participates;

The philosophical outlook, breadth of knowledge, and sense of values which will increase the student's understanding and enjoyment of life and enable each student to recognize and deal effectively with the human, economic, and social aspects of professional problems; and

The ability to communicate ideas to others.

The curriculum encourages students to confront professional problems. This is accomplished through problem-oriented courses, as well as courses which emphasize design or individual projects. These courses stress creativity and independent thought and require the student to define the problem, propose a solution or design in the presence of technical and socioeconomic constraints, to make judgments among alternative solutions, and to explore innovative alternatives to more conventional solutions.

In addition to the strong graduate and research programs specific to the various departments, interdisciplinary graduate studies are pursued also in energy and environmental studies, materials design, robotics, biomedical engineering, planning and management, design research, and other specialized areas. These programs benefit undergraduates through course offerings in special and advanced topics and through projects for undergraduate research. Because of their contribution to undergraduate education, some of the engineering activities not leading to an undergraduate degree are described following the degree curricula in this section.

Freshman Year for Engineering Students

The Carnegie Mellon engineering education is based on engineering and science fundamentals that give you the skills to face new and challenging situations. The freshman year in engineering provides a broad foundation upon which a curriculum in your eventual major area will be built. Since students in CIT do not select a major until the end of the freshman year, all freshmen share a common first year experience consisting of introductory courses in all of the engineering majors (freshmen choose two of these courses), calculus, physics, other science courses which compliment specific introductory engineering courses, and courses in the College of Humanities and Social Sciences (H&SS). This curriculum helps you make an informed decision about your final major.

Fall Semester	Units
Introductory Engineering Elective	12
Restricted Technical Elective	10-13
Calculus	10
A Writing/Expression Course	9
Computer Skills Workshop	3
	44-47

Spring Semester	Units
Introductory Engineering Elective	12
Restricted Technical Elective	10-13
Calculus with Linear Algebra	10
A General Education Course	9
	41-44

Notes:

1. One Introductory Engineering Elective will be offered every semester by each CIT department. Every student must select one such course each semester.

2. Restricted Technical Electives include the following courses:

09-105	Modern Chemistry I	(10 units)
and		
09-101	Intro to Experimental Chemistry	(3 units)
15-127	Introduction to Programming and Computer Science	(10 units)
33-106	Physics for Engineering Students I	(12 units)
33-107	Physics for Engineering Students II	(12 units)

3. 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	Restricted Technical Elective
Chemical Engineering	09-105 and 09-101
Civil Engineering	33-106
Electrical & Computer Engineering	15-127
Engineering & Public Policy	33-106
Mechanical Engineering	33-106
Materials Science and Engineering	33-106

4. All students must complete Physics for Engineering Students I by the end of the freshman year. Therefore, if a student chooses to take Introduction to Chemical Engineering (with 09-105 and 09-101 as co-requisites) during one semester and Introduction to Electrical and Computer Engineering (with 15-127 as a co-requisite), the student must take 33-106 in place of the General Education requirement in the Spring semester of the freshman year and take the General Education course at some later time. Alternatively, a student entering the university with AP credit in a required freshman course may substitute 33-106 in its place.

General Education Program for CIT Students

Breadth Requirement

Humanistic Studies — 9 units

Complete either 79-104 (Introduction to World History) **or one course** from the **"Cultural Analysis"** category of the H&SS general education program. (List of acceptable courses follows.)

Writing / Expression — 9 units

(complete **one** of the following):

76-100	Argument
76-101	Interpretation

Cognition and Institutions — 9 units

Complete **one course** from either the **"Cognition, Choice, and Behavior"** or the **"Economic, Political, and Social Institutions"** categories of the H&SS general education program. (List of acceptable courses follows.)

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, this requirement is met by 27 units offered by a single department. 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. IM, GSIA, Heinz School, and Statistics Department courses may **NOT** be used to satisfy this requirement.

Non-Technical Electives — 18 units

Two unrestricted humanities, social science or fine arts courses. Non-technical courses from the Department of Industrial Management, GSIA, 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.

List of Acceptable Courses

(Not all courses are offered every semester.)

Cultural Analysis:

76-201	Cultural Practices and Literary Production
76-240	What is Cultural Studies
79-110	Dynamics of Cultural Change
79-111	Cultural and Cross-Cultural Perspectives on the Environment
79-112	Race, Nationality and the Development of American Cultures
79-113	Culture and Identity in American Social Life
79-200	Society and the Arts
80-100	What Philosophy Is
80-183	Language, Culture and Thought
82-107	Reflections of French Culture in Film
82-182	Language and Culture: Language in its Social context
82-193	The Faust Legend from Europe to Russia
82-405	Contemporary French Culture
82-407	Moliere and the Traditions of Comedy
82-409	French Literature of the 19th Century
82-412	Twentieth Century French Theater
82-413	Twentieth Century French Novel
82-414	Modern French Poetry
82-415	Studies in French Literary and Cultural Studies
82-416	Studies in French Literary and Cultural Studies
82-427	The New Germany
82-428	German Classical Literature
82-429	German Literature of the Nineteenth Centuy
82-430	German Literature of the Twentieth Century
82-431	Postwar German Literature
82-436	Studies in German Literature
82-441	Survey of Spanish Literature
82-451	Introduction to Latin American Literature and Culture
82-455	Studies in Spanish and Latin American Literature
82-456	Studies in Spanish and Latin American Literature
82-465	Surrealism in France and Spain
82-466	Surrealism in France and Spain
82-491	Literature, Politics and Film in Russia and East Europe Today
82-492	The Historical Imagination in Nineteenth Century Russian Literature

Cognition, Choice and Behavior:

80-150	The Nature of Reason
80-180	The Nature of Language
80-182	Language and Thought
80-242	Conflict and Dispute Resolution
85-100	Cognitive Processes: Theory and Practice
85-102	Introduction to Psychology
85-150	Introduction to Social Problems
85-211	Cognitive Psychology
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Introduction to Personality

Economic, Political, and Social Institutions:

36-203	Sampling, Surveys, and Society
73-100	Principles of Economics
73-110/88-110	Social Decision-Making: a Laboratory Approach
79-114	Education and Inequality
79-115	Causal Models and Historical Explanation
80-136	Social Structure, Public Policy, and Ethical Dilemmas
88-104	Decision Processes in American Political Institutions
88-109	Institutions and Individuals

Free Elective Courses

A free elective is any Carnegie Mellon course. However, a maximum of nine units of physical education and/or military science may be taken as free electives in most CIT degree programs. Credit earned for physical education and military science courses must be in the form of a pass or fail grade.

Double Majors and Double Degrees in CIT

A double major is a single degree in two areas; for example, the degree of bachelor of science in Chemical Engineering and English. It is to be distinguished from a double degree program, which results in two bachelor's degrees. A major is defined as a program, completion of which is necessary for the granting of a degree. The double major requires the completion of two designated programs which may have overlapping elements. The double degree 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.

The general principle used to measure eligibility for a double major is that the major requirements of both departments must be completed. The student is formally enrolled as an undergraduate in one of the departments (the parent department) and that department is responsible for scheduling and other administrative actions for the student.

Requirements for the Double Major Program in CIT

The regular and complete program (with the permissible exceptions as noted below) leading to a degree in CIT is satisfactorily passed by the student. 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 a number of 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 B.S. requirements, then certifies that the student has completed the requirements for a major in the second department.

Bachelor of science degree programs in Chemical Engineering, Civil Engineering, Electrical and Computer Engineering, Mechanical Engineering, and Materials Science and Engineering are accredited by the Engineering Accreditation commission of the Accreditation Board for Engineering and Technology. Double major degree programs between any of these B.S. degree programs and Engineering and Public Policy are likewise accredited. To ensure that accreditation requirements are met, students must adhere strictly to the published curriculum for the professional degree.

At the CIT advisor's discretion, equivalent technical electives may be substituted from either MCS or CIT 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 in CIT

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:

- Biomedical Engineering
- Electronic Materials
- Engineering Design
- Environmental Engineering
- Manufacturing Engineering
- Mechanical Behavior of Materials

Complete descriptions of the designated minors follow the CIT departmental descriptions.

Minor in Engineering Studies

Carnegie Mellon undergraduate students enrolled in colleges other than the college of engineering can complete a Minor in Engineering Studies in addition to their regular majors for B.S., B.A., or B.F.A. degrees. 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 the student wishing to do so 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* and all supporting co- or pre-requisite courses as follows:

1. Two of the following:

06-101	Introduction to Chemical Engineering
12-101	Innovation and Design in Civil Engineering
18-100	Introduction to Electrical & Computer Engineering
19-101	Introduction to Engineering & Public Policy
24-101	Introduction to Mechanical Engineering
27-100	Materials in Engineering

2. Three courses of at least 9 units each from one or more CIT departments with the exception of the following courses which may NOT be included as part of the Minor in Engineering Studies:

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.

* In order to be awarded the Minor in Engineering Studies, a student must earn a cumulative QPA of 2.0 in these five engineering courses.

Academic Standards

Grading Practices

Undergraduate grading regulations are detailed on page 48.

CIT Dean's Honor List

Carnegie Institute of Technology recognizes each semester those students who have earned outstanding academic records by naming them to the dean's honor list. The criterion for such recognition is a quality point average of at least 3.75 while completing a minimum of 45 factorable units and earning no incomplete grades.

Transfer into CIT Departments

Undergraduate students admitted to the CIT common first year have the right to choose any major within the college to which they were admitted. 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 CIT and wishing to transfer into a CIT department during their first year should consult with the associate dean of CIT. Students admitted to CIT but excluded from certain departments must also consult with the associate dean if they wish to transfer into a restricted CIT department during their first year. No undergraduate 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 past academic performance and academic programs.

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 and wishing to transfer into a CIT department beyond the first year will be considered for transfer on a space available/academic performance basis. A CIT department may refuse a transfer to a non-CIT 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 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, 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 2.0.

Probation

The action of probation will be taken in the following cases:

One semester of the freshman 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 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 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.

Suspension

A student who does not meet minimum standards at the end of one semester of probation will be suspended.

A freshman 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 for undergraduate studies;

Completing an Application for Readmission form from the Registrar's Office; 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 back to Carnegie Mellon.

Students who have been suspended or have withdrawn are required to absent themselves from the campus (including residence halls and fraternity and sorority 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.

A student who has been suspended is not eligible for employment by the university during the period of suspension.

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 who fails to meet minimum standards after returning to school is dropped.

If students have been suspended or dropped, they are required to absent themselves from the campus (including dormitories and fraternity 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 for the duration of the period of the action.

The relation indicated above between probation, suspension, and drop is normal, not binding. In unusual circumstances, College Council may suspend or drop a student without prior probation.

Graduation Requirements

A requirement for graduation is the completion of the program specified for a degree with a cumulative quality point average of 2.00 or higher for all courses taken after the freshman year. A student may also need to achieve a cumulative quality point average of 2.00 in a series of courses specified by the department up to a maximum of 184 units.

Students must be recommended for a degree by the faculty of CIT.

A candidate must meet the residence requirement, detailed on page 49.

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 CIT College Council.

Other Regulations Affecting Students Status

Schedule Changes

(See page 46 for add/drop procedure information, page 48 for grading procedures for dropped courses, and page 52 for withdrawal information)

The last date to add courses is the one 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 second week of the course.

The last date to drop courses (scheduled as part of a normal load, i.e., above 36 units and normally 48 to 54 units but excluding Physical Education and Military Science courses) is two weeks after mid-semester grades are due in the Registrar's Office. This applies to all courses with the following exception: the final date to drop half-semester mini courses is the last class day of the fourth week of the course.

Students carrying an approved overload may petition to drop the overload courses to bring their load down to normal up to and including the last day of classes, excluding the final examination period. In any case a full-time student as of the 10th class day of a given semester will be expected to maintain a load of at least 36 units.

Any adding or dropping of courses occurring within the above deadlines may be done simply by filing with the Registrar's Office a change of schedule form including appropriate signatures of instructors and advisors. When students drop courses within the above time frame, then the courses will be erased entirely from their records. If extenuating circumstances are established and approval to drop a course is given after the above deadlines, then the courses will be erased entirely from their records.

If extenuating circumstances are established and approval to drop a course is given after the above deadlines, then the course dropped will appear on the students' grade report and transcript followed by a "W" indicating that a student was, in fact, registered for more courses than s/he actually completed. This would also include students who are carrying overloads.

A student may petition to withdraw from the college at any time until and including the last day of classes and excluding the final examination period, with the understanding that "W" grades will be recorded if the withdrawal takes place after the official drop deadline. At the time of withdrawal a written statement will be placed on record setting forth the time and conditions under which the student may be permitted to return, with copies to the student, the student's Dean's Office and the student's department head. At the time of withdrawal, the university will notify the student's parents by letter, except in the case of a student over 21 years of age (see page 52 for more details about withdrawals).

Exceptions to the regulations above will be granted only upon approval of a petition to the College Council.

Department of Chemical Engineering

Ignacio E. Grossmann, Head
Office: Doherty Hall 1107

Chemical engineering is a discipline which is both science-oriented and focused on problem solving. The range of problems addressed by chemical engineers is extremely broad, ranging from distillations and refining of crude oil, to designing fermentation reactors in which microorganisms produce drugs and other pharmacological agents. It even includes the semiconductor industry where processing of thin films is important. The curriculum is designed to prepare students for immediate employment after graduation, or to enter graduate school to obtain the M.S. or Ph.D. degree. The range and depth of coursework in science also makes chemical engineering a good major for students interested in medical and other professional schools.

In the past the majority of chemical engineering graduates were hired by the chemical and petroleum industries; however, this situation has changed. Exciting new opportunities are opening in many new technologies. The pharmaceutical industry recruits chemical engineers who possess expertise in both process engineering and biochemistry/molecular biology. There are many technical opportunities for chemical engineering graduates in industries associated with coatings (paint, integrated circuits, magnetic tapes) and polymers (plastics and resins). Furthermore, our national need for fuels demands large numbers of chemical engineers well-trained in catalysis (the enhancement of chemical reactions using precious metals and other catalysts). The solution to environmental and waste-disposal problems will also require the technical skills acquired in the chemical engineering curriculum. The profession of chemical engineering offers challenging and rewarding careers in both the traditional industries as well as the more high-technology areas currently being developed.

Computing has had a long and important history in chemical engineering. Some of the very first large-scale scientific and engineering calculations were performed by chemical engineers involved in research on and design of petroleum refineries and chemical plants. This tradition has continued with the development of process simulation programs which allow designers, plant managers and long-range planners to predict and optimize the performance of very complex chemical systems. Computers are also used by chemical engineers to solve models of the environment, for example, how toxic chemicals are dispersed and degraded in soils, the oceans and the atmosphere, and what effect these chemicals will have on our lives. Availability of powerful desk-top computers will lead to software systems that allow each engineer to perform scientific, engineering and business studies of great sophistication.

Curriculum

Freshman Year

	Fall	Units
21-121	Calculus	10
76-xxx	Writing/ Expression Course	9
99-101	Computing Skills Workshop	3
xx-xxx	Introductory Engineering Elective	12
xx-xxx	Restricted Technical Elective	10-13
		44-47

	Spring	
21-122	Calculus with Linear Algebra	10
xx-xxx	Introductory Engineering Elective	12
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		41-44

Sophomore Year

	Fall	Units
21-259	Calculus in Three-Dimensions	9
06-151	Thermodynamics	12
09-117	Organic Chemistry I	9
xx-xxx	Computer Sci/Basic Sci*	10-12
xx-xxx	General Education Course	9
		49-51

	Spring	
06-152	Principles of Transport Processes I	9
06-155	Chemical Engineering Mathematics I	6
06-204	Chemical Engineering Thermodynamics	6
xx-xxx	Computer Sci/Basic Sci.*	10-12
xx-xxx	Adv.Chem/Biochem Elective	9
xx-xxx	General Education Course	9
		49-51

*At the end of the sophomore year, a chemical engineering student will have completed the following required basic science and computer science courses.

33-106	Physics for Engineering Students I - 12 units
33-107	Physics for Engineering Students II - 12 units
09-101	Introduction to Experimental Chemistry - 3 units
09-105	Modern Chemistry I - 10 units
15-127	Intro. to Programming/Computer Science - 10 units

The total number of units completed by the end of the sophomore year should be 190 units.

For those students who have not taken 06-100 as one of the two Introductory Engineering Electives, 06-100 should be taken in the Fall Semester of Sophomore year instead of the General Education Course Elective which will be taken in the Junior year. These students should consult with their academic advisors as soon as possible. The extra Introductory Engineering Elective can be used to fulfill a technical elective slot later on.

Students pursuing a ChemE/EPP double major are waived from taking the Adv.Chem/Biochem Elective (see Double Major requirements).

Junior Year

	Fall	Units
06-201	Principles of Transport Processes II	9
06-156	Chemical Engineering Mathematics II	6
06-205	Chemical Engineering Process Control	6
09-206	Physical Principles of Analytic Chemistry	9
09-245	Physical Chemistry II	9
xx-xxx	General Education Course	9
		48
	Spring	
06-202	Unit Operations of Chemical Engineering	9
06-211	Transport Processes Laboratory	6
09-246	Physical Chemistry III	9
09-131	Experimental Techniques in Chemistry I	10
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
		52

Senior Year

	Fall	Units
06-301	Chemical Engineering Kinetics	9
06-302	Process Engineering and Synthesis	12
06-308	Chemical Engineering Seminar	3
06-311	Unit Operations Laboratory	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
		51
	Spring	
06-303	Design Project	6
06-304	Economics and Optimization	6
xx-xxx	Technical Elective	9
xx-xxx	Technical Elective	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		48

Notes:

1. In addition to the graduation requirement of an overall 2.0 QPA (not counting the freshman 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 degree: 389.

Colloids, Polymers and Surfaces Option

Students admitted to the colloids, polymers and surfaces option will take:

06-607	Physical Chemistry of Colloids and Surfaces
06-313	Experimental Colloid and Surface Science
06-314	Experimental Polymer Science
09-509	Physical Chemistry of Macromolecules
or	
06-609	Physical Chemistry of Macromolecules

06-607 is taken in the Spring of the junior year, while 06-609/09-509, 06-313 and 06-314 are taken during the senior year as part of the elective requirements outlined above.

Double Major in Engineering and Public Policy

Students may pursue a double major in Chemical Engineering and Engineering and Public Policy. This double major is a very flexible one, built around Technical Electives, Social Analysis Electives, Probability and Statistics courses, and Projects. Specific course choices should be discussed with the advisor.

Faculty

JOHN L. ANDERSON, Professor of Chemical Engineering— Ph.D., University of Illinois; Carnegie Mellon, 1976—.

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

ETHEL Z. CASASSA, Associate Professor Emerita of Chemical Engineering — Ph.D., Columbia University; Carnegie Mellon, 1974—.

PAUL A. DIMILLA, Assistant Professor of Chemical Engineering — Ph.D., University of Pennsylvania; Carnegie Mellon, 1993—.

MICHAEL M. DOMACH, Associate Professor of Chemical Engineering — Ph.D., Cornell University; Carnegie Mellon, 1983—.

ANDREW J. GELLMAN, Associate Professor of Chemical Engineering- PhD, University of California, Berkeley; Carnegie Mellon, 1992—.

IGNACIO E. GROSSMANN, Dean Professor of Chemical Engineering ; Head of Department— Ph.D., Imperial College, University of London; Carnegie Mellon, 1979—.

WILLIAM S. HAMMACK, Associate Professor of Chemical Engineering — Ph.D., University of Illinois; Carnegie Mellon, 1988—.

MYUNG S. JHON, Professor of Chemical Engineering — Ph.D., University of Chicago; Carnegie Mellon, 1980—.

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

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

SPYROS N. PANDIS, Assistant Professor of Chemical Engineering and Engineering and Public Policy — PhD., 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. Professor of Chemical Engineering — Ph.D., University of Delaware; Carnegie Mellon, 1974—.

ROBERT R. ROTHFUS, Professor Emeritus of Chemical Engineering — Sc.D., Carnegie Mellon University; Carnegie Mellon, 1947—.

PAUL J. SIDES, Professor of Chemical Engineering — Ph.D., University of California; Carnegie Mellon, 1981—

JENNIFER L. SINCLAIR, Assistant Professor of Chemical Engineering—Ph.D., Princeton University; Carnegie Mellon, 1990—.

ROBERT D. TILTON, Assistant Professor of Chemical Engineering — PhD., Stanford University; Carnegie Mellon, 1992—.

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

ARTHUR W. WESTERBERG, Swearingen Professor of Chemical Engineering — Ph.D., DIC, Imperial College, University of London; Carnegie Mellon, 1976—.

B. ERIK YDSTIE, Professor of Chemical Engineering — Ph.D., Imperial College, University of London; Carnegie Mellon, 1992—.

Department of Civil and Environmental Engineering

Richard G. Luthy, Head
Office: Porter Hall 119-D

The role of civil 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. Todays civil 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, for remediation of hazardous waste sites, and for incorporation of environmental safeguards in facility designs. Civil engineering requires broad technical training and strong communication skills because of the complexity of large projects and the attendant interactions with engineers in other fields, lawyers, politicians, and the public. Carnegie Mellon's curriculum is aimed at providing this versatility.

The Department of Civil and Environmental Engineering offers a wide spectrum of opportunities aimed both toward preparation for direct entry into the engineering profession and toward graduate education in engineering or 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 for educating graduates capable of designing safe, economical and efficient facilities that serve society's needs. Indeed, the notion of engineering design is introduced in the freshman year and is emphasized throughout the curriculum in both traditional and open-ended project-oriented courses.

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 essential to 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 civil engineering profession in such specialties as structural engineering, engineering planning and management, or environmental engineering, this approach to teaching allows them to apply immediately 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 the development of robotics in construction. 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, or to pursue a minor in one of the CIT designated minor programs, or to design a double-major or double-degree program. The specialty areas offered by the Civil and Environmental Engineering Department are described in this section. The CIT designated minor programs can be found under Carnegie Institute of Technology. The double-major requirements with Engineering and Public Policy are described in the curriculum for CE/EPP specified by that department. Other double-major programs selected by recent graduates include economics, mathematics, industrial management, 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.

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 12-101 Innovation and Design in Civil 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
15-127	Intro to Programming and Computer Science	10
21-121	Calculus	10
21-122	Calculus with Linear Algebra	10
33-106	Physics for Engineering Students I	12
33-107	Physics for Engineering Students II	12

Since the majority of civil engineering students is expected to have completed 12-101 in the freshman year, a four-year curriculum for civil engineering majors is described below for such students. If a student has not taken 12-101 in the freshman year, he/she is required to take it in the Fall semester of the sophomore year and defer an H&SS Elective to the Junior year. Refer to the General Education Program for CIT students for course requirements in H&SS/CFA.

Freshman Year

	Fall	Units
12-101	Innovation and Design in Civil Engineering	12
21-121	Calculus	10
33-106	Physics for Engineering Students I	12
99-103	Computer Skills Workshop	3
76-xxx	Writing/Expression Course	9
		46
	Spring	
xx-xxx	Introduction to Engineering (other than 12-101)	12
21-122	Calculus with Linear Algebra	10
33-107	Physics for Engineering Students II	12
xx-xxx	General Education Course	9
		43

Sophomore Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
09-105	Modern Chemistry I	10
09-101	Introduction to Experimental Chemistry	3
12-207	Statics and Kinematics	9
12-241	Intro. Computer Appl. in Civil Eng.	9
xx-xxx	General Education Course	9
		49
	Spring	
21-260	Differential Equations	9
12-208	Dynamics	9
12-212	Solid Mechanics	12
15-127	Intro. to Programming and Computer Science	10
xx-xxx	General Education Course	9
		49

Junior Year

	Fall	Units
12-320	Structural Mechanics I	9
12-331	Fluid Mechanics	12
36-211	Probability and Applied Statistics I	9
or		
36-220	Engineering Statics and Quality Control	
xx-xxx	Basic Science Elective	9
xx-xxx	General Education Course	9
		48

	Spring	
12-310	Engineering Economics	9
12-315	Materials	9
12-325	Soil Mechanics	12
12-647	Civil Engineering Project Seminar	3
12-xxx	Civil Engineering Elective	9
xx-xxx	General Education Course	9
		51

Senior Year

	Fall	Units
12-400	Civil Engineering Design	12
12-648	Civil Engineering Project	9
12-xxx	Civil Engineering Elective	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
		48

	Spring	
12-xxx	Civil Engineering Electives	18
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
xx-xxx	Free Elective	9
		45

Minimum number of units required for degree: 379

Notes on Junior and Senior Electives

Basic Science Elective

The basic science elective will generally be selected from the following list:

09-106	Modern Chemistry II
03-121	Modern Biology
33-104	Experimental Physics

Civil Engineering Electives

24 to 36 units of civil engineering electives are to be selected in combination with project-type electives for a total of 48 units.

Project-Type Electives

A Civil Engineering student will be required to take a minimum of 12 units but not more than 24 units of project-type courses selected from the following list:

12-647 & 12-648	Civil Engineering Project Seminar and Project (12 units total)
12-645	Independent Study (units vary)
39-500	CIT Honors Research Project (24 units maximum)
19-451 & 19-452	EPP Projects for Double Majors (24 units total)

The project-type courses are intended to supplement other civil engineering electives for a total combination of 48 units.

Technical Electives

18 units of technical electives are required. They may be selected from the list of civil engineering electives not included in the minimum requirement. If a student has taken two Introductory Engineering Electives outside of civil engineering in the freshman year, one of them may be counted as a technical elective. Advanced undergraduate or graduate courses in CIT, MCS or Computer Science may be substituted for civil engineering electives with the approval of the advisor in the Civil Engineering Department.

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. The available options for grouping electives into specialty areas, together with representative course selections, are indicated below.

Computer-Aided Engineering and Management

12-607	Project Management for Construction
12-609	Traffic Flow Theory and Operations
12-623	Structural Design
12-627	Geotechnical Engineering
12-630	Design & Construction
12-632	Water Resources Engineering
12-640	Computer-Aided Tools for Civil Engineers
18-100	Introduction to Electrical and Computer Engineering

Environmental Engineering

12-607	Project Management for Construction
12-632	Water Resources Engineering
12-634	Water Quality Engineering Laboratory
12-635	Water Quality Engineering
12-636	Environmental Engineering: Air Pollution
12-640	Computer-Aided Tools for Civil Engineers
06-309	Physical Chemistry of Colloids and Surfaces
09-142	Physical Chemistry I

Structures, Mechanics and Geotechnical Engineering

12-607	Project Management for Construction
12-621	Structural Mechanics II
12-623	Structural Design
12-627	Geotechnical Engineering
12-630	Design & Construction
12-632	Water Resources Engineering
12-640	Computer-Aided Tools for Civil Engineers
24-242	Engineering Vibrations

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Department of Electrical and Computer Engineering

Robert M. White, Head
B.V.K. Vijaya Kumar, Associate Head
Undergraduate Office: Hamerschlag Hall 1109

The nature of electrical and computer engineering has changed significantly over the course of the careers of most electrical and computer engineers practicing in the field today. The technological advances of the past several decades have altered the face of industry and educational institutions alike. The Department of Electrical and Computer Engineering at Carnegie Mellon is actively engaged in education and research at the forefront of these new technologies.

Fifty years ago electronics was based upon the vacuum tube. Thirty-five years ago, electronics had largely converted to the transistor, and the use of integrated circuits was beginning. Twenty-five years ago, development of the technology of microelectronics and very large scale integration (VLSI) that would lead to the computer revolution of the '80's had begun.

Today, electrical and computer engineering as a discipline encompasses a remarkably diverse and fertile set of technological areas, including analog and digital electronics, computer architecture, computer-aided design and manufacturing, robotic and control systems, telecommunications and computer networking, communication systems, signal and information processing, solid state physics and devices, electromagnetic and electromechanical systems, magnetic information technology, digital signal processing, and optical data processing.

The B. S. in Electrical and Computer Engineering is a highly flexible degree program, based upon a recognition that the field of Electrical and Computer Engineering is broad and multidimensional. The program is structured so as to provide students with the smallest set of constraints consistent with a rich and comprehensive view of the field, as judged by the Faculty of the Department of Electrical and Computer Engineering. Through consultation with their individual Faculty advisors, students design a specific set of courses, tailored to individual interests and goals.

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 course work at Carnegie Mellon. The degrees may or may not be awarded simultaneously depending on the progress and preference of the student. The primary purpose of the new Integrated Masters/Bachelors 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. 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. In the face of the ever increasing technological complexity of the work place, the additional year of advanced undergraduate and graduate classes required for the Integrated M.S./B.S. Degrees substantially enhances a students readiness to contribute in an industrial position.

The Department's undergraduate laboratories are well-equipped with state-of-the-art instruments that provide students with hands-on experience with concepts introduced in the classroom. In these laboratories students study the physical behavior of semiconductor devices such as transistors, design and experiment with electronic circuits, develop an understanding of real-time computer systems, and design and develop control systems. Design experiences emphasize contemporary problems and provide a background for developing logic and computer design skills at the professional level. Students use instruments such as oscilloscopes for visualizing periodic signals, curve tracers for measuring the characteristics of transistors, function generators for producing voltage signals, and logic analyzers for investigating the performance of digital circuits. The laboratories are equipped with 60 PC workstations that are used for circuit simulation and analysis, real-time data acquisition, and processing and control activities.

The ECE Department is a leader in the innovation and use of computer-based educational tools. Computer-aided instruction has radically expanded the educational resources available to both faculty and students, and these new educational alternatives are having a major impact upon the ways in which students learn about and derive insights into engineering concepts. The Personal Computing Laboratory houses 30 DECstation 5000 series color workstations that are connected to a campus-wide network. These computers give students access to industry-standard computer-aided design and simulation programs and to specifically developed software for departmental courses. In addition to regular course offerings, some advanced courses use the Personal Computing Laboratory to run software developed by the department's research centers.

Students are encouraged to participate in research by undertaking project work. Undergraduate projects not only provide the student with the opportunity to participate in the research programs of individual faculty members, but earn technical elective credits as well. The Department is home for several prestigious research centers which provide a broad spectrum of research opportunities. The National Science Foundation's Engineering Research Center for Data Storage Systems is working to develop high density magnetic and magneto-optical recording systems. The SRC-CMU Research Center for Computer-Aided Design is developing software tools for automatic synthesis, simulation, verification, test, and manufacture of integrated circuits and systems. Research projects in the Center for Excellence in Optical Data Processing have applications in such areas as product inspection, automation, robotics, pattern recognition, signal processing, advanced computing, artificial intelligence, missile guidance and multiple target tracking and pointing. The Pennsylvania SEMATECH Center of Excellence is developing methods, algorithms and software for controlling an integrated circuit manufacturing line to maximize manufacturing yield. The Computing Systems Center focuses on dependable computing, real-time systems, high-speed networks, multimedia systems engineering, computer architecture, and low-cost distributed computing. Research in the Integrated Microsystems Laboratory encompasses electronic, optical, and electromechanical microsystems made in thin-film form using microfabrication techniques. In addition to these research centers, the Department has strong research programs in telecommunications and controls/robotics.

B.S. Curriculum

Freshman Year

	Fall	Units
18-100	Introduction to Electrical & Computer Engineering	12
15-127	Introduction to Programming & Computer Science	10
21-121	Calculus	10
76-xxx	Writing/Expression Course	9
99-100	Computer Skills Workshop	3
		44
	Spring	
xx-xxx	Introductory Engineering Elective	12
33-106	Physics for Engineering Students I	12
21-122	Calculus with Linear Algebra	10
xx-xxx	General Education Course	9
		43

Sophomore Year

	Fall	Units
18-2x0	ECE Core Course	12
21-xxx	Restricted Math Elective	9
33-107	Physics for Engineering Students II	12
xx-xxx	General Education Course	9
		42
	Spring	
18-2x0	ECE Core Course	12
21-xxx	Restricted Math Elective	9
xx-xxx	ECE Breadth Course 1	12
xx-xxx	General Education Course	9
		42

Junior Year

	Fall	Units
xx-xxx	ECE Breadth Course 2	12
xx-xxx	ECE Breadth Course 3	12
xx-xxx	Probability and Statistics	9
xx-xxx	Math/Science Elective 1	9
xx-xxx	General Education Course	9
		51
	Spring	
xx-xxx	ECE Depth Course	12
xx-xxx	ECE Coverage Course 1	12
xx-xxx	Engineering Elective	12
xx-xxx	General Education Course	9
		45

Senior Year

	Fall	Units
xx-xxx	ECE Coverage Course 2 (e.g., Capstone Design)	12
xx-xxx	Math/Science Elective 2	9
xx-xxx	Free Elective	12
xx-xxx	Free Elective	6
xx-xxx	General Education Course	9
		48
	Spring	
xx-xxx	Free Elective	12
xx-xxx	Free Elective	12
xx-xxx	Free Elective	12
xx-xxx	General Education Course	9
		45

Minimum number of units required for degree: 360

Notes on the Curriculum

Introductory Engineering Electives

Although shown in the Fall, Introduction to Electrical and Computer Engineering (18-100) may be taken in either semester of the Freshman year, or as late as Fall of the Sophomore year. However, students who have not taken 18-100 by the end of the Freshman year should see their departmental advisor.

ECE Core

Students are required to take two fundamentals courses along with their associated Restricted Math Elective corequisites:

		Units
18-220	Fundamentals of Electrical Engineering	12
21-241	Linear Algebra (corequisite to 18-220)	9
18-240	Fundamentals of Computer Engineering	12
21-127	Introduction to Modern Math (corequisite to 18-240)	9

Although the fundamentals courses may be taken in either order, students should usually take the course they are most interested in first. This gives added flexibility to later course selections in related areas.

ECE Breadth

The courses in the ECE curriculum have been grouped into five principal subject areas: *Applied Physics, Signals and Systems, Circuits, Computer Hardware, and Computer Software.* The courses in these areas are listed at the end of these notes. To satisfy the ECE Breadth requirement, at least one course must be taken from three of the five principal areas (nominally 36 units).

ECE Depth

At least one course (nominally 12 units) must be taken that has one of the courses used to satisfy the Breadth requirement as a prerequisite. In other words, the student must go "two-deep" in at least one of the five principal subject areas.

ECE Coverage

At least two additional ECE curriculum courses are required (nominally 24 units). The courses used to satisfy this requirement may come from the *Professional and Policy* or *Undergraduate Projects* lists as well as the five principal area lists.

ECE Capstone Design Elective

One course from the following list must be taken (nominally 12 units). In many cases, this requirement simultaneously satisfies an ECE depth or ECE coverage requirement.

		Units
15-413	Software Engineering	12
18-373	Computer-Controlled Testing and Measurement System Design	12
18-400	High Frequency System Design	12
18-405	Computer-Aided Design of Electromagnetic Systems	12
18-474	Computer Control Systems Design Laboratory	12
18-481	Analysis, Synthesis and Evaluation	12
18-517	Data Storage Systems Measurement and Design Laboratory	12
18-523	Analog Integrated Circuit Design	12
18-525	Integrated Circuit Design Project	12
18-545	Advanced Digital Design Project	12
18-575	Control System Design	12
18-725	Digital Integrated Circuit Design	12
18-728	Applied Analog Integrated Circuits	12
39-405	Techniques and Theory of Engineering Design	12
39-500	CIT Honors Research Project (if advised and certified by ECE faculty member)	variable

Engineering Elective

One additional engineering course (12 units) is required. Any technical course in CIT or any 200 level or higher course in CS will satisfy this requirement.

Probability and Statistics

Probability and Statistics is required (9 units). This requirement may be satisfied by 36-217, 36-220, or the two course sequence 36-225, 36-226. 36-217 is a prerequisite for 18-550, Fundamentals of Communications systems, and is recommended for students interested in communications, networks, and signal processing. 36-220 is appropriate for students interested in quality control, manufacturing, and statistical methods. The two-course sequence 36-225, 36-226 will be of interest for IM double majors.

Math/Science Electives

Two additional Math/Science Electives (18 units) are required. This requirement can be satisfied with any course in biology, chemistry, or physics; or any 200 level course or higher in Mathematics or Statistics except 21-257, 21-261, 36-209, and 36-210. Although shown in the Fall of the Junior and Senior years, these courses may be taken at any time. Two courses of particular interest to students in ECE are:

21-259	Calculus in Three Dimensions (prerequisite to 18-303 and 18-316)
21-260	Differential Equations

Free Electives

A Free Elective is defined as any graded course offered by an academic unit of the university (including research institutes such as the Robotics Institute and the Software Engineering Institute). A total of at least 54 units of Free Electives must be taken. Substitutions of courses from other high quality universities may be accepted through petition to the Associate Department Head in consultation with the Undergraduate Education Committee. In the curriculum schedule

shown above, all but one of the free elective courses have been assumed to be 12 units each. Under this assumption, the course load exceeds 45 units in only two semesters. However, when choosing free electives outside of the ECE Department, courses may often be less than 12 units each. When such courses are chosen, additional semesters for which the course load exceeds 45 units may be required. ROTC and Physical Education courses will not be counted toward meeting the total units requirement. The large number of units without categorical constraints provides the student, in consultation with his or her advisor, with a great deal of flexibility to design a rich educational experience.

Policy on ECE Coverage Courses with less than 12 Units

The basic curriculum requirements for breadth, depth, coverage, and design are stated in terms of courses rather than units. The nominal total units for these categories is determined by assuming each course is 12 units. In the event that courses with less than 12 units are used to satisfy some or all of these requirements, additional courses from the ECE coverage lists must be taken until the total units in ECE courses beyond the core meets or exceeds this minimum. Any ECE coverage course is acceptable.

Presently, the breadth, depth, coverage, and design courses sum to 72 units. Thus, if courses with less than 12 units are taken, additional courses from the ECE coverage lists must be taken until the total ECE units beyond the core meets or exceeds 72 units. Any excess units may be counted as free elective credit.

QPA Requirement and Overload Policy

An overload is defined as any schedule with more than 54 units in one semester. A student will only be permitted to overload if he or she achieved a QPA of at least 3.5 out of 4.0 in the previous semester. This policy applies only to units which can be counted toward degree requirements, as defined in the Free Elective note above.

To graduate, students must achieve a cumulative QPA of 2.0 or higher for all courses taken after the freshman year. In addition, a minimum QPA of 2.0 is required in the following courses:

18-100	Introduction to Electrical and Computer Engineering
18-220	Fundamentals of Electrical Engineering
18-240	Fundamentals of Computer Engineering
xx-xxx	ECE Breadth course 1
xx-xxx	ECE Breadth course 2
xx-xxx	ECE Breadth course 3
xx-xxx	ECE Depth course
xx-xxx	ECE Coverage course 1
xx-xxx	ECE Coverage course 2
xx-xxx	ECE Capstone Design course (This may be a course which is also used to satisfy an ECE Depth or ECE Coverage requirement.)

When more than one possibility exists for meeting a specific requirement (e.g., Breadth), the courses will be chosen so as to maximize the QPA. Similarly, when a course is retaken, the best grade will be used in the computation of the minimum QPA in the above courses.

Double Degrees

In addition to satisfying the CIT college requirements, the student must take all of the courses that are included in computing the ECE Department QPA requirement. If some of these courses have been previously taken, then additional free electives must be selected so that the total additional units taken is at least 90.

Requirements for the Integrated M.S./B.S. Degrees Program

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, no course can be counted as satisfying more than one of the requirements listed below and no course used to satisfy the basic B.S. Degree requirements can be used to satisfy one of the requirements listed below. The requirements total 96 units (nominally eight 12 unit courses).

Breadth Requirement

To increase the breadth in ECE, students must take 12 units of course work in a "new" area—an area in which they have not already taken an introductory course (this makes 4 breadth areas rather than the 3 required for the B.S. Degree).

Additional Design Capstone Requirement

To further prepare students for engineering design work, they must take an additional course (12 units) from the list of acceptable engineering design capstone courses (this makes 2 design capstone courses rather than the 1 required for the B.S. Degree). Both design capstones can be in the same area or in different areas. In the case of a CIT Honors Research Project (39-500), an extended project involving at least 24 units can be used to satisfy the Capstone Design Requirements of both the undergraduate and graduate degrees.

ECE Graduate Course Work

Graduate course work in ECE totalling 12 units must be taken. This can be any 18-5xx or higher course.

Advanced ECE Course Work

Advanced graduate courses in ECE totalling 36 units are required. Any 18-7xx or higher courses can be used to satisfy this requirement.

Advanced Engineering Course Work

An additional 24 units of Advanced Engineering Course work is required. Any courses that satisfy the Advanced ECE Course Work requirement or courses drawn from the Advanced Engineering Course list may be used to satisfy this requirement. Students may also petition the Graduate Education Committee (GEC) for approval to use other Advanced Engineering Courses and examples of these courses that have been approved in the past include the following:

15-612	Distributed Systems	12
16-743	Robotic Control	12
19-714	Telecom and Inform Pol Envir	6
45-875	Corp. Telecom Networks	6

Notes

The Integrated Masters/Bachelors Degrees Program is available to all undergraduates who maintain a cumulative QPA of 3.0 or better. 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 Masters Degree requirements for the Combined M.S./B.S. Degree (those over and above the requirements for the B.S. Degree). Students become eligible to apply to the program 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 graduate project can be used in place of any of the courses used to satisfy the ECE Graduate, Advanced ECE, or Advanced Engineering Course work requirements, provided 39-500 is not used to satisfy the additional Capstone Design requirement. The graduate project must contain substantial design and/or research experience. Graduate projects must be proposed (1 page abstract describing the project), supported by a Faculty advisor, and approved by the Graduate Education Committee.

In the event that courses with less than 12 units are used to satisfy some of the M.S. requirements, additional courses from the same category must be taken to meet or exceed the units requirement for that category.

Area Course Lists

In the following lists, courses satisfy one or more of the ECE requirements as indicated by the symbols: B = Breadth, Ds = Design, Co = Coverage, Dp = Depth.

Freshman Engineering and ECE Core		Units
18-100	Introduction to Electrical and Computer Engineering	12
18-220	Fundamentals of Electrical Engineering	12
18-240	Fundamentals of Computer Engineering	12

Applied Physics

18-303	Engineering Electromagnetics I (B, Co)	12
18-304	Engineering Electromagnetics II (Dp, Co)	12
18-311	Semiconductor Devices I (B, Co)	12
18-312	Semiconductor Devices II (Dp, Co)	12
18-316	Introduction to Data Storage Systems Technology (Dp, Co)	12
18-400	High Frequency System Design (Ds, Co)	12
18-405	Computer-Aided Design of Electromagnetic Systems (Ds, Co)	12

18-501	Electromechanics (Dp, Co)	12
18-517	Data Storage Systems Measurement Design Laboratory (Ds, Co)	12
18-701	Electromagnetic Field Theory (Co)	12
18-702	Finite Element Methods in Electrical Engineering (Co)	12
18-708	High Frequency Engineering (Co)	12
18-711	Solid State Electronics (Co)	12
18-712	Microwave and Optical Magnetics (Co)	12
18-714	Introduction to Superconducting Devices (Co)	12
18-715	Physics of Applied Magnetism (Dp, Co)	12
18-716	Advanced Applied Magnetism (Co)	12
27-432	Electrical, Magnetic, and Optical Properties of Materials (Co)	9
33-234	Quantum Physics I (B, Co)	10
33-335	Quantum Physics II (Dp, Co)	10
33-338	Intermediate Electricity and Magnetism I (B, Co)	10
33-439	Intermediate Electricity and Magnetism II (Dp, Co)	10
33-446	Advanced Quantum Physics (Co)	9
33-448	Introduction to Solid State Physics (Co)	9
33-453	Intermediate Optics (Co)	12

Signals and Systems

18-350	Fundamentals of Communication Systems (Dp, Co)	12
18-370	Fundamentals of Control (Dp, Co)	12
18-371	Design Optimization Techniques (Co)	12
18-373	Computer-Controlled Testing and Measurement System Design (Ds, Co)	12
18/15-384	Artificial Intelligence: Robotic Manipulation (Co)	9
18-396	Signals and Systems (B, Co)	12
18-474	Computer Control Systems Design Laboratory (Ds, Co)	12
18-575	Control Systems Design (Ds, Co)	12
18-751	Applied Stochastic Processes (Co)	12
18-752	Estimation, Detection and Identification (Co)	12
18-754	Error Control Coding: Theory and Applications (Co)	12
18-756	Circuit Switching & Packet Switching (Co)	12
18-757	Principles of Broadband Communications (Dp, Co)	12
18-791	Digital Signal Processing I (Dp, Co)	12
18-792	Digital Signal Processing II (Co)	12
18-793	Optical Image and Radar Processing (Co)	12
18-794	Pattern Recognition Theory (Co)	12
18-796	Numerical Optimization Methods (Co)	12
24-245	Dynamics of Physical Systems (Co)	11
24-246	Feedback Control Systems (Co)	9
24-247	Instrumentation and Design of Control Systems (Co)	9

Circuits

18-321	Analysis and Design of Analog Circuits (B, Co)	12
18-322	Analysis and Design of Digital Circuits (B, Co)	12
18-523	Analog Integrated Circuit Design (Dp, Ds, Co)	12
18-525	Integrated Circuit Design Project (Dp, Ds, Co)	12
18-723	Advanced Analog Integrated Circuit Design (Co)	12
18-725	Digital Integrated Circuit Design (Ds, Co)	12
18-728	Applications of Analog Integrated Circuits (Ds, Co)	12
18-762	Circuit Simulation: Theory and Practice (Co)	12

Computer Hardware

18-347	Introduction to Computer Architecture (B, Co)	12
18-349	Concurrency and Real-Time Systems (B, Co)	12
18-545	Advanced Digital Design Project (Dp, Ds, Co)	12
18-547	Superscalar Processor Design (Dp, Co)	12
18-549	Time Critical Computing Systems (Dp, Co)	12
18-760	VLSI CAD: Logic to Layout (Dp, Co)	12
18-742	Advanced Computer Architecture (Co)	12
18-746	Parallel Processing (Dp, Co)	12
18-748	Dependable System Design (Dp, Co)	12
18-763	Physical CAD for VLSI (Co)	12

Computer Software

15-211	Fundamental Structures of Computer Science I (B, Co)	12
15-212	Fundamental Structures of Computer Science II (Dp, Co)	12
15-312	Programming Languages Design and Processing (Co)	9
15-381	Artificial Intelligence: Representation and Problem Solving (Co)	9
15-385	Artificial Intelligence: Computer Vision (Co)	9
15-411	Compiler Design (Co)	12
15-412	Operating Systems (Co)	12
15-413	Software Engineering (Ds, Co)	12
15-414	Structured Programming and Problem Solving (Co)	9
15-451	Algorithms (Co)	9
15-453	Formal Languages and Automata (Co)	9
15-462	Computer Graphics (Co)	9
15-612	Distributed Systems (Co)	12
15-682	Engineering of Knowledge-Based Systems (Co)	12

Professional, Policy, and Interdisciplinary Topics

18-480	Senior Seminar	0
18-481	Analysis, Synthesis and Evaluation (Ds, Co)	12
18-482	Telecommunications: Technology, Policy and Management (Co)	12
18-483	Civilian and Military Applications of Space (Co)	12
18-489	Basic Trends in the Evolution of Modern Microelectronics (Co)	12
39-405 (Ds, Co)	Engineering Design: The Creation of Products and Process	12

Undergraduate Projects

18-231	Sophomore Project-Fall (Co)	variable
18-232	Sophomore Project-Spring (Co)	variable
18-331	Junior Project-Fall (Co)	variable
18-332	Junior Project-Spring (Co)	variable
18-431	Senior Project-Fall (Co)	variable
18-432	Senior Project-Spring (Co)	variable
18-439	Special Topics in ECE (Co)	variable
39-500	CIT Honors Research Project (Ds, Co)	variable

Advanced Engineering Courses

Any 18-7xx or higher course

15-612	Distributed Systems	12
16-741	Mechanics of Manipulation	12
16-743	Robotic Control	12
17-721	Software Design, Creation, Maint.	12
19-714	Telecom and Inform. Pol. Envir.	6
33-761	Classical Electrodynamics I	12
33-762	Classical Electrodynamics II	12
33-755	Quantum Mechanics I	12
45-940	Heuristic Syst. in Opt. Mgt.	6
45-945	Project in Heuristic Syst.	6
45-875	Corp. Telecom. Networks	6

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DANIEL P. SIEWIOREK, Professor of Electrical and Computer Engineering and Computer Science; Director, Design for Manufacturing Laboratory, Engineering Design Research Center — Ph.D., Stanford University; Carnegie Mellon, 1972—.

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GEOFFREY W. D. SPRATT, Research Engineer. Ph.D., Lancashire Polytechnic, U.K.; Carnegie Mellon, 1991—.

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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—.

ROBERT M. WHITE, Head and Professor of Electrical and Computer Engineering— Ph.D., Stanford University, Carnegie Mellon, 1993—.

Department of Materials Science and Engineering

Paul Wynblatt, Head
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It is difficult to cite any significant technological advancement since the Stone Age which has not been related to the development of a new or improved material or to the discovery of a new method of processing a given material. Materials Science and Engineering is a discipline which draws heavily on basic sciences such as chemistry, mathematics and physics, and also on engineering fundamentals, to refine, prepare, process, and manufacture materials which are useful for the technological needs of our society. The development of new materials, and the understanding and control of the structure and properties of new as well as existing materials, are essential parts of this discipline. Traditionally, materials subjects are divided into two broad areas: one dealing with the synthesis and processing of materials in order to obtain desired properties, and a second one which provides the basis to understand the behavior of materials under diverse conditions. Thus a materials engineer or scientist is concerned with many different processes for synthesizing new materials, improvement of existing processing methods through engineering fundamentals, and using the techniques of both materials science and physics to understand the interplay between the internal structure of materials and their properties, whether physical, chemical or mechanical.

Materials science has come to be regarded as the overarching term describing specific interests in metals, polymers, ceramics 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 incorporation of ceramics and polymer topics into long-established metallurgical academic programs has been a natural evolutionary occurrence.

The challenges to those trained in these areas have expanded recently as the importance of new topics has been recognized. Recycling of materials and substitution for scarce elements, conservation of energy, control of pollution, improved biomedical materials, superconducting materials, composite materials, and improved production techniques are just a few of the new topics receiving attention in this field. Graduates are finding careers shifting from an emphasis in the primary metals and materials producing industries to an expanding spectrum of high technology companies. Employment opportunities thus exist in research, development, production, and sales of most industrial organizations as well as government laboratories and universities.

The standard curriculum of the department provides fundamental training for these expanding areas. The elective program allows the attainment of excellence in a student's chosen specialty. The option of concentration in the areas of electronic materials*, engineering design*, biomedical engineering*, environmental engineering*, manufacturing engineering*, mechanical behavior of materials*, and engineering and public policy ** is available. (*= Designated Minor, **= Double Major)

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 summer 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 eventual leadership in our highly technological society which continues to demand more and more from the materials used in its engineering systems. Many of our graduates elect to continue their education to the Master's and Doctoral Level.

Standard Program

Freshman Year

	Fall	Units
21-121	Calculus	10
33-106	Physics for Engineering Students I	12
xx-xxx	Introductory Engineering Elective	12
76-xxx	Writing/Expression Course	9
		43
	Spring	
21-122	Calculus with Linear Algebra	10
15-127	Introduction to Programming and Computer Science	10
xx-xxx	Introductory Engineering Elective	12
xx-xxx	General Education Course	9
99-101	Computing Skills Workshop.	3
		44

Sophomore Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
33-107	Physics for Engineering Students II	12
09-101	Introduction to Experimental Chemistry	3
09-105	Modern Chemistry I	10
27-201	Structure of Materials	9
xx-xxx	General Education Course	9
		52
	Spring	
21-260	Differential Equations	9
36-220	Engineering Statistics and Quality Control	9
09-106	Modern Chemistry II	10
27-250	MSE Sophomore Seminar	3
27-215	Thermodynamics of Materials	2
xx-xxx	General Education Course	9
		52

Junior Year

	Fall	Units
33-225	Quantum Physics and Structure of Matter	9
27-303	MSE Lab I	9
27-321	Transport and Kinetics	12
27-311	Phase Relations	2
xx-xxx	General Education Course*	9
or		
xx-xxx	Free Elective*	9
		51
	Spring	
27-304	MSE Laboratory II	9
xx-xxx	General Education Course	9
xx-xxx	Free Elective*	9
or		
xx-xx	General Education Course*	9
xx-xxx	Technical Elective	9
or		
27-xxx	Restricted Elective	9
27-xxx	Restricted Elective	9
or		
xx-xxx	Technical Elective	9
		45

Senior Year

	Fall	Units
27-555	Senior Project I	9
27-xxx	Restricted Elective	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
27-xxx	Restricted Elective**	9
or		
xx-xxx	General Education Course**	9
		45

	Spring	
27-557	Selection and Performance of Engineering Materials	9
27-xxx	Restricted Elective	9
xx-xxx	Technical Elective	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course**	9
or		
27-xxx	Restricted Elective**	9
		45

Minimum number of units required for degree: 377

* If the general education course is chosen in the fall, then the free elective should be taken in the spring, and vice versa.

** If the restricted elective is chosen in the fall, then the general education course should be taken in the spring, and vice versa.

Notes on the Curriculum

Quality Point Average

In addition to the College requirement of a minimum cumulative quality point average of 2.00 for all courses taken beyond the freshman year, the Department requires a quality point average of 2.00 or higher in courses taken in the MSE department. Students may repeat a course to achieve the QPA requirement. Only the higher grade will be used for this departmental calculation.

Restricted Electives and Technical Electives

Two restricted electives must be chosen from each of the course lists below, entitled "Properties and Performance of Materials" and "Processing of Materials". Up to four technical electives may be chosen from those two lists, the "Enrichment" list, or other courses approved by the student's advisor to meet the requirements of a minor, or to deal with scheduling difficulties of transfer students.

At least 18 units of Technical Electives must be selected from courses in CIT (excluding 19-319, 19-321, 42-500, and 42-501).

Properties and Performance of Materials

27-412	Phase Transformations
27-432	Electrical, Magnetic and Optical Properties of Materials
27-441	Deformation and Fracture of Materials
27-530	Advanced Physical Metallurgy
27-551	Properties of Ceramics and Glasses
06-609	Physical Chemistry of Macromolecules

Processing of Materials

27-322	Processing Methods
27-421	Processing Design
27-442	Deformation Processing
27-533	Principles of Growth and Processing of Semiconductors
06-314	Experimental Polymer Science

Enrichment

27-350	Industrial Projects Seminar
27-454	Supervised Reading
27-512	Diffraction Methods in Materials Science
27-542	Structure and Properties of Thin Films
27-556	MSE Senior Project II
27-566	Special Topics in MSE
27-592	Solidification Processing

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 summer following 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. More detail may be found in the booklet entitled "The Industrial Internship Option."

Freshman Year

Standard Program

Sophomore Year

Standard Program for the academic year; the first industry period occurs in the summer following the Sophomore year.

Junior Year

	Fall	Units
Same as Standard Program.		51
	Spring	
	Industry 2	0
	Summer	
27-304	MSE Laboratory II	9
27-xxx	Restricted Elective	9
or		
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
xx-xxx	Technical Elective	9
or		
27-350	Industrial Projects Seminar	9
xx-xxx	Free Elective*	9
or		
xx-xxx	General Education Course*	9
		45

Senior Year

	Fall	Units
	Industry-3	0
	Spring	
27-557	Selection and Performance of Engineering Materials	9
27-xxx	Restricted Elective	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
xx-xxx	Technical Elective**	9
or		
27-xxx	Restricted Elective**	9
		45
	Summer	
	Industry-4	0

Fifth Year

	Fall	Units
27-555	Senior Project I***	9
27-xxx	Restricted Elective	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
27-xxx	Restricted Elective**	9
or		
xx-xxx	Technical Elective**	9
		45

Minimum number of units required for degree: 377

* If the general education course is chosen in the fall, then the free elective should be taken in the summer, and vice versa.

** If the restricted elective is chosen in the fall of the senior year, then the technical elective should be taken in the fall of the fifth year, and vice versa.

*** Can be taken in Spring semester with restricted or technical elective moved to Fall semester.

Industrial Internship Option Leading to B.S. and M.S. Degrees

This program is open to exceptionally able students who will be taking some graduate courses in their fifth year and who will continue through the summer of their fifth year. The first four years of study, including four industry periods, are the same as for the normal industrial internship option. The fifth year and the following summer are different as illustrated below. If academic performance is satisfactory, the student will receive a B.S. degree in May of the fifth year and will complete requirements for the M.S. prior to September 1 of the fifth year. The actual M.S. degree will be granted at the following May commencement, but the student will be given a letter, for employment purposes, stating that requirements for the degree have been completed. Interested students should apply to the head of the Department of Materials Science and Engineering prior to February 15 of their fourth year. The standards for admission to this program are very high and it is anticipated that very few students will qualify.

Freshman through Senior Year

See Industrial Internship Option curriculum

Fifth Year

	Fall Semester - Applied Toward B.S.	Units
27-555	Senior Project I***	9
	Fall Semester - Applied Toward M.S.**	
27-780	Thermodynamics	12
27-778	Mathematical Methods	12
27-779	Bonding, Crystals and Defects	12
		45
	Spring Semester - Applied Toward B.S.	
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
27-xxx	Restricted Elective	9
27-xxx	Restricted Elective	9
or		
xx-xxx	Technical Elective	9
	Spring Semester - Applied Toward M.S.**	
27-xxx	Graduate Elective	9
xx-xxx	Elective*	9
xx-xxx	Graduate Seminar	0
		54
	Summer - Applied Toward M.S.**	
27-755	Materials Problems	33
xx-xxx	Elective*	9
		42

Unit Totals in fifth year: undergraduate, 45; graduate, 96.

Minimum number of units required for B.S. degree: 377.

Minimum number of units required for M.S. degree 96.

* These electives should be graduate courses or advanced undergraduate courses of the type that can be counted toward the M.S. degree.

** 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 fifth year. Although some specific graduate courses are recommended above, substitutions are permitted within the freedom of the normal requirements for the M.S. degree. (See the Graduate Catalog for further details.) Students interested in a program with a strong research orientation are encouraged to elect 27-556 Senior Project II as part of their undergraduate program. Tuition will be at the undergraduate rate for the fall of the fifth year and at the graduate rate for the subsequent spring and summer. Financial assistance for spring and summer will be on a competitive basis with the normal graduate program. Students who wish to continue for study toward the Ph.D. degree should make such arrangements during the spring of the fifth year.

*** Can be taken in Spring semester with restricted or technical elective moved to Fall semester.

Faculty

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BAHRI OZTURK, Research Faculty of Materials Science and Engineering — Ph.D., Pennsylvania State University; Carnegie Mellon, 1983—.

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Department of Mechanical Engineering

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The profession of mechanical engineering is concerned with the development of new methods for the utilization of physical phenomena through various mechanical and thermal systems. Mechanical engineers are employed by industry, government, consulting firms, and universities. Their work involves innovation, design, analysis, evaluation, and optimization of complex systems. The Department of Mechanical Engineering at Carnegie Mellon University is known for the many significant advances in technology made by its graduates.

The continual evolution of modern technology and new demands which must be met in the future are recognized in the departmental curriculum. There is a good balance of mechanical engineering courses, including mechanics of solids and fluids, thermodynamics, heat transfer, control systems, analysis, and design. All build upon the basic courses in mathematics, physics, and chemistry. Advanced-level courses are available in such areas as air pollution, energy conversion, materials processing, manufacturing, quality control, and engineering design. Mechanical engineering students may take courses in other departments to study biology, environmental matters, engineering as related to public policy, and many other topics. Structured options in several areas of interest are available.

Course work emphasizes both theory and experiment. Study of theory proceeds from a firm grasp of mathematics, physics, and chemistry to the use of these principles in engineering problems. Experimental work in newly-renovated laboratories is part of some courses so that each student may develop an ability to solve real problems, using the principles presented in the classroom. Some laboratory experiments involve turbines, jet propulsion engines, internal combustion engines, structures, energy conversion, and special mechanical devices.

An engineering design course in the senior year provides an opportunity for students to develop the solution to an unstructured engineering problem. In recent years the senior class was involved with using solar energy for cooling, a microprocessor-monitored engine, a high performance ski binding, fuel metering apparatus, and a linear carrier for a welding robot. In order to allow undergraduates to study a subject of personal interest, a project course may be elected by special arrangement. Under the supervision of a faculty member, the student can pursue a design problem, analyze a system, become familiar with the state of the art in a particular field, or undertake a research investigation. Many seniors have used the project course to continue problems which were begun in the engineering design course. A project course is required for students to graduate with honors from the department.

Through both university and departmental facilities, each mechanical engineering student has access to computer capability more extensive and more powerful than that provided by most schools of mechanical engineering. The department provides a student machine shop where students may become familiar with basic metalworking machinery.

Frequent seminars are sponsored by the department, which keep students and faculty aware of progress in mechanical engineering and related fields. Speakers of national and international reputation are invited to lecture to undergraduates, graduate students, and faculty on new developments in various specialized fields of interest.

In addition to its interest in teaching, the departmental faculty is strongly involved in extensive research programs that cover many areas and utilize excellent laboratory and computational facilities. Almost all of these programs are supported by industry or government. Research carried out in the department serves the undergraduate by direct enrichment of classroom courses and by providing opportunities for individual students to pursue special personal interests when these interests coincide with ongoing research. The field of mechanical engineering is both challenging and rewarding, and the department encourages its undergraduate students to begin their careers by taking part in many of the departmental activities.

About the Curriculum

A core of required courses covers the fundamental material in mechanical engineering and meets the requirements for an accredited curriculum as certified by the Accreditation Board for Engineering and Technology (ABET). In addition, there are elective courses which may be used to build a program suited to the desires and interests of each student. To facilitate a student's choice of a program, the elective courses have been assembled in a variety of options. Normally, a student will be guided by one of these options but if there are good reasons to do so the department may approve a special program requested by a student. Recommended options are listed later in this section. Programs not listed might include work in electrical engineering, electronics, computer systems, mathematics, administration and management, biology, biomedical engineering, engineering and public policy, and environmental studies. There is one free elective in the curriculum. It may be any course in the university for which the student has the prerequisites. The free elective is shown in the senior year but it may be taken earlier. A faculty adviser is assigned to each student before the beginning of the sophomore year. The student usually will have the same faculty adviser until graduation. The faculty adviser helps the student put together a coherent program that is best suited for that student.

Curriculum

Freshman Year

	Fall	Units
21-121	Calculus	10
24-101	Fundamentals of Mechanical Engineering	12
33-106	Physics for Engineering Students I	12
99-101	Computing Skills Workshop	3
xx-xxx	Writing/Expression Course	9
		46
	Spring	
21-122	Calculus with Linear Algebra	10
xx-xxx	Introductory Engineering Elective	12
xx-xxx	Restricted Technical Elective	10 -13
xx-xxx	General Education Course	9
		41-44

Sophomore Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
24-121	Thermodynamics I	9
24-141	Statics and Dynamics	12
xx-xxx	Restricted Technical Elective*	10-13
xx-xxx	General Eduation Course**	9
		49-52
	Spring	
21-260	Differential Equations	9
24-112	Fluid Mechanics	9
24-202	Mechanics of Deformable Solids	10
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		47-50

Junior Year

	Fall	Units
24-223	Thermodynamics II	12
24-245	Dynamics of Physical Systems	11
24-258	Numerical Methods	9
24-281	Mechanical Engineering Seminar I	1
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
		51

	Spring	
18-113	Fundamentals of Electrical Engineering	9
24-203	Stress Analysis	10
24-233	Heat Transfer	9
24-246	Feedback Control Systems	9
24-282	Mechanical Engineering Seminar II	1
xx-xxx	General Education Course	9
		47

Senior Year

	Fall	Units
24-251	Engineering Analysis	
or		
24-266	Engineering Design	12
24-2xx	Fluid Mechanics Elective	
or		
xx-xxx	Technical Elective	10-9
xx-xxx	Technical Elective	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
		49-48

	Spring	
24-266	Engineering Design	
or		
24-251	Engineering Analysis	12
24-2xx	Fluid Mechanics Elective	
or		
xx-xxx	Technical Elective	10-9
xx-xxx	Technical Elective	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		49-48

Minimum number of units required for degree: 382

* At the end of the sophomore year, a mechanical engineering student should have completed the following mathematics, science, computer science, and introductory engineering courses:

		Units
21-121	Calculus	10
21-122	Calculus with Linear Algebra	10
21-259	Calculus in Three Dimensions	9
21-260	Differential Equations	9
33-106	Physics for Engineering Students I	12
33-107	Physics for Engineering Students II	12
09-101	Introduction to Experimental Chemistry	3
09-105	Modern Chemistry I	10
15-127	Introduction to Programming & Computer Science	10
24-101	Introduction to Mechanical Engineering	12
xx-xxx	Second Introductory Engineering Elective	12

** For those freshmen who have not taken 24-101 as one of the two Introductory Engineering Electives, 24-101 should be taken in the Fall semester of the Sophomore year instead of the H&SS elective which will be made up during the Junior or Senior year. The extra Introductory Engineering Elective can be used to fulfill a technical elective.

Notes on the Curriculum

In addition to the College requirement of a cumulative quality point average of 2.00 or higher for all courses taken after the freshman year, the Mechanical Engineering Department requires a quality point average of 2.00 or higher for all required Mechanical Engineering courses. Students may repeat a course in which a grade below C was received to achieve the QPA requirement. The highest grade obtained will be used to calculate the average in required Mechanical Engineering courses.

24-251 Engineering Analysis and 24-266 Engineering Design: Students take one of these courses in the fall semester and the other in the spring semester.

Fluid Mechanics Elective:

The student must schedule at least one of the following —

24-213	Viscous Flow
24-215	Potential Flow and Aerodynamics
24-216	Gas Dynamics

Technical Electives and Options

Technical electives allow students to take courses in technical areas where they have special interests.

The technical electives in the junior and senior years are usually chosen from the following list of approved courses offered by the Department of Mechanical Engineering, provided that the student has satisfied the prerequisites. With the exception of 24-160 Engineering Graphics, the courses in this list are all at an advanced undergraduate level.

Technical Elective Courses

24-160	Engineering Graphics
24-208	Manufacturing Sciences
24-213	Viscous Flow
24-215	Potential Flow and Aerodynamics
24-216	Gas Dynamics
24-224	Thermal Systems Analysis
24-225	Direct Energy Conversion
24-227	Internal Combustion Engines
24-242	Engineering Vibrations
24-243	Engineering Dynamics
24-247	Instrumentation and Design of Control Systems
24-248	Kinematics and Dynamics of Mechanisms
24-249	Dynamics and Vibrations
24-268	Design for Manufacture
24-269	Quality Assurance
24-271	Mechanical Engineering Project*
24-272	Mechanical Engineering Project*
24-273	Departmental Research Honors*
24-274	Departmental Research Honors*
24-295	Air Pollution
24-297	Energy and Environmental Systems
24-301	Nuclear Power Generation

*A maximum of two may be taken as technical electives.

Certain graduate courses offered by the Department of Mechanical Engineering may also be taken as senior technical electives, provided that the student has met the prerequisites and secured approval of a faculty advisor and the instructor for the course. A list of Mechanical Engineering graduate courses may be found in the Course Description section of the catalog. In addition, courses offered by other departments in Carnegie Institute of Technology or Mellon College of Science, may be selected as technical electives, provided that approval is obtained from the student's advisor or the Undergraduate Committee. Accounting, production, marketing, finance and management courses offered by the Industrial Management Department and statistics courses for engineers offered by the Statistics Department may also be used as technical electives.

The senior technical electives are grouped into options to help students select a coherent program. An option should be chosen before the senior year or else a special program should be developed with approval of a faculty advisor. The options listed below are only suggestions. Students can create their own options by taking any combination of technical electives with advisor approval. After choosing an option, a student may still have space for additional technical electives or may make a substitution within an option, with the approval of a faculty advisor. The department will try to offer all courses for the options but it can neither guarantee their availability nor guarantee that there will be no scheduling conflicts, especially since the department has no control over courses offered by other departments. The prerequisites for non-mechanical engineering courses are subject to change with very little or no notice, which could affect an option group. The following options are available:

General Mechanical

	Fall Semester
24-208	Manufacturing Sciences
24-227	Internal Combustion Engines
24-242	Engineering Vibrations
24-701*	Mathematical Techniques in Mechanical Engineering I

	Spring Semester
24-224	Thermal Systems Analysis
24-243	Engineering Dynamics
24-248	Kinematics and Dynamics of Mechanisms

Aerospace Engineering

Fall Semester

24-213 Viscous Flow
24-227 Internal Combustion Engines
24-242 Engineering Vibrations
24-751* Introduction to Solid Mechanics I
24-771* Modern Control Engineering

Spring Semester

24-215 Potential Flow and Aerodynamics
24-216 Gas Dynamics
24-243 Engineering Dynamics

Automotive Engineering

Fall Semester

24-227 Internal Combustion Engines
24-242 Engineering Vibrations
24-295 Air Pollution

Spring Semester

24-224 Thermal Systems Analysis
24-243 Engineering Dynamics

Computational Fluid Mechanics

Fall Semester

24-213 Viscous Flow

Spring Semester

24-215 Potential Flow and Aerodynamics
24-216 Gas Dynamics
24-703* Numerical Methods in Mechanical Engineering
24-718* Computational Fluid Dynamics

Computational Solid Mechanics

Fall Semester

24-751* Introduction to Solid Mechanics I

Spring Semester

24-703* Numerical Methods in Mechanical Engineering
24-768* Finite Element Method in Structural Mechanics

Design

Fall Semester

24-208 Manufacturing Sciences
24-242 Engineering Vibrations
24-781* Design Procedures

Spring Semester

24-243 Engineering Dynamics
24-248 Kinematics and Dynamics of Mechanisms
24-268 Design for Manufacture
24-782* Design and Entrepreneurship

Energy/Environment

Fall Semester

24-227 Internal Combustion Engines
24-295 Air Pollution
24-721* Thermodynamics I

Spring Semester

24-216 Gas Dynamics
24-224 Thermal Systems Analysis
24-225 Direct Energy Conversion

Manufacturing/Robotics

Fall Semester

24-208 Manufacturing Sciences
24-765* Dynamics

Spring Semester

24-268 Design for Manufacture
24-269 Quality Assurance
36-220 Engineering Statistics and Quality Control

Systems and Dynamics

Fall Semester

24-208 Manufacturing Sciences
24-242 Engineering Vibrations
24-249 Dynamics and Vibrations
24-765* Dynamics
24-771* Modern Control Engineering

Spring Semester

24-243 Engineering Dynamics
24-248 Kinematics and Dynamics of Mechanisms

Thermal-Fluid Sciences

Fall Semester

24-213 Viscous Flow
24-227 Internal Combustion Engines
24-711* Fluid Mechanics
24-721* Thermodynamics I

Spring Semester

24-215 Potential Flow and Aerodynamics
24-216 Gas Dynamics
24-224 Thermal Systems Analysis

*This is a graduate course and can only be taken with the instructor's approval.

Also available are minors in Biomedical Engineering, Electronic Materials, Engineering Design, Environmental Engineering, Manufacturing Engineering, and Mechanical Behavior of Materials, as well as a double-major in Engineering and Public Policy; these programs utilize the technical elective slots in the Mechanical Engineering curriculum. To enroll in any of these programs students should consult the faculty member in Mechanical Engineering responsible for advising the minor.

Departmental Research Honors

In order to graduate with Departmental Research Honors, a student must have a QPA of 3.2 or higher at graduation and complete 18 units of thesis research under 24-273 and 24-274 (see course description) with a grade of B or better. A student who completes all requirements for the CIT Research Honors will also graduate with Departmental Research Honors if a written thesis describing the work done under 18 units of 39-500 (see course description) is submitted and approved before graduation. Projects must be conducted under the supervision of a mechanical engineering faculty member.

Faculty

ADNAN AKAY, Professor of Mechanical Engineering; Head, Department of Mechanical Engineering — Ph.D., North Carolina State University; Carnegie Mellon, 1992—.

CRISTINA HORTENSIA AMON, Associate Professor of Mechanical Engineering — Sc.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.

DAVID HORACE ARCHER, Adjunct Professor of Mechanical Engineering — Ph.D., University of Delaware; Carnegie Mellon, 1991—.

DWIGHT MAYLON BILLY BAUMANN, Professor of Engineering Design — Sc.D., Massachusetts Institute of Technology; Carnegie Mellon, 1970—.

JACK LEE BEUTH, Assistant Professor of Mechanical Engineering — Ph.D., Harvard University; Carnegie Mellon, 1992—.

JONATHAN CAGAN, Assistant Professor of Mechanical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1990—.

NORMAN CHIGIER, William J. Brown Professor of Mechanical Engineering — Sc.D., University of Cambridge; Carnegie Mellon, 1981—.

MINGKING K. CHYU, Professor of Mechanical Engineering — Ph.D., University of Minnesota; Carnegie Mellon, 1987—.

JERRY HOWARD GRIFFIN, Professor of Mechanical Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1980—.

THOMAS ROLAND KURFESS, Associate Professor of Mechanical Engineering and Engineering and Public Policy — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1989—.

WILLIAM CHARLES MESSNER, Assistant Professor of Mechanical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1993—.

JOHN FLETCHER OSTERLE, Theodore Ahrens Professor of Mechanical Engineering — D.Sc., Carnegie Mellon University; Carnegie Mellon, 1946—.

WILFRED THOMAS ROULEAU, Professor of Mechanical Engineering — 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—.

ARMISTEAD GOODE RUSSELL, Professor of Mechanical Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1985—.

TOM I-P. SHIH, Professor of Mechanical Engineering — Ph.D. , University of Michigan; Carnegie Mellon, 1988—.

GLENN SINCLAIR, Professor of Mechanical Engineering — Ph.D., California Institute of Technology; Carnegie Mellon, 1977—.

PAUL SETH STEIF, Professor of Mechanical Engineering — Ph.D., Harvard University; Carnegie Mellon, 1983—.

ROBERT HAROLD STURGES, JR., Associate Professor of Mechanical Engineering — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1987—.

JONATHAN ADAM WICKERT, Assistant Professor of Mechanical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1990—.

JOHN WILLIAM WISS, Adjunct Professor of Mechanical Engineering — M.Mech.E., Rensselaer Polytechnic Institute; Carnegie Mellon, 1982—.

SHI-CHUNE YAO, Professor of Mechanical Engineering — Ph.D., University of California, Berkeley; Carnegie Mellon, 1977—.

Department of Engineering and Public Policy

M. Granger Morgan, Head
Indira Nair, Associate Department Head
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The Department of Engineering and Public Policy (EPP) is a unique engineering department, whose objective is to enhance 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 that engineers design 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.

The department offers double-major B.S. degree programs with each of the five traditional engineering departments in the college (e.g., B.S. in chemical engineering/engineering and public policy). 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. These double-major programs all 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.

All the undergraduate degree programs in Engineering and Public Policy 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 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 abstracted from local, state, and national situations and include such topics as industrial automation and robotics, environmental control, telecommunication and computer technologies, product safety, and energy systems. Engineering and Public Policy students take the 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 the Department of Industrial Management. There is also significant interaction between EPP students and the Environmental Institute, the H. John Heinz III School of Public Policy and Management, and the Department of Social and Decision Sciences.

All undergraduates interested in the programs of the department complete the common freshman year of Carnegie Institute of Technology and Mellon College of Science 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 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 IM or a H&SS discipline may not be possible without overloads. If you are interested in exploring these options, please contact the EPP undergraduate 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 then 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: Spyros Pandis

For Civil Engineering/Engineering and Public Policy majors: Cliff I. Davidson, Francis C. McMichael, Sue McNeil, Mitchell J. Small

For Electrical and Computer Engineering/Engineering and Public Policy majors: Jon Peha, Marvin A. Sirbu

For Mechanical Engineering/Engineering and Public Policy majors: Edward S. Rubin

For Materials Science and Engineering and Public Policy majors: Henry R. Piehler

For EPP-Heinz School 3-2 program: Indira Nair

Designated Minors are possible with an EPP double major. Students should see their adviser early to plan for these.

Students can also obtain general academic advice and guidance from Indira Nair, the associate department head of Engineering and Public Policy.

Double-Major Curricula

Bachelor of Science in an Engineering Specialty 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 engineering career. With the appropriate curriculum the student simultaneously satisfies all requirements for the undergraduate degree in one of the five traditional engineering departments and all requirements for the undergraduate degree in Engineering and Public Policy. A single, fully accredited bachelor's degree in the two areas (e.g., bachelor of science in chemical engineering/ engineering and public policy) is awarded. With early planning, some of the designated minors are also possible without overload.

This degree program has the attractive feature of allowing engineering 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.

Specific degree requirements for the double major program vary with department. However, with the exception of a three unit seminar course, the double-major program requires the same number of courses for completion as the corresponding single-major departmental degree programs. However, as the curricula on the following pages illustrate, there are substantial differences between elective course requirements for the double-major and single-engineering-major students. 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:

Engineering Field	Number of Courses: Single Major	Number of Courses: Double Major with EPP	Number of Units: Single Major	Number of Units: Double Major with EPP
Chemical Engineering	42	42	387	393
Civil Engineering	41	41	379	382
Electrical & Computer Engineering	40	41	360	369
Mechanical Engineering	42	42	379	387
Material Science and Engineering	42	42	376	384

Course requirements for each double-major degree are listed below. By completing these requirements, a student simultaneously completes all requirements for each departmental degree. Students who feel that they may be interested in an EPP double major program are advised to check with the appropriate faculty advisor or with Indira Nair in the EPP Department about the optimal selection of courses. By planning the four-year curriculum in the freshman year, the student can be sure to get the maximum flexibility, and the maximum advantage from any advanced placement credits he or she may have.

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. Following the suggested curriculum listings given after this note, more details are given about EPP Project Courses, technical electives, and social analysis electives.

Freshman Electives: An EPP major does not need 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 engineering major department. These requirements are listed below.

ChE/EPP, Civ E/EPP and MechE/EPP:

By the end of the sophomore year, the students should have completed the following mathematics and science courses:

21-121	Calculus I
21-122	Calculus II
21-259	Calculus in Three Dimensions
21-260	Differential Equations
33-106	Physics for Engineering Students I
33-107	Physics for Engineering Students II
09-101	Introduction to Experimental Chemistry
09-105	Modern Chemistry
15-127	Intro to Programming/ Computer Science
99-101	Computer Skills Workshop

In addition, 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 two distribution requirements - cognition and institutions, depth sequence and other general education elective categories are replaced by the policy components of the double major curriulum as reflected in the social analysis electives described later.

Core courses

The EPP double major curriculum consists of two sets of core courses: one set for the disciplinary engineering major (ChE, CE, ECE, MechE, 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 engineering major. The EPP core contains the sophomore seminar, two EPP project courses, two semesters of a probability and statistics sequence, an introductory economics and a decision science course, taken in the H&SS elective slots . Specifically, the EPP core consists of the following courses:

19-102	EPP Sophomore Seminar
19-451	EPP Project I
19-452	EPP Project II
36-211	Probability & Statistics for Physical Science &Engineering I
OR	
36-217	Probability Theory and Random Processes (preferrable for ECE /EPP majors)
36-212	Probability and Statistics for Physical Sciences & Engineering II
OR	
36-220	Engineering Statistics and Quality Control
73-100	Principles of Economics
88-223	Decision Analysis and Decision Support Systems
OR	
88-302	Behavioral Decision Making
OR	
88-348	Strategic Games and Decisions

In addition to the core, the EPP double major also takes four EPP technical electives and four social analysis electives as described below.

The above EPP core courses in general replace technical, general education and mathematics electives of the single major. The one exception is the EPP Project I which replaces the engineering core course indicated below in each case:

ChemE/EPP : 19-451, EPP Project replaces the Chemical Engineering elective in the Junior year.

CivE/EPP : 19-451, EPP Project replaces 12-647, CivE Project and 12-648, Civ E Seminar.

EE or CompE/EPP : 19-451, EPP Project replaces a free elective.

MechE/EPP : 19-451, EPP Project replaces 24-251, Engineering Analysis.

MSE/EPP : 19-451, EPP Project replaces a free elective.

Except for the replacements indicated above, the disciplinary engineering core course requirements remain unchanged for the EPP double major.

The second EPP Project replaces a technical or engineering elective in the single major curriculum.

EPP Technical Elective Requirement

EPP technical electives are 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 are given later in this section. All double majors take any four EPP technical electives with the following special cases:

- ChemE/EPP students count the following two ChemE core courses as EPP technical electives and hence take only two more EPP technical electives:

(1) 06-302 Process Engineering and Synthesis
(2) 06-303 Design Project &
06-304 Eonomics and Optimization

-CivE/EPP students take two EPP electives in the CivE department. The other two may also be in Civil engineering .

-MechE/EPP students count 24-267, Engineering Design as an EPP technical elective. So they ME/EPP students take only three more EPP technical electives.

-MSE/EPP students count 27-557, Selection and Performance of Materials as an 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.

Other Technical Elective Requirements:

Probability & Statistics Sequence Requirement

All EPP double majors take two semesters of statistics. The first one is 36-211, Probability and Applied Statistics I for all students except ECE majors who take 36-217, Probability Theory and Random Processes. The second course may be either 36-212, Probability and Applied Statistics II or 36-220, Engineering and Quality Control Statistics. MSE students must take 36-220 as their second course.

• ChemE/EPP majors take 36-211 in place of a technical elective and 36-212 or 36-220 in place of a free elective.

• CivE/EPP majors have 36-211 or 36-220 in their single major curricula, and take 36-212 or, 36-220 as a free elective.

• EE/EPP majors must take 36-211 or 36-217 and 36-220 or 36-212.

• MechE/EPP majors take 36-211 in place of 24-254 Numerical Methods and 36-212 or 36-220 in place of a free elective.

• MSE/EPP majors take 36-211 in place of a free elective and take 36-220 as part of their MSE curriculum.

Social Analysis Elective Requirement

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 Department of Industrial Management (IM). All EPP majors are required to take the following two courses in addition to four other social analysis courses.

73-100	Principles of Economics
88-223	Decision Analysis and Decision Support Systems
or	
88-302	Behavioral Decision Making
or	
88-348	Strategic Games and Decisions

Social Analysis courses are described in greater detail in a later section. The most advisable choice is to take 73-100 as early as possible, for instance, in the Freshman year if the student has advanced placement in Freshman Writing or Humanities requirement. 88-223 has to be taken with 36-211 Probability and Statistics I as a pre-or co-requisite.

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.

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 double major (__ engineering/EPP) 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, accounting, 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 Indira Nair (EPP) for more information.

Special Feature: 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 researching and attempting to solve actual and critical problems currently affecting society. The student, faculty, and graduate student managers for the project are drawn from EPP, Heinz School and the Social Sciences (SS), and hence bring different areas of expertise to the structuring and solution of the problem.

The topics for these 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:

The problem selected for study is associated with a public policy constrained both technically and socio-economically;

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.

A set of external experts acts as a client for the project and composes a review panel which critiques class efforts during the semester;

Class organization is aimed at synthesis of a problem solution. 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.

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.

• "Design of Pollution Alert-Warning-Emergency System" (1971) — Allegheny County Bureau of Air Pollution Control;

• "An Assessment of Pennsylvania's Periodic Motor Vehicle Inspection System" (1975)— public;

• "Product Liability Tort Reform: Crisis of Uncertainty "(1979)— Pennsylvania State Legislators;

• "An Assessment of Civil Sector Uses of Digital Data Encryption" (1980) - Public;

"Compensation for Delayed Disease from Exposure to Chemicals and Drugs" (1982) - Public;

• "Milltowns in the Pittsburgh Region : Conditions and Prospects" (1983) - Allegheny County Department of Development;

• "Local Emergency Response to Hazardous materials transportation Accidents in Allegheny County" (1986) - Allegheny County Emergency Management Office

• "Water Supply for the Greater Pittsburgh Area: 1988 and Beyond" (1988)— Municipalities in Allegheny County;

• "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 ;

• "Impacts of Defense Cuts and Economic Conversion" (1992)- Government and Industry Policy makers;

• "The Automobile and the Environment : A Greener Automobile th rough Materials Substitution" (1992)- Automobile manufacturers;

• "Aral Sea Regional Ecological Crisis" (1992) - Senator Albert Gore of Tennessee;

• "Personal Communication Systems : A Policy Analysis" (1993) - Bell Atlantic;

• "Environmental Labeling" (1993) - Public

Chemical Engineering

Single Major

Sophomore Year

	Fall	Units
21-259	Calculus in Three-Dimensions	9
06-151	Thermodynamics	12
09-117	Organic Chemistry I	9
xx-xxx	Computer Sci/Basic Sci*	10-12
xx-xxx	General Education Course	9
		49-51

	Spring	
06-152	Principles of Transport Processes I	9
06-155	Chemical Engineering Mathematics I	6
06-204	Chemical Engineering Thermodynamics	6
xx-xxx	Computer Sci/Basic Sci.	10-12
xx-xxx	Adv.Chem/Biochem Elective	9
xx-xxx	General Education Course	9
		49-51

Junior Year

	Fall	Units
06-201	Principles of Transport Processes II	9
06-156	Chemical Engineering Mathematics II	6
06-205	Chemical Engineering Process Control	6
09-206	Physical Principles of Analytic Chemistry	9
09-245	Physical Chemistry II	9
xx-xxx	General Education Course	9
		48

	Spring	
06-202	Unit Operations of Chemical Engineering	9
06-211	Transport Processes Laboratory	6
09-246	Physical Chemistry III	9
09-131	Experimental Techniques in Chemistry I	10
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
		52

Senior Year

	Fall	Units
06-301	Chemical Engineering Kinetics	9
06-302	Process Engineering and Synthesis	12
06-308	Chemical Engineering Seminar	3
06-311	Unit Operations Laboratory	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
		51

	Spring	
06-303	Design Project	6
06-304	Economics and Optimization	6
xx-xxx	Technical Elective	9
xx-xxx	Technical Elective	9
xx-xxx	Free Elective	9
xx-xxx	General Education Course	9
		48

Minimum number of units required for degree: 389

Chemical Engineering/ Engineering and Public Policy Double Major

Sophomore Year

	Fall	Units
21-259	Same	9
06-151	Same	12
09-117	Same	9
xx-xxx	Same	10-12
73-100	Principles of Economics	9
19-102	EPP Sophomore Seminar	3
		52-54

	Spring	
06-152	Same	9
06-155	Same	6
06-204	Same	6
xx-xxx	Same	10-12
36-220	Engineering Statistics and Quality Control	9
xx-xxx	Social Analysis Elective	9
		49-51

Junior Year

	Fall	Units
06-201	Same	9
06-156	Same	6
06-205	Same	6
09-206	Same	9
09-245	Same	9
xx-xxx	Social Analysis Elective*	9
		48

	Spring	
06-202	Same	9
06-211	Same	6
09-246	Same	9
09-131	Same	10
19-451	EPP Project	12
xx-xxx	Social Analysis Elective*	9
		55

Senior Year

	Fall	Units
06-301	Same	9
06-302	Same	12
-		
06-311	Same	9
19-452	EPP Project	12
36-211	Probability and Statistics I	9
		51

	Spring	
06-303	Same	6
06-304	Same	6
xx-xxx	EPP Technical Elective	9
xx-xxx	EPP Technical Elective	9
xx-xxx	Social Analysis Elective	9
xx-xxx	Social Analysis Elective	9
		48

Minimum number of units required for degree: 393

* One of these must be taken from the following list:

88-302	Behavioral Decision Making
88-223	Decision Analysis and Decision Support Systems
88-344	Strategic Games and Decisions

Civil Engineering

Single Major

Sophomore Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
09-105	Modern Chemistry I	10
09-101	Introduction to Experimental Chemistry	3
12-207	Statics and Kinematics	9
12-241	Intro. Computer Appl. in Civil Eng.	9
xx-xxx	General Education Course	9
		49

	Spring	
21-260	Differential Equations	9
12-208	Dynamics	9
12-212	Solid Mechanics	12
15-127	Intro. to Programming and Computer Science	10
xx-xxx	General Education Course	9
		49

Junior Year

	Fall	Units
12-320	Structural Mechanics I	9
12-331	Fluid Mechanics	12
36-211	Probability and Applied Statistics I	9
or		
36-220	Engineering Statics and Quality Control	
xx-xxx	Basic Science Elective	9
xx-xxx	General Education Course	9
		48

	Spring	
12-310	Engineering Economics	9
12-315	Materials	9
12-325	Soil Mechanics	12
12-647	Civil Engineering Project Seminar	3
12-xxx	Civil Engineering Elective	9
xx-xxx	General Education Course	9
		51

Senior Year

	Fall	Units
12-400	Civil Engineering Design	12
12-648	Civil Engineering Project	9
12-xxx	Civil Engineering Elective	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
		48

	Spring	
12-xxx	Civil Engineering Electives	18
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
xx-xxx	Free Elective	9
		45

Minimum number of units required for degree: 379

Civil Engineering/ Engineering and Public Policty Double Major

Sophomore Year

	Fall	Units
21-259	Same	9
09-105	Same	10
09-101	Same	3
12-207	Same	9
12-241	Same	9
73-100	Principles of Economics	9
19-102	EPP Sophomore Seminar	3
		52

	Spring	
21-260	Same	9
12-208	Same	9
12-212	Same	12
15-127	Same	10
xx-xxx	Social Analysis Elective	9
		49

Junior Year

	Fall	Units
12-320	Same	9
12-331	Same	12
36-211	Probability and Applied Statistics I	9
-		
-		
xx-xxx	Same	9
xx-xxx	Social Analysis Elective*	9
		48

	Spring	
12-310	Same	9
12-315	Same	9
12-325	Same	12
-		
19-451	EPP Project	12
xx-xxx	Social Analysis Elective*	9
		51

Senior Year

	Fall	Units
12-400	Same	12
19-452	EPP Project	12
12-xxx	Same**	9
xx-xxx	EPP Technical Elective	9
xx-xxx	Social Analysis Elective	9
		48

	Spring	
12-xxx	Same**	18
xx-xxx	EPP Technical Elective	9
xx-xxx	Social Analysis Elective	9
36-220	Engineering Statistics and Quality Control	9
		45

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
88-344	Strategic Games and Decisions

** 18 units of Civil Engineering Electives should be chosen from the EPP Technical Elective list.

Electrical and Computer Engineering

Single Major

Sophomore Year

	Fall	Units
18-2x0	ECE Core Course	12
21-xxx	Restricted Math Elective	9
33-107	Physics for Engineering Students II	12
xx-xxx	General Education Course	9
		42

	Spring	
18-2x0	ECE Core Course	12
21-xxx	Restricted Math Elective	9
xx-xxx	ECE Breadth Course 1	12
xx-xxx	General Education Course	9
		42

Junior Year

	Fall	Units
xx-xxx	ECE Breadth Course 2	12
xx-xxx	ECE Breadth Course 3	12
xx-xxx	Probability and Statistics	9
xx-xxx	Math/Science Elective 1	9
xx-xxx	General Education Course	9
		51

	Spring	
xx-xxx	ECE Depth Course	12
xx-xxx	ECE Coverage Course 1	12
xx-xxx	Engineering Elective	12
xx-xxx	General Education Course	9
		45

Senior Year

	Fall	Units
xx-xxx	ECE Coverage Course 2 (e.g., Capstone Design)	12
xx-xxx	Math/Science Elective 2	9
xx-xxx	Free Elective	12
xx-xxx	Free Elective	6
xx-xxx	General Education Course	9
		48

	Spring	
xx-xxx	Free Elective	12
xx-xxx	Free Elective	12
xx-xxx	Free Elective	12
xx-xxx	General Education Course	9
		45

Minimum number of units required for degree: 360

Electrical and Computer Engineering/ Engineering and Public Policy Double Major

Sophomore Year

	Fall	Units
18-2x0	Same	12
21-xxx	Same	9
33-107	Same	12
73-100	Principles of Economics	9
19-102	EPP Sophomore Seminar	3
		45

	Spring	
18-2x0	Same	12
21-xxx	Same	9
xx-xxx	Same	12
xx-xxx	Social Analysis Elective	9
		42

Junior Year

	Fall	Units
xx-xxx	Same	12
xx-xxx	Same	12
36-217/211	Same	9
xx-xxx	Same	9
xx-xxx	Social Analysis Elective*	9
		51

	Spring	
xx-xxx	Same	12
xx-xxx	Same	12
19-451	EPP Project	12
xx-xxx	Social Analysis Elective*	9
		45

Senior Year

	Fall	Units
xx-xxx	Same	12
xx-xxx	EPP Technical Elective	9
19-452	EPP Project	12
xx-xxx	EPP Technical Elective	9
xx-xxx	Social Analysis Elective	9
		51

	Spring	
xx-xxx	EPP Technical Elective	12
xx-xxx	EPP Technical Elective	12
36-220	Engineering Statistics and Quality Control	9
xx-xxx	Social Analysis Elective	9
		42

Minimum number of units required for degree: 369

* One of these must be taken from the following list:

88-302	Behavioral Decision Making
88-223	Decision Analysis and Decision Support Systems
88-344	Strategic Games and Decisions

Materials Science and Engineering

Single Major

Sophomore Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
33-107	Physics for Engineering Students II	12
09-101	Introduction to Experimental Chemistry	3
09-105	Modern Chemistry I	10
27-201	Structure of Materials	9
xx-xxx	General Education Course	9
		52
	Spring	
21-260	Differential Equations	9
36-220	Engineering Statistics and Quality Control	9
09-106	Modern Chemistry II	10
27-250	MSE Sophomore Seminar	3
27-215	Thermodynamics of Materials	12
xx-xxx	General Education Course	9
		52

Junior Year

	Fall	Units
33-225	Quantum Physics and Structure of Matter	9
27-303	MSE Lab I	9
27-321	Transport and Kinetics	12
27-311	Phase Relations	12
xx-xxx	General Education Course	9
or		
xx-xxx	Free Elective	9
		51
	Spring	
27-304	MSE Laboratory II	9
xx-xxx	General Education Course	9
xx-xxx	Free Elective	9
or		
xx-xx	General Education Course	9
xx-xxx	Technical Elective	9
or		
27-xxx	Restricted Elective	9
27-xxx	Restricted Elective	9
or		
xx-xxx	Technical Elective	9
		45

Senior Year

	Fall	Units
27-555	Senior Project I	9
27-xxx	Restricted Elective	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
27-xxx	Restricted Elective	9
or		
xx-xxx	General Education Course	9
		45
	Spring	
27-557	Selection and Performance of Engineering Materials	9
27-xxx	Restricted Elective	9
xx-xxx	Technical Elective	9
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
or		
27-xxx	Restricted Elective	9
		45

Minimum number of units required for degree: 377

Materials Science and Engineering/ Engineering and Public Policy Double Major

Sophomore Year

	Fall	Units
21-259	Same	9
33-107	Same	12
09-101	Same	3
09-105	Same	10
27-201	Same	9
73-100	Principles of Economics	9
19-102	EPP Sophomore Seminar	3
		55
	Spring	
21-260	Same	9
36-220	Same	9
09-106	Same	10
27-250	Same	3
27-215	Same	12
xx-xxx	Social Analysis Elective	9
		52

Junior Year

	Fall	Units
33-225	Same	9
27-303	Same	9
27-321	Same	12
27-311	Same	12
xx-xxx	Social Analysis Elective*	9
		51
	Spring	
27-304	Same	9
xx-xxx	EPP Technical Elective	9
xx-xx	Social Analysis Elective*	9
19-451	EPP Project	12
27-xxx	Restricted Elective	9
or		
xx-xxx	EPP Technical Elective	
		48

Senior Year

	Fall	Units
27-555	Same	9
36-211	Probability and Statistics I	9
19-452	EPP Project	12
xx-xxx	Social Analysis Elective	9
xx-xxx	EPP Technical Elective	9
or		
27-xxx	Restricted Elective	
		48
	Spring	
27-557	Same	9
27-xxx	Same	9
xx-xxx	EPP Technical Elective	9
xx-xxx	Social Analysis Elective	9
27-xxx	Restricted Elective	9
		45

Minimum number of units required for degree: 386

* One of these must be taken from the following list:

88-302	Behavioral Decision Making
88-223	Decision Analysis and Decision Support Systems
88-344	Strategic Games and Decisions

Mechanical Engineering

Single Major

Sophomore Year

	Fall	Units
21-259	Calculus in Three Dimensions	9
24-121	Thermodynamics I	9
24-141	Statics and Dynamics	12
xx-xxx	Restricted Technical Elective*	10-13
xx-xxx	General Eduation Course**	9
		49-52

	Spring	
21-260	Differential Equations	9
24-112	Fluid Mechanics	9
24-202	Mechanics of Deformable Solids	10
xx-xxx	Restricted Technical Elective	10-13
xx-xxx	General Education Course	9
		47-50

Junior Year

	Fall	Units
24-223	Thermodynamics II	12
24-245	Dynamics of Physical Systems	11
24-258	Numerical Methods	9
24-281	Mechanical Engineering Seminar I	1
xx-xxx	Technical Elective	9
xx-xxx	General Education Course	9
		51

	Spring	
18-113	Fundamentals of Electrical Engineering	9
24-203	Stress Analysis	10
24-233	Heat Transfer	9
24-246	Feedback Control Systems	9
24-282	Mechanical Engineering Seminar II	1
xx-xxx	General Education Course	9
		47

Senior Year

Fall	Units	
24-251	Engineering Analysis	
or		
24-266	Engineering Design	12
24-2xx	Fluid Mechanics Elective	
or		
xx-xxx	Technical Elective	10-9
xx-xxx	Technical Elective	9
xx-xxx	Technical Elective	9
xx-xxx	A General Education Course	9
		49-48

	Spring	
24-266	Engineering Design	
or		
24-251	Engineering Analysis	12
24-2xx	Fluid Mechanics Elective	
or		
xx-xxx	Technical Elective	10-9
xx-xxx	Technical Elective	9
xx-xxx	Free Elective	9
xx-xxx	A General Education Course	9
		49-48

Minimum number of units required for degree: 382

Mechanical Engineering/ Engineering and Public Policy Double Major

Sophomore Year

	Fall	Units
21-259	Same	9
24-121	Same	9
24-141	Same	12
xx-xxx	Same	10-13
73-100	Principles of Economics	9
19-102	EPP Sophomore Seminar	3
		52-55

	Spring	
21-260	Same	9
24-112	Same	9
24-202	Same	10
xx-xxx	Same	10-13
xx-xxx	Social Analysis Elective	9
		47-50

Junior Year

	Fall	Units
24-223	Same	12
24-245	Same	11
24-258	Same	9
36-211	Probability and Statistics I	9
xx-xxx	Social Analysis Elective*	9
		51

	Spring	
18-113	Same	9
24-203	Same	10
24-233	Same	9
24-246	Same	9
19-451	EPP Project I	12
		50

Senior Year

	Fall	Units
24-266	Engineering Design	12
–		
–		
24-2xx	Same	9
19-452	EPP Project	12
xx-xxx	EPP Technical Elective	9
xx-xxx	Social Analysis Elective*	9
		51

	Spring	
36-220	Engineering Statistics and Quality Control	9
xx-xxx	EPP Technical Elective	9
xx-xxx	EPP Technical Elective	9
xx-xxx	Social Analysis Elective*	9
xx-xxx	Social Analysis Elective	9
		45

Minimum number of units required for degree: 387

* One of these must be taken from the following list:

88-302	Behavioral Decision Making
88-223	Decision Analysis and Decision Support Systems
88-344	Strategic Games and DecisionsMSE/EPP Industrial Internship Option

Engineering and Public Policy Electives

Engineering and Public Policy technical elective courses are taught in CIT or MCS, or CS. EPP technical electives generally belong to two categories: they may be courses which synthesize engineering analysis and social analysis perspectives and apply them to problems with substantial societal and technological components; or, they may be 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; telecommmunications, 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.

Energy, Resources and the Environment

19-297/ 24-297	Energy-Environmental Systems
06-304	Economics and Optimization
12-635	Water and Wastewater
12-636	Air Pollution
19-420	Chemical Technology, the Environment and Society
19-422	Radiation, Health, and Public Policy
19-710	Principles of Hazardous Waste Management

Information and Telecommunication Technologies

19-402/18-482	Telecommunications Policy Analysis
15-381	Artificial Intelligence: Representation and Problem Solving
15-382	Artificial Intelligence: Vision and Motion
12-742	Computer-Aided Design Methods

International Peace and Security

19-430/18-483	Civilian and Military Applications of Space
19-431	Technology and International Security

Other

03-121	Modern Biology
12-637	Problems in Engineering Project Evaluation
12-704	Risk and Reliability Analysis
12-706	Public Investment Planning
19-442	Risk: Perception, Assessment and Management
19-448	Science, Technology and Ethics
19-501	Special Topics in Engineering and Public Policy
19-701	Introduction to Applied Policy Analysis
19-702	Quantitative Methods in Policy Analysis
21-292	Operations Research

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 which 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 88-223.

Economics

Economics skills are aimed at the understanding of man as a social being, the study of the mixed free economy, and the development and use of analytical tools for handling complex social variables. All economics courses qualify as social analysis electives. Examples are:

73-100	Principles of Economics (required)
73-250	Intermediate Microeconomics
73-452	The Economics of the Environment
73-459	Benefit-Cost Analysis
88-246	Labor Economics

Interpersonal Processes

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:

85-241	Social Psychology
88-202	Introduction to Sociological Theory
70-335	Business and Labor
88-313	Introdiction to Models of Political Science
88-317	Social Structure and Human Development

Organizations

Since most students will be located within organizations, students need to acquire some understanding of the dynamics of organizations, how they work, how they can be changed, and the conditions under which changing one part of an organization affects other parts as well. Examples are:

88-260	Organizations
88-261	Organizational Decision Making
70-311	Organizational Behavior

Ethics

As technology and society becomes 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.

80-210	Professional Ethics
80-242	Ethical Issues in Management
80-244	Ethics and computer technology
80-252	World Hunger and Moral Obligation
45-847	Management, Ethics and Public Policy
80-355	Philosophical Issues in Policy Analysis

Political Analysis

Political analysis includes knowledge of the structure of American government, especially legislative, executive, budgetary, regulatory and electoral processes.

19-319	Law and the Engineer
70-361	Foundations of Law
70-363	Law in Modern American Society
88-312	Political Psychology
88-322	Legislative Processes
88-321	Electoral Processes
88-323	Regulatory Processes
88-320	Political Theory and Institutions
88-341	Law and Public Policy

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.

88-223	Historical and Cross-Cultural Perspective in Urban Affairs
90-866	Housing and Community Development
90-805	Urban and Regional Economics
90-865	Urban Land Use Planning
48-386	Urban Neighborhoods
88-362	Cities and Technology

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.

79-509	R&D: The Formation of Research and Development Policy
79-511	The Scientific Outlook
79-519	Technology in Western Civilization
79-661	Philosophy of Technology
88-330	Technology and Social Change
90-757	Economics of Technology

International Peace and Security

National and international problems dealing with security and strategy and their political and historical perspectives are examined in these courses.

99-200	Nuclear Era
79-253	American Foreign Policy Since 1945
79-372	American Security Policy Since World War II
88-329	Decision-Making for Foreign and National Security Policy

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.

88-220	Policy Analysis I
88-223	Decision Analysis and Decision Support Systems (required)
88-301	Political Economy
88-311	Organizational Decision Making
88-401	Forecasting Methods for the Social and Policy Sciences
88-404	Issues in Domestic Public Policy
45-847	Management, Ethics and Public Policy
80-355	Philosophical Issues in Policy Analysis

Role of Computers in Institutions

This area deals with the institutional, interpersonal, and policy aspects of the increasing role of computers in our society.

85-363	Human Factors
85-213	Information Processing Psychology and Artificial Intelligence
88-366	Emerging Social Issues in Computing
88-367	Computers in Organizations
90-739	Decision Support Systems in the Public Sector
90-510	Management Information Systems

Students are urged to elect as a social analysis elective one technical writing course, such as 76-270 Professional Writing or 76-379 Technical Writing for Engineers.

Faculty

MICHAEL S. BARAM, Adjunct Professor of Engineering and Public Policy — L.L.B., Columbia University School of Law; Carnegie Mellon, 1978—.

GARY E. BLAU, Adjunct Associate Professor of Chemical Engineering/ Engineering and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1981—.

ALFRED BLUMSTEIN, Professor of Urban Systems and Operations Research/ Engineering and Public Policy — Ph.D., Cornell University; Carnegie Mellon, 1969—.

MICHAEL B. CALLAHAM, Adjunct Associate Professor of Engineering and Public Policy— Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1979—.

ASHTON B. CARTER, Adjunct Associate Professor of Engineering and Public Policy—Ph.D., Oxford University; Carnegie Mellon, 1987—.

WESLEY MARC COHEN , Associate Professor of Social and Decision Sciences/ Engineering and Pubic Policy — Ph. D., Yale University. Carnegie Mellon, 1982—.

CLIFF I. DAVIDSON, Associate Professor of Civil Engineering/Engineering and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon, 1977—.

OTTO B. DAVIS, Professor of Economics/Engineering and Public Policy — Ph.D., University of Virginia; Carnegie Mellon, 1960—.

URMILA DIWEKAR, Senior Research Engineer, Engineering and Public Policy — Ph.D., Indian Institute of Science, Carnegie Mellon, 1988—.

HADI DOWLATABADI, Senior Research Engineer and Senior Lecturer, Engineering and Public Policy — Ph.D., University of Cambridge; Carnegie Mellon, 1991—.

JOHN J. FEARNSIDES, Adjunct Professor of Engineering and Public Policy — Ph.D., University of Maryland; Carnegie Mellon, 1981—.

BARUCH FISCHHOFF, Professor of Engineering and Public Policy/Social and Decision Sciences — Ph.D., Hebrew University; Carnegie Mellon, 1987—.

RICHARD FLORIDA , Associate Professor of Public Policy / Engineering and Pubic Policy — Ph.D., Columbia University. Carnegie Mellon 1987 —.

JAMES EUGENE GOODBY, Distinguished Service Professor, Engineering Public Policy/ Program in International Peace and Security — Ph.D. University of Michigan, Carnegie Mellon 1989—.

S. WILLIAM GOUSE, Adjunct Professor of Engineering and Public Policy — Sc.D., Massachusetts Institute of Technology; Carnegie Mellon, 1967-69; 1971-73; 1979—.

ROBERT HAHN, Adjunct Associate Professor of Economics/Engineering and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon, 1982—.

MAX HENRION, Adjunct Assistant Professor of Engineering and Public Policy, — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1982—.

ALEX HILLS, Distinguished Service Professor of Engineering and Public Policy — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1992—.

JAYANT KALAGNANAM, Research Engineer, Engineering and Public Policy — Carnegie Mellon, 1991—.

MARYELLEN KELLEY, Assistant Professor of Management /Engineering and Pubic Policy — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.

THOMAS R. KURFESS, Assistant Professor of Mechanical Engineering/ Engineering and Public Policy, — Ph.D., Massachusetts Institute of Technology, Carnegie Mellon, 1989—.

LESTER B. LAVE, Professor of Economics and Engineering and Public Policy — Ph.D., Harvard University; Carnegie Mellon, 1963—.

GORDON HARRIMAN LEWIS, Associate Professor of Sociology/Engineering and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1969—.

NANCY LUBIN, Adjunct Associate Professor of Engineering and Public Policy/ History — D.Phil., Oxford University; Carnegie Mellon, 1989—.

FRANCIS CLAY McMICHAEL, Professor of Civil Engineering/Engineering and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon, 1967—.

SUE MCNEIL, Associate Professor of Civil Engineering / Engineering and Public Policy — Ph.D., Carnegie Mellon; Carnegie Mellon, 1988—.

GREGORY J. MCRAE, Adjunct Professor of Chemical Engineering/Engineering and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon, 1983—.

STEVEN MARC MILLER, Adjunct Assistant Professor of Engineering and Public Policy/Industrial Administration — Ph.D., Carnegie Mellon University; Carnegie Mellon 1983—.

CAROLINE ANN MITCHELL, Instructor, Engineering and Public Policy — B.S.Ch.E., University of Pittsburgh; J.D., Duquesne University; Carnegie Mellon, 1973—.

BENOIT MOREL, Associate Professor of Engineering and Public Policy/ Physics—Ph.D., University of Geneva; Carnegie Mellon, 1987—.

M. GRANGER MORGAN, Professor of Engineering and Public Policy/Electrical Engineering; Head, Department of Engineering and Public Policy — Ph.D., University of California, San Diego; Carnegie Mellon, 1974—.

SAMUEL C. MORRIS, Adjunct Professor of Engineering and Public Policy — Sc.D., University of Pittsburgh; Carnegie Mellon, 1976—.

INDIRA NAIR, Associate Professor and Associate Department Head, Engineering and Public Policy — Ph.D., Northwestern University; Carnegie Mellon, 1978—.

SPYROS N. PANDIS, Assistant professore of Chemical Engineering / Engineering and public Policy — Ph.D., California Institute of Technology; Carnegie mellon, 1993—.

JON PEHA , Assistant Professor of Electrical and Computer Engineering/ Engineering and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1991—.

HENRY RALPH PIEHLER, Professor of Metallurgy and Materials Science/ Engineering and Public Policy — Sc.D., Massachusetts Institute of Technology; Carnegie Mellon, 1967—.

RAJ REDDY, University Professor—Ph.D., Stanford University; Carnegie Mellon, 1969—.

EDWARD STEPHEN RUBIN, Professor of Mechanical Engineering/Engineering and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1969—.

ARMISTEAD RUSSELL, Associate Professor of Mechanical Engineering / Engineering and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon, 1985—.

MARVIN A. SIRBU, Associate Professor of Engineering and Public Policy, Industrial Administration, and Electrical and Computer Engineering— Sc.D., Massachusetts Institute of Technology; Carnegie Mellon, 1985—.

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

JOEL ARTHUR TARR, Professor of History, Technology and Urban Affairs — Ph.D., Northwestern University; Carnegie Mellon, 1967—.

HERBERT LAWRENCE TOOR, Professor of Chemical Engineering/Engineering and Public Policy — Ph.D., Northwestern University; Carnegie Mellon, 1953—.

CHARLES F. WIECHA , Adjunct Assistant Professor of Engineering and Public Policy—Ph.D., Carnegie Mellon. Carnegie Mellon, 1987—.

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:

- Biomedical Engineering
- Electronic Materials
- Engineering Design
- Environmental Engineering
- Manufacturing Engineering
- Mechanical Behavior of Materials

A student in any engineering major may elect to complete a CIT designated minor. Generally, the student takes all the required courses in an engineering major but uses the elective segments of the curriculum to take courses needed to fulfill the requirements of the designated minor. At the completion of the requirements of a CIT designated minor — in addition to those of the engineering major — a formal recognition of the CIT designated minor will be included 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 by a student, but the 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. Nontechnical 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 major department.

The requirements for various CIT designated minors are listed under the programs offering such minors. 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 may be more compatible with the curriculum of his/her major department than others because of different relations between various major and minor requirements.

Biomedical Engineering Designated Minor

Michael M. Domach, Director,
Biomedical Engineering Program
Office: Doherty Hall 2313

Biomedical Engineering 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.

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. Current faculty advisors are:

Chemical Engineering — Michael M. Domach

Civil and Environmental Engineering — Cliff I. Davidson

Electrical and Computer Engineering — L. Richard Carley and Richard M. Stern

Engineering and Public Policy — Henry R. Piehler

Mechanical Engineering — Mark L. Nagurka

Materials Science and Engineering — Henry R. Piehler

Students also can obtain general academic advice and guidance from Hilda Diamond, Associate Director of Biomedical Engineering.

Course Requirements for Biomedical Engineering Minor

Students are required to take 42-100, Biomedical Engineering Seminar, and complete five courses from the following list.

42-500	Physiology — neurophysiology
42-501	Physiology — circulatory system
42-560	Undergraduate Project
42-604	Biological Transport
42-609	Fermentation Processes
42-624	Advanced Topics in Air Pollution
42-636	Air Pollution
42-644	Medical Devices (alternate years)
42-652	Musculoskeletal Biomechanics
42-677	Rehabilitation Engineering
42-680	Bioinstrumentation and Bioinformation Processing
42-695	Sensory Processes: Perception and Psychophysics (alternate years)
42-820	Experimental Electrophysiology
03-121	Modern Biology
03-230	Genetics
03-331	Biochemistry
03-438	Physical Biochemistry
03-439	Introduction to Biophysics
03-441	Molecular Biology of Prokaryotes
03-533	NMR in Biomedical Sciences
03-510	Computational Biology OR
09-560	Computational Chemistry
36-253	Introduction to Biostatistics

It is suggested that the student take 42-100 in the second semester of the freshman year (although 42-100 is offered in both the fall and spring semesters), and one course from the above list as a sophomore. Students may elect to pursue one of the three tracks defined below, or design their own course of study. In each track, the recommended core courses are denoted to assist students in course selection.

Track 1: Molecular Biology and Fermentation Processes

(primarily ChE and CE)

42-100	Biomedical Engineering Seminar
03-121	Modern Biology
03-230	Genetics
03-331	Biochemistry
06-310	Fermentation Processes

Track 2: Medicine, Human Health and Clinical Practice

(primarily ChE, EE, CE, and ME)

42-100	Biomedical Engineering Seminar
03-121	Modern Biology
42-501	Physiology
03-331	Biochemistry

Track 3: Systems and Devices

(primarily ME, MSE and EE)

42-100	Biomedical Engineering Seminar
42-500	Physiology
42-652	Musculoskeletal Biomechanics
42-677	Rehabilitation Engineering

Electronic Materials Designated Minor

Subhash Mahajan and David W. Greve, Co-Directors
Office: Wean Hall 3311

The Electronic Materials minor is designed to provide a firm technological basis for the application of electronic materials to numerous specialty domains. This minor is intended primarily 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 who are interested in pursuing this minor should first consult their advisors to find out whether or not it will be practical in their own curriculum.

Faculty Advisors

The designated minor will be administered by the co-directors listed above. Current faculty advisors are:

Chemical Engineering — Edmond I. Ko

Civil and Environmental Engineering — Jacobo Bielak

Electrical and Computer Engineering — Stanley H. Charap, Michael Reed and T. E. Schlesinger

Engineering and Public Policy — M. Granger Morgan

Mechanical Engineering — Robert H. Sturges Jr.

Materials Science and Engineering — Marek Skowronski and Lloyd Bauer

Course Requirements for Electronic Materials Minor

The minor requires a minimum of five courses as specified below. If any one course overlaps with a required course in the department curriculum, it cannot be double counted and an additional course must be taken in its place.

Required Courses:

18-xxx Solid State I
27-201 Materials Science I

(Since 27-201 is a required course in the regular MSE curriculum, it should not be counted as one of the five courses for the minor by MSE students.)

Elective Courses:

At least two courses must be selected from Group A and one course from Group B, except that MSE students will not be allowed to use 27-311 as an elective while other students are recommended to take 27-311. Furthermore, MSE students are expected to take one more elective course from Group B to fulfill the five-course requirements for the minor.

Group A

06-619	Semiconductor Processing Technology
27-311	Materials Science II
27-432	EMOP
27-533	Growth and Processing of Semiconductors
27-542	Structure and Properties of Thin Films
27-551	Properties of Ceramics and Glasses

Group B

18-xxx	Solid State II
18-354	Introduction to Data Storage Systems
18-221	Analysis and Design of Analog Circuits
18-7xx	An appropriate graduate course

Engineering Design Designated Minor

Daniel P. Siewiorek, Director; Chris Hendrickson, Education 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 courses in methodology of design and three elective courses in design with prescribed distributions for a total of 45 units.

Faculty Advisors

The designated minor in Engineering Design is administered by the Education Director of the Engineering Design Research Center. Students undertaking the designated minor can consult with the program advisor in their major department. Current faculty advisors are:

Chemical Engineering — Larry Biegler, Ignacio Grossman and Arthur W. Westerberg

Civil and Environmental Engineering — Steven J. Fenves and Susan Finger

Electrical and Computer Engineering — Rob A. Rutenbar and Daniel P. Siewiorek

Engineering and Public Policy — Thomas R. Kurfess

Mechanical Engineering — Thomas R. Kurfess and Jonathan Cagan

Materials Science and Engineering — Henry Piehler

Course Requirements for Engineering Design Minor

Required Courses:

Select at least two of the following courses.

39-405	Engineering Design: Creation of Products and Processes
39-648	Special Topics: Wearable Computers
39-649	Special Topics: Green Design
99-600	Design, Manufacturing and Marketing of New Products

Elective Courses in Design:

Additional elective courses are required to a total of 45 units, including required courses, of which at least 9 units are outside a student's major department. At least one of the courses selected should involve applications of computer-aided design methods. Courses can be chosen from the lists below or by permission of the Minor Director.

Undergraduate Elective Courses:

06-305	Process Dynamics and Control
06-606	Comp. Models for Process Design and Analysis
12-400	Engineering Synthesis and Design
12-623	Structural Design
12-640	Computer-Aided Tools for Civil Engineers
18-221	Analysis and Design of Digital Integrated Circuits
18-222	Analysis and Design of Analog Integrated Circuits
18-313	Computer-Controlled Testing and Measurement System Design
18-314	Computer Control Systems Design Laboratory
18-349	Concurrency and Real-Time Systems
18-425	Integrated Circuit Design Project
18-445	Logic and Processor Design Project
18-381	Computer-Aided Design of Electromagnetic Systems
18-450	Computer-Aided Design Methods for Digital IC Design
19-323	Products Liability
19-503	Quality Assurance in the Manufacturing Environment
24-208	Manufacturing Sciences
24-266	Engineering Design
24-267	Engineering Design
24-168	Design for Manufacture
27-357	Selection and Performance of Engineering Materials
39-647	Independent Study in Engineering Design

Graduate Elective Courses:

(permission of instructor(s) required)

06-715	Advanced Process Synthesis
18-762	Circuit Simulation: Theory and Practice
18-763	Physical CAD for VLSI
18-848	Design for Reliability and Testability
24-782	Design and Entrepreneurship
24-788	Mechanics of Manufacturing
39-741	Manufacturing Processes & Materials
39-743	Computer-Aided Design Tools
39-745	Manufacturing Statistics
39-749	Quality Assurance

Environmental Engineering Designated Minor

Mitchell J. Small, Undergraduate Minor Director
Cliff I. Davidson, Director, Environmental Institute
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 Environmental Engineering requires broad knowledge and skills in the areas of environmental science, environmental engineering and environmental policy. Course requirements from each of these areas are included as part of the program for the Environmental Engineering minor.

Faculty Advisors

The Environmental Engineering program provides 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 — Michael M. Domach

Civil and Environmental Engineering — Cliff I. Davidson and David A. Dzombak

Electrical and Computer Engineering — M. Granger Morgan

Engineering and Public Policy — Edward S. Rubin

Mechanical Engineering — Armistead G. Russell

Materials Science and Engineering — Henry R. Piehler

Course Requirements for Environmental Engineering Minor

Course 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 can be 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 list below.

A. Two Environmental Science Courses:

03-121	Modern Biology
03-130	Biology of Organisms
03-331	Biochemistry I
06-151, 24-121/ or 27-215	Thermodynamics
06-313	Experimental Colloid and Surface Science
06-607	Physical Chemistry of Colloids and Surfaces
09-106	Modern Chemistry II OR
09-206	Physical Principles of Analytical Chemistry
09-117	Organic Chemistry I
09-144	Physical Chemistry
09-441	Nuclear and Radiochemistry
36-220	Engineering Statistics and Quality Control

B. Three Environmental Engineering Courses:

06-317	Problems and Prospects of Environmental Quality
12-632	Water Resources Engineering
12-634/635	Water Quality Engineering with Lab
12-636	Environmental Engineering:Air Pollution; OR
24-295	Air Pollution
19-297	Energy-Environmental Systems (also 24-297)
19-420	Chemical Technologies, the Environment and Society
19-422	Radiation, Health and Public Policy
27-322	Processing I OR
27-357/557	Selection and Performance of Eng. Materials
42-604	Biological Transport
42-609	Fermentation Technology (also 03-609, 06-717)
12-632	Water Resources Engineering
48-315	Environmental Systems
48-410	Total Building Performance

C. Two Environmental Policy Courses:*

19-319	Law and The Engineer
19-448	Technology and Ethics
73-357	Regulation: Theory and Policy
73-358	Economics of the Environment and Natural Resources
73-359	Benefit-Cost Analysis
79-247	History of the American Landscape
79-230	Population and History
79-284	Critical Issues in American Environmental History
79-329	Environmental Issues and Policy
79-389	City and Technology (also 88-362)
80-241	Ethical Judgements in Professional Life
80-242	Conflict, Controversy and Dispute
80-243	Markets and Ethics
80-306	Social Choice Theory
88-220	Policy Analysis I
88-221	Policy Analysis II
88-223	Decision Analysis and Decision Support Systems
88-302	Behavioral Decision Making
88-425	Regulatory Processes
90-764	Natural Resource Policy Analysis
90-765	Historical Perspective on the City
90-769	Values and Public Policy

* Other Environmental Policy courses may be included with permission of the Undergraduate Minor Director.

Manufacturing Engineering Designated Minor

Bruce H. Krogh, Undergraduate Minor Director
Office: Porter Hall B22

The Designated Minor in Manufacturing Engineering provides the student with a background in the basic engineering issues that arise in all manufacturing enterprises, from product design through production processes, to issues in marketing and management.

Faculty Advisors

A faculty member from each department will serve as the faculty advisor for the students who are pursuing the minor degree in their respective departments. Current faculty advisors are:

Chemical Engineering — Arthur Westerberg

Civil and Environmental Engineering — Susan Finger

Electrical and Computer Engineering — Bruce H. Krogh

Engineering and Public Policy — Thomas R. Kurfess & Indira Nair

Mechanical Engineering — Robert H. Sturges

Materials Science and Engineering — Harold W. Paxton

Course Requirements

Two Core Courses:

24-208	Manufacturing Sciences
27-357 or 27-557 (MSE Majors)	Issues in Materials Selection (non MSE Majors) Selection and Performance of Engineering Materials

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. New courses in manufacturing-related areas will be added to the technical elective lists as they become available.

Real-Time Systems and Robotics

06-305	Process Dynamics and Control
16-721	Advanced Robot Perception
16-741	Mechanics of Manipulation
16-743	Robot Control
18-349	Concurrency and Real-Time Systems
18-384	Robotic Systems
18-473	Computer-Controlled Testing/Measurement Systems
18-474	Computer Control Systems Design Laboratory

Design, Materials and Processes

12-400	Civil Engineering Design
12-630	Design and Construction
12-640	Computer-Aided Tools for Civil Engineers
24-268	Design for Manufacture
24-269	Quality Assurance
24-789	Advanced Topics in Manufacturing
27-322	Processing Methods
27-421	Processing Design
27-442	Plasticity and Fracture of Materials
27-533	Growth and Processing of Semiconductors
39-405	Engineering and Design: the Creation of Products & Processes
99-600	Design, Manufacturing and Marketing

Production Management and Control

12-310	Engineering Economics
12-607	Project Management for Construction
19-269	Quality Assurance for Manufacturing (cross listed as 24-269)
19-504	Economics and Management in CAM
36-220	Engineering Statistics and Quality Control
70-430	International Management
70-371	Production I
70-471	Production II
70-477	Sequencing and Scheduling

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

Mechanical Behavior of Materials Designated Minor

Warren Garrison, Director
Office: Wean Hall 3301

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 — Edmond I. Ko

Civil and Environmental Engineering — Sunil Saigal

Electrical and Computer Engineering — David W. Greve

Mechanical Engineering — Paul S. Steif

Materials Science and Engineering — Warren M. Garrison, Jr.

Course Requirements for Mechanical Behavior of Materials Minor

The minor requires six courses: three solid mechanics courses and three materials science courses.

Core Courses:

Each student is required to take the three following courses.

27-201	Structure of Materials
27-441	Deformation and Fracture of Materials
12-207	Statics
or	
24-141	Statics and Dynamics

Group A: Materials Science

Each student is required to take one of the following courses.

27-311	Phase Relations[1]
27-442	Deformation Processing
27-357	Selection and Performance of Materials[2]
27-552	Ceramics and Glasses
27-530	Advanced Physical Metallurgy
12-315	Materials[3]

Group B: Solid Mechanics

Each student is required to take two of the following courses.

12-212	Solid Mechanics OR
24-202	Mechanics of Deformable Solids
12-320	Structural Mechanics OR
24-203	Stress Analysis
24-751	Introduction to Solid Mechanics

In satisfying the above course requirements, each student must take three out-of-department courses.

[1] Cannot be used by MSE students to satisfy requirements of minor.

[2] Not available to MSE students.

[3] Cannot be used by students in Civil Engineering to satisfy requirements of minor.

The College of Fine Arts

The College of Fine Arts

Martin Prekop, Dean
Office: The College of Fine Arts 100

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 87 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 55 international museums; have composed for and are performing and conducting in major symphony 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, The Three Rivers Shakespeare Festival Theater, Phipps Botanical Conservatory, and 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 an intense learning environment. It is a highly competitive federation of departments (Architecture, Art, Design, Drama and Music) made up of students and faculty having an intense need to create and excel. Interacting among the departments, the University and the wider community are research centers such as the Studio for Creative Inquiry and the Center for Building Performance and Diagnostics. 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 departments. In addition, the College offers the Bachelor of Humanities and Arts (BHA, jointly with The College of Humanities and Social Sciences) and a 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 for these programs may be found in the departmental descriptions later in this section and elsewhere in this volume.

Architecture
Office: CFA 201

The Department of Architecture offers an undergraduate five year-long B.Arch degree for students who seek careers in architectural practice. Beyond standard 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 departmental sequences in design, building science/technology, and architectural history. Other degrees offered by the Department are a M.S. in Architecture and a Ph. D. in Architecture in the areas of Building Performance and Diagnostics and Computer Aided Design.

Art
Office: CFA 312

The primary mission of the Art Department 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.

Design
Office: MM 110

The Department of Design aims at educating the designers who will have the responsibility for assuring a compatible relationship among the visual, functional, and social aspects of a wide variety of communications and industrial products which we encounter in daily life. In addition to learning the theories and processes basic to the profession, students may specialize in graphic or industrial design

Drama
Office: CFA 108

The Department of Drama seeks to provide both the professional training and the cultural background necessary in attaining the highest standards of theater. The undergraduate programs lead to the degrees of bachelor of fine arts in acting, directing, set design, production, and musical theater.

Music
Office: CFA 105

The Department of Music has as its goal the preparation of musicians for careers in performance, composition, and teaching. The program provides the opportunity to study with experienced artists in a conservatory environment, combining the educational with the intensely professional.

Bachelor of Humanities and Arts

CFA Dean's Office , CFA 100
H&SS Academic Advisory Center , Baker Hall 161

The bachelor of Humanities and Arts is a four year program designed to take advantage of the professional orientation of CFA course work within a liberal arts program. It combines a General Education requirement (8 courses or 72 units), a Concentration of courses in the College of Fine Arts (108 units, in one or more department) , a Concentration of courses in the College of Humanities and Social Sciences (6 courses or 54 units), and fourteen free electives (126 units).

The Master of Arts Management (3-1-1 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 3-1-1 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; fundraising 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 exclusively for students in the College of Fine Arts are the American Institute of Architects, Phi Mu Alpha Sinfonia, Sigma Alpha Iota (music honorary for women) and Tau Sigma (honorary for students in architecture), Alpha Rho Chi (architectural award for leadership), and the Music Educators' National Conference.

Academic Standards

Grading Practices

Grades given to record academic performance in the College of Fine Arts are detailed below. All courses taught by the departments 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 its instructor and the department 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.

Undergraduate grading regulations are detailed on page 48.

Academic Actions

The decision to impose academic action is first initiated at the conclusion of each semester by the departmental faculty most involved in the student's primary area of study and then presented at the end of the semester to the College Council for confirmation.

A student who is not making satisfactory progress toward professional standards in a department may be asked to withdraw from that department 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 departmental 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 department; 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 department; or failure to meet the professional standards of the department although no failing grades are given; or failure to earn the minimum quality point average required to continue in the department. 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 Advised to Withdraw from the Department, Suspended, or Dropped from the university at the end of the semester.

Final Probation: For significantly poor performance, or for continued failure to meet the professional standards of the department. The student must improve scholastic standing to an acceptable level in order to be removed from Probation. A student not doing so may be Advised to Withdraw from the Department, Suspended, or Dropped from the University at the end of the semester. This action may be taken without previous academic action.

Advised to Withdraw from the Department: An action imposed by the department in the case of any student whose progress in professional training is considered 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 department, but is not intended to prejudice admission to another department or college of the university, or to another institution.

This academic action allows the student three choices:

- Transfer to another Carnegie Mellon University department. A student must contact that department 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.

In the event that the student so advised does not, by the effective date of this action, follow through with one of the options listed above, this action will be changed to Drop at the discretion of the faculty concerned without additional College Council action.

Departmental Suspension: For poor performance, or for personal problems that create an impediment to professional achievement in the department. A student is suspended from the department, but not the university, when it is deemed in the best interest of the student to allow continuation of study outside of the department during the period of the suspension. The student is not permitted to take courses in the department for a period to be determined by this faculty action, but will be re-admitted at the end of the period of Departmental Suspension specified by the faculty after the condition of the Departmental 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. Readmission is subject to conditions specified in each case by the departmental 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: A student is dropped when it is clear that the student will never be able to meet minimum standards of performance. This is a permanent severance. The student is required to withdraw from the university and is not permitted to re-enter. 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, has been dropped, or has withdrawn is required to leave the campus, including dormitories and fraternity houses, within a maximum of two days after the the action and to remain off the 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 departmental work in the College of Fine Arts, the first year in all departments 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. That is, 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. 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 departmental 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 department. Further questions about specific course requirements and the total number of units required should be directed to the respective departmental 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 Department Head and the Dean of the College. (See page 46 for Add/Drop procedures.)

Withdrawal/Leave of Absence

A student who withdraws, or takes a leave of absence from the university, at any time up to and including the last day of classes and excluding the final examination period does so with the understanding that no grades will be recorded for the semester. In some cases the student's department may choose to state the time at which or the conditions under which the student may be permitted to return.

Withdrawal or voluntary leave of absence requires that a student file a Withdrawal/Leave of Absence form with the Registrar, after securing the appropriate signature approvals. Return from withdrawal or voluntary leave of absence requires department approval through a Request for Return from Leave of Absence form. (See pages 49 and 52 for further details.)

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 department 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 departmental 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 department of the College of Fine Arts must file an application with the Admissions Office and proceed with the established transfer application procedure, audition, portfolio review or ASAT requirements the same as a student seeking transfer to Carnegie Mellon University from another college or university. 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 departments concerned. The college assumes no liability for student materials in its custody.

Minors Offered by the College of Fine Arts

The College of Fine Arts offers minors in Architecture, Art, Design, Drama and Music to students from other colleges at Carnegie Mellon University. These minors allow students at Carnegie Mellon to take courses and develop a direction for electives in any of the five departments in CFA. Students in The College of Fine Arts may also earn minors outside of their major within other departments 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)
History of the Arts
Jazz Performance
Music
Product Design
Theatre Arts
Visual Communications

Guidelines for students are: 1) except where so designated, CFA students are not eligible to earn a minor in their own department; students from outside CFA may earn a minor in any department in CFA; 2) faculty advisers in the student's home department (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 advisers 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 department.

Students interested in earning a minor in any of the CFA departments should contact: Architecture: Judith Kampert, Assistant Head; Art: Mary Schmidt, Assistant Head; Design: Melissa Cicozi, Assistant Head; Drama: Benedicta Gray; Music: Lewis Strouse.

A Minor in Architecture

This sequence is for candidates who intend to develop intellectual links to the architectural profession. The scope of courses offered includes a full spectrum of professional issues in architecture.

Prerequisite Courses		**9 units**
79-104	Introduction to World History	9
Required Courses		**27 units**
48-100	Arch. Design and Computer Modeling or 48-096,7*	18
48-140	Introduction to Architectural History	9
Elective Courses (Choose three)		**27 units**
48-035	Introduction to Architectural Drawing	9
48-220	Fundamentals of Architectural Geometry	9
48-2xx	Arch. History Lecture	9
48-330	Perspective Drawing (Prereq. 48-030)	9
48-4xx	Arch. History (Prereq. Two 48-2xx Arch His.)	9
48-4xx	Dept. Elective (Prereq. various)	9
33-103	Physics for Building Sci. (Prereq. 21-121, 33-106)	9
48-210	Statics (Prereq. 33-103)	9
48-215	Structures (Prereq. 48-210)	9
48-310	Materials and Assemblies (Prereq. 48-215)	9
48-315	Environmental Systems	9
48-321	Psychology of Habitation	9
48-420	Design Economics (Prereq. 73-100)	9
48-320	Decision Making and Architecture (Prereq. 36-209 or 73-100)	9

Minimum Units: 54

* Where students can demonstrate equivalent experience with design issues within other disciplines, as for example in the Design Department, this requirement can be waived. However this 18 unit requirement must then be replaced with another 18 units of elected coursework within the Department.

A Minor in Architectural History (available also to B.Arch Candidates)

This sequence is intended for candidates interested in the discipline of history as it relates to the architectural profession. Participation in professional courses is intended to assist the student's awareness of the scope of the profession and place historical questions within this perspective.

Prerequisite Courses		**9 units**
79-104	Introduction to World History	9
Required Courses		**27 units**
48-140	Introduction to Architectural History	9
48-2xx	Architectural History	9
48-2xx	Architectural History	9
Elective Courses (Choose three)		**27 units**
48-4xx	Architectural History	9

Minimum Units: 54

A Minor in Architectural Representation and Visualization

This sequence is for candidates who intend to develop particular skills in architectural representation.

Required Courses		**36 units**
48-135	Introduction to Architectural Drawing	9
48-030	Introduction to Computer Modeling	9
48-220	Fundamentals of Architectural Geometry	9
48-330	Perspective Drawing	9
Elective Courses		**18 units**
48-335	Color Drawing (Prereq. 48-330)	9
48-435	Architectural Rendering (Prereq. 48-330, 335)	9
48-745	Geometric Modeling (Prereq. 48-711, 713, 750)	6
48-747	Shape Grammars (Prereq. 48-711, 713, 750)	6
48-744	Graphics (Prereq. 48-711, 713, 750)	6
48-725	Lighting and Buildings (Prereq. 21-121, 33-106)	6

Minimum Units: 54

A Minor in Architectural Technology

This sequence is for candidates who intend to develop intellectual links to the technical aspects of the profession.

Prerequisite Courses		**20 units**
21-121	Calculus	10
33-108	Physics I	10
Required Courses		**9 units**
33-103	Physics for Building Sciences*	9
Elective Courses (Choose five)		**45 units**
48-210	Statics (Prereq. 33-103)	9
48-215	Structures (Prereq. 48-210)	9
48-310	Materials and Assemblies (Prereq. 48-215)	9
48-315	Environmental Systems	9
48-410	Total Building Performance	9
48-415	Mechanical Equipment	9
48-4xx	Designated Dept. Technical Elective	9

Minimum Units: 54

* Where students can demonstrate equivalent experience with topics of this course, as for example in 33-107 PhysicsII , this requirement can be waived. However this 9 unit requirement must then be replaced with another 9 units of elected coursework within the Department.

A Minor in Building Science (available only to B.Arch Candidates)

This sequence is intended for candidates seeking in depth knowlege in several areas of architectural science and for those interested in gaining advance placement into the Graduate M.S. Program offered by the Department of Architecture in Building Performance and Computer Aided Design.

Required Courses		21 units
48—711	Research Paradigms and Methods	6
48-713	Prediction and Evaluation	6
48-750	Programming in C	9

Elective Courses		30 units
48-721	Thermal Design I	6
48-742	Design Databases (prereq. 12-740)	6
48-745	Geometric Modeling	6
48-747	Shape Grammars (prereq. 12-740)	6
48-724	Thermal Design II	6
48-743	Expert Systems	6
48-744	Graphics (prereq. 12-740)	6
48-746	Design Interface	6
48-725	Building Economics	9
48-749	Special Topics in BPD	9
48-775	Special Topics in CAD	9

Minimum units required: 51

A Minor in Art

Concept Studio (Choose one)		10 units
60-101	Concept Studio I (fall only)	10
60-102	Concept Studio II (spring only)	10
60-201	Concept Studio III (fall only)	10
60-202	Concept Studio IV (spring only)	10

Media Studios (Choose two)		20 units
60-110	Electronic Media Studio I (fall only)	10
60-210	Electronic Media Studio II (spring only)	10
60-130	Three-Dimensional Media Studio I (spring only)	10
60-230	Three-Dimensional Media Studio II (fall only)	10
60-150	Two-Dimensional Studio I (fall only)	10
60-151	Two-Dimensional Studio II (spring only)	10
60-250	Two-Dimensional Studio III (fall only)	10
60-251	Two-Dimensional Studio IV (spring only)	10

Advanced Media (Choose two)		20 units
60-4xx	Advanced ETB: Electives	10
60-4xx	Advanced SIS: Electives	10
60-4xx	Advanced PDP: Electives	10

Art history/theory (Choose one)		9 units
60-6xx	Art History Elective	9

Minimum units required: 59

A Minor in the History of Arts

This minor of six or more courses as designated below, will offer students a grouping of Arts Histories courses that can provide a broad survey in the arts or a highly specialized field. Interested students should contact the Associate Dean in the CFA Dean's office. An appropriate faculty advisor will be designated by the Assiociate Dean.

Introductory Level Courses: (Choose three)		27 units
48-140	Introduction to Architectural History	9
51-201	Design Principles: History and Theory of Design	9
54-211	Drama and Civilization	9
57-173	Survey of Western Music History	9
60-610/611	Arts Time and World Civilization I/II	9

Advanced Courses: (Choose three)		27 units
48-2xx	Architectural History	9
48-4xx	Architectural History	9
54-2xx	Advanced Drama History Electives	9
57-2xx	Advanced Music History Electives	9
60-6xx	Advanced Art History Electives	9

Minimum units required: 54

A Minor in Visual Communication

This program gives an overview of basic visual communication skills and the concerns of the visual communication professions. It is intended for students from H&SS or other colleges who have a professional interest in publishing, advertising or public relations. 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 and an interview. Students must receive approval and course counseling for a Minor in Visual Communication from the Design Department Student 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. Contact the Design department office for details.

Required Courses		18 units
51-170/1	Graphic Design Fundamentals	9
51-201	History and Theory of Design	9

Elective Courses **36 units**

Elective courses to be chosen from those listed in the current course catalog. Only those courses listed as being open to minors will satisfy this elective requirement. This program description is based on the latest information at the time of publication. Interested students should contact the Design Department regarding any changes in the program and the availability of courses.

Minimum units required: 54

A Minor in Product Design

This program gives an overview of basic product design skills and concerns. 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 and an interview. Students must receive approval and course counseling for a Minor in Product Design from the Design Department Student 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. Contact the Design department office for details.

Required Courses:		18 units
51-180	Industrial Design Fundamentals	9
51-201	History and Theory of Design	9

Elective Courses: **36 units**

Elective courses to be chosen from those listed in the current course catalog. Only those courses listed as being open to minors will satisfy this elective requirement. This program description is based on the latest information at the time of publication. Interested students should contact the Department of Design regarding any changes in the program and the availability of the courses.

Minimum units required: 54

A Minor in Theatre Arts

The Theatre Arts minor provides students with opportunity to participate in a preliminary professional exposure to the theatre arts. Courses involve acting, dance, text analysis, directing, playwriting, and a series of related history of theatre and drama courses.

Students may also become involved with Drama productions by signing up for Production I and II. These courses specifically involve evening crew work on various Drama productions, both main stage and studio theatre.

Required Courses **18 units**

54-183/184	Fundamentals of Drama (two semester sequence) one semester required	6
54-281/282	History of Drama (minis)	3 (per mini)
54-381/382	History of Drama (minis)	3 (per mini)

Elective Courses:

36 units

54-161/162	Production IPreparation	6
54-173*	Technical Production I (mini)	4
54-174*	Technical Production I (mini continued full semester)	4
54-187/188	Introduction to Playwriting	6
54-239/240*	History of Architecture and Decor	6
54-245/246*	History of Clothing	6
54-251/252*	Intro. to Lighting Design	6
54-261/262*	Production Preparation	6
54-283/284	Fundamentals of Directing (4units each)	4
54-381/382	History of Drama (minis)	3 (per mini)
54-309/310	Theatre Lab	4
54-475	Theatre Management	6
62-129/130	Ballet Elective	6
62-151/152	Acting Elective	9
62-153/154	Introduction to Playwriting for Non-Majors	9

The following courses are available by audition and the agreement of the instructor

54-119	Music Theatre Workshop (mini)	3
54-120	Music Theatre Workshop	6
54-123/124*	Dance	6
54-223/224*	Dance II	6

* Indicates year long courses. The fall sections of these courses are prerequisite for the spring sections, except with permission of the instructor.

Minimum units required: 54

A Minor in Jazz Performance

Admission Requirements

1. The student must apply to enter the program in the office of the advisor for music minors (CFA 162)
2. The student must have passed Solfege I and Theory I.
3. The student must perform an audition. For the audition, the student should perform two contrasting pieces and demonstrate the potential for the development of improvisatory skills.

Required Courses **48 units**

57-499	Jazz Studio (4 semesters)	24
57-453/454	Jazz Improvisation (2 semesters)	6
57-319	Jazz Piano (2 semesters)	6
57-328	Jazz Chamber Music (2 semesters)	6
57-xxx	Jazz Ensemble or Jazz Choir (2 semesters)	6

Electives: (Choose 1) **6 units**

57-450	Jazz Ear Training	6
57-457	Jazz History	6
57-458	Jazz History II	6
57-451	Jazz Orchestration	6
57-452	Jazz Orchestration II	6

Minimum units required: 54

A Minor in Music

The Music Minor is available for students capable of acceptable levels of achievement in the required courses listed below.

Admission Requirements

1. Students must apply to enter the program in the office of the advisor for music minors (CFA 162)
2. Students must take placements tests in solfege and in theory.

Prerequisite Courses **0 units**

These courses are required for students who do not qualify for entrance into Solfege I and/or Theory I, based on their scores on the solfege and theory placement tests.

57-091	Solfege Basic Skills	Fall: 0 units
57-090	Theory Basic Skills	Fall: 0 units

Required Courses **24 units**

Eurhythmics I must be taken before or concurrently with Solfege I.

57-151	16th Century Counterpoint	Fall: 6 units
or 57-152	Harmony I	Spring: 6 units
57-161	Eurhythmics I	Fall: 3 units
57-173	Survey of Western Music History	Fall: 9 units
57-181	Solfege I	Fall: 6 units

Elective Courses **30 units**

Elective courses can be chosen from courses in the current course catalogue for which students are qualified and in which there is space.

57-151	16th Century Counterpoint	Fall: 6 units
57-152	Harmony I	Spring: 6 units
57-153	Harmony II	Fall: 6 units
57-154	18th Century Counterpoint	Spring: 6 units
57-162	Eurhythmics II	Spring: 3 units
57-182	Solfege II	Spring: 6 units
57-202	Opera History	Spring: 9 units
57-203	Medieval, Renaissance, and Baroque Music History	Spring: 9 units
57-204	18th and 19th Century Music History	Fall: 9 units
57-205	20th Century Music History	Spring: 9 units
57-337	Sound Recording I	Fall: 6 units
57-338	Sound Recording II	Spring: 6 units
57-347	Electronic and Computer Music	Fall: 9 units

Ensembles:

Auditions are required for entrance into any departmental ensemble.

57-227	Jazz Ensemble	Fall & Spring: 3 units
57-417	Concert Choir	Fall & Spring: 6 units
57-418	Wind Ensemble	Fall & Spring: 6 units
57-419	Repertory Chorus	Fall & Spring: 6 units
57-420	Jazz Choir	Fall & Spring: 3 units
57-430	Orchestra	Fall & Spring: 6 units

Lessons:

Private lessons are available on all classical and jazz instruments, voice, and composition. An additional fee is required.

Minimum units required: 54

Department of Architecture

Vivian Loftness, Department Head
Office: CFA 201

Bachelor of Architecture Program

The Bachelor of Architecture Program is five-years in length and is fully accredited by the National Architectural Accreditation Board. It provides preparation for entry into the practice of architecture. Beyond standard preparation in architectural design, history, and representation, its curriculum stresses the importance of scientific knowledge and technical know-how in the preparation of future practicing professionals. The curriculum consists of four sets of courses: design, science/technology, architectural history/departmental electives, and university electives. Core university courses in mathematics, physical sciences, social sciences, writing and history are prerequisite to each sequence.

Design Sequence

Architectural design is the core of the undergraduate curriculum. It is organized around a sequence of semester topics that are central to each semester's design projects. In sequence, these topics are: computer modeling, drawing, composition, structure, construction, site, occupancy, systems integration, and urban design. In general, design studios address smaller scale issues at the beginning of the program and broader issues in the later years. Design studios are taught on a team approach with a common lecture series and set of related exercises required of all students. With the exception of the first year where studios are larger, students at each level are divided into individual studios of 10-12 students each. But consistent with a team approach, similar design projects are conducted in all studios at a given level.

Technology and Science Sequence

The mission of the science and technology sequence is to offer a rigorous introduction to science fundamentals, provide a systematic and comprehensive introduction into the major fields of building science and technology, and provide a solid technical foundation both for architectural design studios and for more advanced subsequent science and technology electives. Through its links to the design studios, the sequence is intended to nurture students' abilities to apply their skills and knowledge to concrete problems in architecture and to provide innovative strategies toward architectural design and building engineering. Each course in the building science technology sequence builds upon the knowledge gained in previous courses. The early courses emphasize fundamentals, whereas the latter courses focus on practical application and engineering approaches.

Architectural History Sequence

Three courses in architectural history are required for the Bachelor of Architecture degree. All first-year students must complete the one-semester Introduction to Architectural History course. This course focuses on the major monuments of western civilization, but also briefly examines non-western, non-monumental traditions. Two additional lecture courses are required at the intermediate level; these courses consider more specific topics and are intended to provide students with the skills to investigate architecture from the perspectives of culture, society, politics, theory economics, and technology. In addition to the required architectural history courses, elective courses offering the opportunity to study more advanced topics of architectural history may be taken in place of any or all of the required departmental electives during the fourth and fifth years. Students allocating all of their departmental electives in this manner can graduate with a Minor in Architectural History. In its architectural history offerings, the Department seeks to offer a balance of topic areas each semester, while at the same time offering individual history faculty the opportunity to present topics central to their research.

Departmental Electives

Four departmental electives, usually taken during the fourth and fifth years, are required for the Bachelor of Architecture degree. (As indicated immediately above, the departmental elective requirements can also be satisfied by taking advanced architectural history electives.) The general goal of the departmental electives is to build knowledge of architecture within the broad context of society. That is, in the 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. All departmental electives build on prerequisite courses taken in science, technology, architectural history, and drawing. Areas in which departmental electives are offered are: drawing/media (including computer aided design), environmental psychology, criticism, architectural history, planning/management, and building engineering. Within three of these areas, computer aided design, planning/management, and building engineering, qualified students can take graduate level courses in satisfaction of the departmental electives requirement. Under certain conditions, such course work can provide advance placement into the M. S. program in the Department of Architecture.

Drawing and Media

Drawing and media representation are introduced as the central topics of the first year design studios, Fall Semester—Architectural Design and Computer Modeling, Spring Semester— Architectural Design and Drawing. These are followed by two required studio courses during the third year, one in perspective drawing and the other in color drawing . Thereafter, students may elect to take further drawing and media courses during years four and five in fulfillment of the departmental elective requirements. The primary goal of the drawing and media sequence is to develop abilities of three dimensional visualization. The secondary goal (important because practitioners use drawing as a quick and dependable representational tool throughout the design process) is to develop skill in particular media, including computer-aided design.

University Electives and Minors in other Disciplines

A significant set of university courses in mathematics, physical sciences, social sciences, writing and history is prerequisite to the Department's own offerings. Beyond the preparation in fundamentals that these courses provide, this early emphasis upon core university course work allows for ease of transfer to other departments within the College and University following the first or second semester of the student's first year. In addition to these eight prerequisite university courses, a minimum of ten university electives are required for the Bachelor of Architecture degree. The Department considers these courses to be crucial for the intellectual breadth of an architect as a citizen in contemporary society. In this spirit, the Department requires that these courses be taken outside of the Department of Architecture and urges its students to use these courses as an opportunity to take advantage of the unique strengths of Carnegie Mellon University and to develop intellectual ties to other disciplines by earning minors or completing depth sequences in other departments. Minors may be earned in other departments in the College of Fine Arts in Art, Design, Drama and Music as well as in other Colleges at Carnegie Mellon. A full listing of these minors may be found within this catalogue in the CFA section on Interdisciplinary Programs and in similar sections provided by each college.

Minors in Architecture

Undergraduate students in architecture can also qualify to earn two minors within the subject of architecture. These are the Minor in Building Science and the Minor 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 Department in the areas of Building Performance and Computer Aided Design. The Minor in Architectural History is intended for those candidates who want particular depth in this area. It is earned by applying all four departmental electives to courses in architectural history.

Student Advising and Review of Student Progress

Students are urged to meet with the Associate or Assistant Head of the Department to go over their academic progress and plans before each semester. Such meetings are important to take full advantage of elective possibilities within the curriculum, but they are equally important as a opportunity for discussion of long term career goals and problems.

At the end of every semester, each student's progress in all courses is reviewed by the faculty. Reviews during the first year are used to determine a student's suitability for studying architecture at Carnegie Mellon University. Subsequent reviews monitor and insure continued progress in all sequences of the program. It is a principle of the program that no student who has a grade below "C" from the previous semester can take an overload.

Curriculum

First Year

	Fall	Units
48-100	Architectural Design and Computer Modeling	18
21-121	Calculus	10
33-106	Physics	12
79-104	Introduction to World History	9
		49
	Spring	
48-105	Architectural Design and Drawing	18
33-108	Physics for Building Sciences	9
48-140	Introduction to Architectural History	9
76-10x	Designated Writing	9
99-101	Computing Skills Workshop	3
		48

Second Year

	Fall	Units
48-200	Architectural Design and Composition	18
48-210	Statics	9
48-2xx	Architectural History	9
xx-xxx	University Elective	9
xx-xxx	Directed Elective*	9
		54
	Spring	
48-205	Architectural Design and Construction I	18
48-215	Structures	9
36-209 or	Probability and Statistics	9
73-100	Economics	
48-2xx	Architectural History	9
xx-xxx	Directed Elective*	9
		54

Third Year

	Fall	Units
48-300	Architectural Design and Construction II	18
48-310	Materials and Assemblies	9
48-320	Decision Making and Architecture	9
48-330	Perspective Drawing	9
xx-xxx	University Elective	9
		54
	Spring	
48-305	Architectural Design and Site	18
48-315	Environmental Systems	9
48-321	Psychology of Habitation	9
48-335	Color Drawing	9
xx-xxx	University Elective	9
		54

Fourth Year

	Fall	Units
48-400	Architectural Design and Occupancy	18
48-415	Mechanical Equipment	9
48-420	Design Economics	9
48-4xx	Arch. History or Dept. Elective	9
xx-xxx	University Elective	9
		54
	Spring	
48-405	Architectural Design and Systems Integration	18
48-410	Total Building Performance	9
48-421	Urban Design	9
48-4xx	Arch. History or Dept. Elective	9
xx-xxx	University Elective	9
		54

Fifth Year

	Fall	Units
48-500	Architectural Design and Urban Design	18
48-520	Issues of Practice	9
48-4xx	Arch. History or Dept. Elective	9
xx-xxx	University Elective	9
xx-xxx	University Elective	9
		54
	Spring	
48-505	Architectural Design and Urban Design	18
48-4xx	Arch. History or Dept. Elective	9
xx-xxx	University Elective	9
xx-xxx	University Elective	9
xx-xxx	University Elective	9
		54

*Directed electives are chosen from the following selection of courses: 76-2xx English course, 76-3xx English course; 79-2xx history course, 79-300 history course; 80-xxx philosophy course.

Awards

In addition to university scholarships and work-study aid, several endowed scholarships and traveling fellowships are available. These are The Stewart L. Brown Scholarship of the Pittsburgh Chapter of the AIA, The John Knox Shear Memorial Traveling Fellowship, The Burdett Assistantships, and the nomination for The Stewardson Award.

Study Abroad and Summer Abroad Program

The Department of Architecture welcomes fourth-year students to apply for substituting credits earned at universities overseas where course work is equivalent to work at Carnegie Mellon. Students present plans to the Department for review during the third year and upon return present their work for final approval for credit. Students may choose from a variety of programs including the University of Adelaide in Australia, the ETH in Zürich, Switzerland, and the University of Sheffield in England. As with other departments at Carnegie Mellon, the Department conducts an officially recognized exchange program with the EPFL in Laussane, Switzerland and ITESM in Monterrey, Mexico. In addition, one summer-abroad program is offered by the Department each summer. The location at which these programs are conducted varies from year to year. Recent offerings have included Austria, The Netherlands, and the Middle East. Students in the, third and fourth years of B. Arch program are eligible to apply.

Other Degree Programs within the Department of Architecture

The department offers two post professional degree programs, a Master of Science and a Ph.D. Consistent with the research directions of the department, M.S. and Ph.D. work has been centered in the areas of computer-aided-design and building performance. Where prerequisites are met, the M.S. Program welcomes qualified advanced undergraduates into its courses. Those qualified undergraduate students who would elect to proceed into the M.S. program after completing their B.Arch degree can under most circumstances complete the M.S. degree within one year (following the B.Arch) provided that they undertake advanced course work during the fourth and fifth years of the undergraduate program.

Summer Courses

Whether to accelerate in a sequence or to make up courses that have been failed or passed at an unsatisfactory level, students are able to take design studios and courses in some sequences during the summer. Studios are taught on a vertical format that develops the focus of each semester's topic on an individual format.

Pre-College Summer Program

The department offers a Pre-College Program to students who have completed their junior year in High School. Course work engages faculty from all sequences in the Department's undergraduate curriculum, including technology, drawing and architectural history, as well as design, and is an opportunity for High School students to gauge their interest in the field and for the Department to assess their potential for success in studying architecture at Carnegie Mellon University.

Faculty Research and Scholarship

Significant numbers of faculty conduct research. Two areas of emphasis that involve multiple faculty and graduate students are computer-aided architectural design and performance evaluation of buildings. Other faculty work singly or as members of smaller teams on subjects in cognitive design process, architectural history, architectural practice and artistic production. The Department makes no distinction between graduate research faculty and undergraduate faculty. All faculty including those who are involved in graduate research teach undergraduate courses as a regular part of their yearly teaching load. As a result, undergraduate students enjoy regular contact with faculty who are in positions of leadership in expanding the knowledge base of the profession. Occasionally this contact can lead to internships or to graduate level course work in research areas.

Faculty

ÖMER AKIN, Professor of Architecture — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977—

WALTER BOYKOWYCZ, Adjunct Associate Professor of Architecture — M.URP., University of Pittsburgh, M.Arch., Carnegie Mellon University; Carnegie Mellon, 1979—.

GARY CARLOUGH, Adjunct Assistant Professor of Architecture — B.Arch., University of Arizona; Carnegie Mellon, 1988—.

MICHAEL CHIRIGOS, Adjunct Assistant Professor of Architecture — B.Arch., Carnegie Institute of Technology; Carnegie Mellon, 1980—.

RICHARD CLEARY, Associate Professor of Architecture — Ph.D., Columbia University; Carnegie Mellon, 1982—.

DOUGLAS COOPER, Professor of Architecture and Associate Dean of the College of Fine Arts — B.Arch., Carnegie Mellon University; Carnegie Mellon, 1976—

STEVEN DUCKWORTH, Assistant Professor of Architecture — PhD., Massachussetts Institute of Technology, Carnegie Mellon, 1993—.

ULRICH FLEMMING, Professor of Architecture — Ph.D., Technical University of Berlin; Carnegie Mellon, 1981—.

CLAIRE GALLAGHER, Education Co-ordinator, Adjunct Instructor of Architecture — M.Arch. Carnegie Mellon University. Carnegie Mellon 1991—.

SHELDON GOETTEL, Adjunct Assistant Professor of Architecture — M.Arch., Carnegie Mellon University; Carnegie Mellon, 1990—.

VOLKER HARTKOPF, Professor of Architecture — Dr. Ing. in Architecture, University of Stuttgart; Carnegie Mellon, 1972—.

DELBERT HIGHLANDS, Professor of Architecture — M.Arch., Carnegie Mellon University; Carnegie Mellon, 1964—.

RAMESH KRISHNAMURTI, Professor of Architecture — Ph.D. (Systems Design), University of Waterloo; Carnegie Mellon, 1989—.

STEFANI LEDEWITZ, Adjunct Associate Professor of Architecture — M.Arch. Yale University, Carnegie Mellon, 1979—.

LAURA LEE, Adjunct Assistant Professor of Architecture — M.Arch., University of Michigan; Carnegie Mellon, 1989—.

STEPHEN R. LEE, Adjunct Assistant Professor of Architecture/Research Associate — M.Arch., Carnegie Mellon University; Carnegie Mellon, 1981—.

DAVID LEWIS, Visiting Professor of Urban Design — M.Arch., Leeds College of Architecture; Carnegie Mellon, 1982—.

BRUCE LINDSEY, Associate Professor of Architecture — M.Arch., Yale University; Carnegie Mellon, 1987—.

VIVIAN LOFTNESS, Professor of Architecture and Department Head — M.Arch., Massachusetts Institute of Technology; Carnegie Mellon, 1981—.

ARTHUR LUBETZ, Adjunct Assistant Professor of Architecture — B.Arch., Carnegie Mellon University; Carnegie Mellon, 1988—

ANTHONY LUCARELLI, Adjunct Instructor of Architecture — M.Arch., University of Maryland; Carnegie Mellon, 1991-.

ARDESHIR MAHDAVI Professor of Architecture — Ph.D., Technical University of Vienna Carnegie Mellon, 1990—.

GERALD MATTERN, Adjunct Assistant Professor of Architecture — B.E., Rose Polytechnic Institute; Carnegie Mellon, 1982—.

SHERRY McKIBBEN, Adjunct Assistant Professor of Architecture — M.Arch., Yale University; Carnegie Mellon, 1991—.

LAURA NETTLETON, Adjunct Assistant Professor of Architecture — M.Arch., University of Oregon; Carnegie Mellon, 1988—

IRVING OPPENHEIM, Professor of Architecture and Civil Engineering — Ph.D., Cambridge University; Carnegie Mellon, 1973—.

STEPHEN QUICK, Adjunct Associate Professor of Architecture — M.Arch., Cornell University; Carnegie Mellon, 1980—.

PAUL ROSENBLATT, Associate Professor of Architecture — M.Arch., Yale University; Carnegie Mellon, 1987—.

HOWARD SAALMAN, Andrew Mellon Professor of Architecture (Emeritus) — Ph.D., New York University; Carnegie Mellon, 1958—.

SCOTT SMITH, Wood Shop Director — M.F.A., Cranbrook Institute; Carnegie Mellon, 1984—.

JILL WATSON Adjunct Associate Professor of Architecture — B.Arch., Carnegie Mellon University; Carnegie Mellon, 1989—.

ROBERT WOODBURY, Associate Professor of Architecture — Ph.D. (Architecture), Carnegie Mellon University; Carnegie Mellon, 1982—.

Department of Art

Bryan Rogers, Head
Office: College of Fine Arts 312

The university-based undergraduate program offered by the Art Department is designed to develop individuals capable of working as artists in a complex, rapidly changing global culture. The program takes an expansive approach to art and acknowledges that "working as artists" leads toward a wide variety of eventualities.

Admission to the undergraduate program is highly competitive. Students must show promise of excellence in both academic and artistic performance.

The art faculty, all practicing artists or scholars, provide an intense, professional learning environment. All art classes are small, enabling students to develop close ties with faculty.

Art students are encouraged to take full advantage of the university environment through exposure to faculty and students from other departments in the College of Fine Arts and throughout the University. They are also encouraged to participate in the numerous cultural opportunities in the larger Pittsburgh community.

The Art Department maintains extensive contemporary studios to engage its wide range of media offerings. It occupies the top two floors of the main College of Fine Arts building as well as a significant portion of Doherty Hall. Numerous exhibition venues for students include the Forbes 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 Art Department 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. Art Academic Courses

V. University Academic Courses

Studio courses comprise 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 includes the understanding that neither concept nor media can be presented independently of one another. This dual approach was instituted to ensure that all students experience high quality, consistent training in both approaches.

I. Concept Studios

The Concept Studios are the *core* of the art curriculum. One Concept Studio is taken each semester for a total of eight courses. Experiences gained in the other four components of the program are integrated in Concept Studios. Topics addressed through these courses are divided into five categories: concepts related to the self and the human being, space/time concepts, systems concepts, process concepts, and context-related concepts.

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 is towards increasing complexity. Junior Concept Studios are devoted entirely to context-related issues, and the senior year Concept Studio is devoted to a single student-generated project.

II. Media Studios

The Media Studios can be viewed as the *foundation* courses for the new 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 department. They also serve as preparation for advanced studio work.

Two-Dimensional Media Studios present drawing during the freshman year, and introduce painting and printmaking during the sophomore year. Electronic Media Studios introduce computer-related work during the freshman year and video in sophomore year. Three-Dimensional Media Studios introduce ceramics, welding and wood during the freshman year, and survey foundry, metals, and construction during the sophomore year.

III. Advanced Studios

Students take a total of eight Advanced Studio courses during the junior and senior years. These courses address specialized studio work in one of the three artistic concentration areas in the department, which are:

- **Painting, Drawing, and Printmaking (PDP)**
- **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. As part of this component of the program, one studio course must be taken outside of the Art Department in Architecture, Design, Drama, or Music.

IV. Art Academic Courses

A two-semester art history survey is required of all freshmen. After the freshman year, students take four art history/theory courses, one in each of the following categories: European, non-European and Contemporary, and one elective art history/theory course.

V. University Academic Courses

Ten academic courses outside of Art are required as follows:

Freshman Year:

Two courses: World History, English Composition

After Freshman Year:

Four courses: In one of three academic options:

- Culture Option (Humanities and Languages)
- Technical Option (Math, Science and Engineering)
- Social Science Option

Two courses: One course from each academic option not chosen above

Two courses: Unspecified academic electives

Sophomore and Senior Year Reviews

At the end of the sophomore year, all students must undergo a faculty review of their work to date in the program. A successful review is required for advancement to the junior year. At the end of the senior year, students present their work for faculty review in a culminating exhibit. Graduation is contingent upon a successful senior review.

Study Abroad

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 Art Department in which a student's financial aid package remains in effect, and programs sponsored by other U.S. and international institutions.

Programs with other Pittsburgh Institutions

Art students are encouraged to take courses at the close-by University of Pittsburgh Art History Department and at Pittsburgh Filmmakers. Established agreements with these excellent institutions offer this opportunity at no additional expense.

Bachelor of Fine Arts (B.F.A.) Curriculum

Following is a sample curriculum which distributes the B.F.A. requirements in a desirable manner over four years. After the freshman year, students have many options regarding the sequencing and selection of their academic courses. Following the sophomore year, students select and schedule their studio courses.

Freshman Year

	Fall	Units
60-101	Concept Studio I	10
60-110	Electronic Media Studio I	10
60-150	Two-Dimensional Media Studio I	10
60-610	The Arts, Time, and World Civilization I	9
76-10x	English Composition	9
		48
	Spring	
60-102	Concept Studio II	10
60-130	3-Dimensional Media Studio I	10
60-151	Two-Dimensional Media Studio II	10
60-611	The Arts, Time, and World Civilization II	9
79-104	World History	9
		48

Sophomore Year

	Fall	Units
60-201	Concept Studio III	10
60-230	3-Dimensional Media Studio II	10
60-250	Two-Dimensional Media Studio III	10
60-6xx	Academic Art Course	9
xx-xxx	Academic Elective	9
		48
	Spring	
60-202	Concept Studio IV	10
60-210	Electronic Media Studio II	10
60-251	Two-Dimensional Media Studio IV	10
60-6xx	Academic Art Course	9
xx-xxx	Academic Elective	9
		48

Junior Year

	Fall	Units
60-301	Concept Studio V	10
60-4xx	Advanced Studio	10
60-4xx	Advanced Studio	10
60-6xx	Academic Art Course	9
xx-xxx	Academic Elective	9
		48
	Spring	
60-302	Concept Studio VI	10
60-4xx	Advanced Studio	10
60-4xx	Advanced Studio	10
60-6xx	Academic Art Course	9
xx-xxx	Academic Elective	9
		48

Senior Year

	Fall	Units
60-401	Concept Studio VII	10
60-4xx	Advanced Studio	10
60-4xx	Advanced Studio	10
xx-xxx	Academic Elective	9
xx-xxx	Academic Elective	9
		48
	Spring	
60-402	Concept Studio VIII	10
60-4xx	Advanced Studio	10
60-4xx	Advanced Studio	10
xx-xxx	Academic Elective	9
xx-xxx	Academic Elective	9
		48

Total Units: 384

Art Minors

The Art Department welcomes students from other colleges and departments who want to pursue a minor in art. A minor requires six courses in the department, selected from a list of requirements and electives. You will find a description of the art minor elsewhere in this catalog under Minors in the College of Fine Arts.

Art Majors Double Majoring in Another Department

Students who have a strong interest in another area of study are encouraged to pursue a second major. If you are contemplating this option, please refer to departmental descriptions in this catalog and discuss your plans with representatives from other departments as well as the Art Department.

The Bachelor of Humanities and Arts (B.H.A.) Degree

Carnegie Mellon offers a degree program which combines a depth of experience in the College of Fine Arts and a well-rounded exposure to coursework in the College of Humanities and Social Sciences. Information on this program may be obtained by contacting the Art Department directly. A description of this interdisciplinary program is found on page 74.

Master of Fine Arts (M.F.A.) Degree

The Art Department also offers a 3-year program leading to a Master of Fine Arts Degree in art. This unique program is designed to connect artmaking to the university at large and to the Pittsburgh community. Information on this program may be obtained by contacting the Art Department directly.

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. A special program allows students to complete both a Bachelor of Fine Arts degree and a Master of Arts Management degree in five years. Interested students should consult with advisors in the Art Department and the Heinz School early in their undergraduate program.

Pre-College Programs

The Art Department 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 Art Department directly.

Faculty

In addition to the permanent faculty listed below, the department maintains a lively visiting faculty program which brings to the campus four to five accomplished artists and scholars to work and teach for up to two years. Also a number of courses are taught by part-time faculty.

EDITH BALAS, Professor of Art History — Ph.D., University of Pittsburgh; Carnegie Mellon, 1977—.

JON BECKLEY, Associate Professor of Art — M.F.A., Ohio University; Carnegie Mellon, 1979—.

PATRICIA BELLAN-GILLEN, Associate 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, Assistant Professor of Art — M.F.A., University of California, Davis; Carnegie Mellon, 1993—.

LOWRY BURGESS, Professor of Art — Post-Graduate Degree, Pennsylvania Academy of Fine Arts / University of Pennsylvania; Carnegie Mellon, 1989 —.

HARRY HOLLAND, Professor of Art — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1963—.

ELAINE A. KING, Associate Professor of Art History — Ph.D., Northwestern University; Carnegie Mellon, 1981—.

CAROL KUMATA, Associate Professor of Art — M.F.A., University of Wisconsin; Carnegie Mellon, 1979—

JOANN MAIER, Professor of Art — M.F.A., Cranbrook Academy of Art; Carnegie Mellon, 1963—.

JOSEPH MANNINO, Associate Professor of Art — M.F.A., University of Southern Illinois; Carnegie Mellon, 1986—.

HERBERT OLDS, Dorothy Stubnitz Professor of Art — M.F.A., Ohio University; Carnegie Mellon, 1965—.

SIMON PENNY, Associate Professor of Art and Robotics — Graduate Diploma in Sculpture, Sydney College of the Arts; Carnegie Mellon, 1993—.

MARTIN PREKOP, Dean of the College of Fine Arts; Professor of Art — M.F.A., Rhode Island School of Design, Carnegie Mellon, 1993—.

BRYAN ROGERS, Department Head, Professor of Art; Director, STUDIO for Creative Inquiry — Ph.D., University of California, Berkeley; Carnegie Mellon, 1988—.

MARY SCHMIDT, Associate Department Head, Lecturer in Art History — M.A., University of Pittsburgh; Carnegie Mellon, 1986—.

SUSANNE SLAVICK, Associate Professor of Art — M.F.A., Tyler School of Art; Carnegie Mellon, 1984—.

JOHN STURGEON, Associate Professor of Art — M.F.A., Cornell University; Carnegie Mellon, 1991—

MARY WEIDNER, Associate Professor of Art — M.F.A., Washington University; Carnegie Mellon, 1976—.

Department of Design

Richard Buchanan, Head
Office: Margaret Morrison Carnegie Hall 110

Every aspect of communal life gives rise to artifacts - utensils, instruments, books, documents, etc. - that are our daily companions. Collectively, they define the symbolic and economic footprint of our civilization, dominating the environment which shapes us and which will be shaping our children. Design is the profession that deals with giving form to these artifacts and designers are responsible for shaping them.

As professionals who work in the context of business and industry, designers share a few important concerns: to understand how artifacts are used in order to develop design concepts; to evaluate the feasibility of these design concepts from the point-of-view of the user as well as the sponsoring institution or "client"; to shape them into finished documents or products by endowing them with meaningful, pleasant, and harmonious qualities with particular concern for how they look and how they feel; to employ technology humanely in the creation of items which will be replicated economically and in large quantities rather than as individual items; to help visualize emerging ideas so that their appropriateness and usefulness can be evaluated at the earliest conceptual stages; to give visual focus to management decision-making processes by showing alternative embodiments of these ideas; to record and document design solutions so that they can be replicated efficiently and elegantly by the most fitting materials and production processes; to work in teams with other professions, making sure that resulting design solutions are compatible with the environment in which they will be produced, distributed, used, and recycled.

Design Education at Carnegie Mellon

The focus of the design curriculum is on design process and on a thorough grounding in the principles of visual form, visual and verbal communication, problem analysis, and the traditional academic studies. These basics are applied in design projects that emphasize the multidisciplinary quality of designing. Students must draw upon their own broad base of abilities and seek out specialized information and services that are pertinent to their projects. Throughout, the emphasis is on the process of design by which ideas are turned into artifacts for use - rather than merely on the artifacts per se.

In preparing students for a design career, the Department of Design emphasizes the interdependence between the various design specializations as well as between design and other professions. Its graduates are expected to possess entry-level design skills in their area of professional specialization; to demonstrate the flexibility necessary to orient themselves in new situations and to make appropriate design decisions; to work with others, especially in a business or industrial context; and to develop a sense of personal values and professional ethics.

Students contemplating a career in design should understand that a basic aptitude and a serious level of commitment are essential. For success in the study of design, a student should have an inclination toward some of the following: interest in technology and how things work; aptitude for drawing and "making" things; concern for how things look and feel, and an appreciation for aesthetic quality; tolerance for uncertainty and risk-taking during the process of exploring new ways of thinking about the qualities of our man-made environment; resourcefulness and imagination for dealing with ambiguous or ill-defined problems, and a desire for structuring such problems; willingness to develop the self-discipline required to build the needed professional skills; empathy for people and the ability to work with others; ability to express ideas verbally and in writing.

Department of Design Curriculum

The curriculum is designed for students interested in a full-time, undergraduate, liberal professional education. It is organized on two levels: the foundation program (the first two semesters) and the professional program in the Sophomore, Junior and Senior years.

The Foundation Program

The Department of Design accepts applications from secondary schools, and transfer students from within Carnegie Mellon University and from other universities. The entrance evaluation for the design department is part of the admission process for the design department. It seeks a balance of academic, creative, and professional potential. Students entering the program at the freshman level are asked to submit a portfolio or complete a portfolio project as evidence of artistic and design ability. This is considered in balance with evidence of academic ability, including High School grades, SAT scores, class rank and letters of recommendation.

The foundation program is designed to provide a broad base for later specialization. Students are introduced to the three main tracts of the program: Studio, Ideas & Methods, Design Studies. Students are exposed to fundamental design processes, techniques, and ideation methods. They learn new ways of seeing and understanding familiar objects and to use visual elements in giving form to their ideas. Each student's progress is reviewed at the end of every semester, and counseling is provided in both personal interests and educational objectives so that a wise choice between communication or industrial design can be made at the end of the foundation program. Courses outside of the department involve the student in traditional academic areas.

Freshman Year

	Fall	Units
51-114	Design Studio I	9
51-126	Human Experience in Design	9
51-134	Design Drawing I	9
51-160	Learning to Look	9
xx-xxx	H&SS Requirement	9
99-101	Computing Skills Workshop	3
		48
	Spring	
51-115	Design Studio II	9
51-135	Drawing II	9
51-155	Introduction to Photo Design	9
51-161	Introduction to Design Thinking	9
xx-xxx	H&SS Requirement	9
		45

The Professional Program

The six semesters of the sophomore, junior and senior years constitute the professional program. The department provides a communication design and an industrial design option. Each option is built around a series of design studio courses, posing a sequence of 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 the studios, each option requires ideas & methods courses and a series of design studies courses covering the history of design, design methods, and the principles of professional practice. The curriculum adheres closely to fundamental entry-level requirements established by the two national design organizations, the American Institute of Graphic Arts (AIGA) and, the Industrial Designers Society of America (IDSA).

The first semester of the Senior year is devoted to a team project and is typically structured in cooperation with an industrial or institutional client. 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 as defined in conjunction with the client. Individual initiative and self-pacing is demanded, but frequent group discussions and client reviews keep each student responsible to the team.

The Senior Degree Project occurs in the spring semester of the Senior year. Students must develop a proposal for a comprehensive project in an area of their own interest, adn identify an appropriate faculty advisor.

Communication Design Specialization

A communication designer gives form to information using type and images primarily, and sometimes sound and time-based media, such as animation and video. The format for the display of this information will vary from books, posters, and interactive computer programs to packaging, exhibitions, and environmental signage. Content will also vary: a timeline of architectural invention, a map explaining the layout of a museum's exhibits, or an interactive animation teaching how the eye perceives color. Common to all these projects is a person who will read, use, and interact with the information being conveyed. It is, therefore, critical that communication designers understand whom they are designing for, as that human factor affects the design process, the search for appropriate form, and the final product.

The process of design - project definition, research, analysis, form iteration, evaluation, presentation, refinement, and production - is at the heart of the design activity. The program of study promotes communication design solutions that balance clarity and conciseness with exploration and innovation.

Sophomore Year

	Fall	Units
51-204	Basic Typography	9
51-220	Darkroom Photo I (mini)	4.5
51-2xx	Design Elective (mini)	4.5
51-212	Design History I	9
xx-xxx	H&SS Requirement	9
xx-xxx	Free Elective	9
		45

	Spring	
51-211	Intermediate Typography	9
51-213	Color and Communication	9
51-201	Design History II	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

Junior Year

	Fall	Units
51-3xx	Design Elective(s)	9
51-330	Advanced Typography	9
51-302	Design Studies	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

	Spring	
51-337	Information Design	9
51-330	Pre-Press Production(mini)	4.5
51-3xx	Design Elective (mini)	4.5
51-303	Design Studies	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

Senior Year

	Fall	Units
51-450	Senior Team Project	9
51-4xx	Design Elective(s)	9
51-400	Design Studies	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

	Spring	
51-425	Senior Individual Project	9
51-4xx	Design Elective(s)	9
51-401	Design Studies	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

Minimum number of units r i for degree: 360

Industrial Design Specialization

The purpose of the Industrial Design program is to equip designers for a world that places a high value on the quality of human interactions. We all need products, devices, and designs that support and enhance these exchanges. To this end, we emphasize a design process strongly flavored by user testing, observation, and modeling, while preserving the richness of the visual and formal traditions in the field.

The program approaches a balance by speaking clearly to several issues in the design process: the understanding of and responding to diverse human needs and qualities, the need for the creative application of appropriate technologies, a sense of place within and contribution to our economy and culture, and an awareness of our position in history and our potential effect on the future.

Sophomore Year

	Fall	Units
51-208	ID Studio I: Generation of Forms	9
51-223	ID Lab I: How Things Work	9
51-222	Prototyping (mini)	4.5
51-230	ID Photo Documentation (mini)	4.5
51-212	Design History I	9
xx-xxx	H&SS Requirement	9
		45

	Spring	
51-261	ID Studio II: Meaning of Forms	9
51-218	ID Lab II: How People Work	9
51-201	Design History II	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

Junior Year

	Fall	Units
51-360	ID Studio III: Product Design	9
51-340	ID Lab III: How Products are Made	9
51-302	Design Studies	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

	Spring	
51-361	ID Studio IV: Products within Systems	9
51-333	ID Lab IV: Advanced Human Factors	9
51-303	Design Studies	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

Senior Year

	Fall	Units
51-454	ID Studio IV: Senior Team Projects	9
51-480	ID Lab IV: How Products Will Be Made	9
51-400	Design Studies	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

	Spring	
51-421	ID Studio VI: Senior Degree Project	9
51-4xx	Design Elective(s)	9
51-401	Design Studies	9
xx-xxx	Academic Elective	9
xx-xxx	Free Elective	9
		45

Minimum number of units required for degree: 360

Department of Design Support Electives

51-116,117, 120,121	Calligraphy	6
51-213	Graphic Translation (mini)	4.5
51-220	Darkroom Photography I (mini)	4.5
51-224	Darkroom Photography II (mini)	4.5
51-308	Drawing and Intent	9
51-442	Mapping	9
51-352	Signs, Symbols, and Marks	9
51-440	Environmental Graphic Design	9
51-381	Documenting the Visual	9
51-3xx	Color in 3D	4.5 or 9
51-345	Advanced Projects in Design Computing	9
51-402	Exhibition Design	9
51-404	Human Computer Interface Design	9
51-410	Fundamentals of Furniture Joinery	9
51-411	Furniture Design	9
51-447	Packaging	9
51-445	Visual Interface Design	9

Independent studies may be pursued in the Junior and/or Senior year of the professional program.

*A minimum 3.0 GPA in the previous and current semesters qualify a student to apply for an independent study.

*Only one independent study may be taken per semester. (A maximum of 18 units of independent study permitted.)

*Proposals outlining the nature of the independent study must be developed jointly with and signed by the faculty sponsor and returned to the student advisor one week before pre-registration for the term of the independent study. Guidelines for the proposal are available upon request from the student advisor.

A minimum QPA of 2.0 is required to maintain Professional program status. If necessary, one or more courses in which a student has received a grade lower than "C" will be repeated until the QPA satisfies the requirement. This may require that the student take courses in the summer or beyond the standard four years. Students should note that the usual regulations regarding overloads will apply.

Degrees: **Bachelor of Fine Arts in Communication Design.**

Bachelor of Fine Arts in Industrial Design.

Summer Programs in Design

The Department of Design offers a limited summer program based on student need and availability of faculty. (See the current summer school brochure for details). Usually, the following courses are offered:

	Summer	Units
51-210	Beginning Photography	9
51-371	Junior Independent Study	var.
51-471	Senior Independent Study	var.

Design Minors

The Department of Design offers two minors:

A Minor in Product Design

A Minor in Visual Communication

See page 118 for further details.

Faculty

JOSEPH M. BALLAY, IDSA, Professor of Design — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1970—.

DANIEL BOYARSKI, AIGA, Professor of Design — M.F.A., Indiana University; School for Design, Kunstgewerbeschule, Basel, Switzerland; Carnegie Mellon, 1982—.

CHARLEE MAE BRODSKY, Associate Professor of Photography — M.F.A., Yale University; Carnegie Mellon, 1978—.

RICHARD BUCHANAN, IDSA, DMI, DRS, ACD, SIP, IICS, Professor of Design, Head, Department of Design — Ph.D. University of Chicago; Carnegie Mellon, 1992—.

SERGIO CORREA deJESUS, AIGA, ACD, Assistant Professor of Design — M.F.A., Virginia Commonwealth University; Carnegie Mellon, 1988—.

JOSEPH DICEY, Photographic & Type Production Lab Supervisor — B.S. Indiana University of Pennsylvania; Carnegie Mellon, 1971—.

BRYAN W. LAFFITTE, IDSA, Associate Professor of Design — M.P.D., North Carolina State University; Carnegie Mellon , 1988—.

ROY D. McKELVEY, Associate Professor of Design Computing — M.S., Carnegie Mellon University; Carnegie Mellon, 1985—.

MARK MENTZER, Associate Professor of Drawing — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1975—.

THOMAS L. MERRIMAN, Production Supervisor/Lecturer of Design — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1985—.

KAREN MOYER, AIGA, ACD, Visiting Associate Professor in Design — B.F.A., Philadelphia College of Art; Carnegie Mellon, 1978—.

DAVID SMITH, Nierenberg Professor of Design; Carnegie Mellon, 1993—.

STEPHEN J. STADELMEIER, IDSA, Associate Professor of Design — M.S., Cornell University; Carnegie Mellon, 1977—.

MICHAEL H. STRATMANN, Associate Professor of Design — Ph.D., Delft University of Technology; Carnegie Mellon, 1989—.

ROBERT O. SWINEHART, HMACD, AIGA, Associate Professor of Design — M.F.A., Northern Illinois University; Carnegie Mellon, 1974—.

CRAIG M. VOGEL, IDSA, GDEA, IVLA, FATE, CAA, Associate Professor of Design — M.I.D., Pratt Institute; Carnegie Mellon, 1990—.

Part-time Faculty

MATTHEW BEALE, IDSA, Lecturer in Design — B.A., University of Michigan; Carnegie Mellon, 1994—.

TODD COCHRAN, Lecturer in Design — B.F.A., Carnegie Mellon Unversity; Carnegie Mellon, 1993-.

TIM CUNNINGHAM, IDSA, HFS, Senior Lecturer in Design — M.A., University of California; Carnegie Mellon 1979—.

DANIEL DROZ, IDSA, Senior Lecturer in Design — B.A., Harvard University; Carnegie Mellon, 1984—.

CHRISTOPHER KASABACH, IDSA, Instructor of Design — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1993—.

RICK LANDESBERG, AIGA, Senior Lecturer in Design — B.F.A., Philadelphia College of Art and Design; Carnegie Mellon, 1985—.

DENNIS MORAN, AIGA, Senior Lecturer in Design — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1989—.

MYRNA ROSEN, Instructor of Calligraphy; Carnegie Mellon, 1985—.

JOHN STIVORIC, IDSA, Instructor of Design — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1993—.

Special Faculty

FREDERICK J. AMERY, Associate Professor of Design, Emeritus.

EDWARD FISHER JR., Associate Professor of Design, Emeritus.

HOWARD WORNER, Associate Professor of Design, Emeritus.

Department of Drama

Elisabeth Orion, Head
Office: College of Fine Arts, 108

The Drama Department at Carnegie Mellon University is the oldest university based drama program in the country. The training is classically rooted while providing for originality and innovation in all areas.

As a member of the Consortium of Conservatory Theatre Training Programs, the department chooses students to participate in the program based on their potential ability. Students are only asked to remain in the Department 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 University Colleges. The undergraduate Drama program, which incorporates approximately 200 students, leads to bachelor of fine arts degrees in drama. The options available are acting, music theatre, design, production, and directing. The continuous production of plays — a natural extension of demanding classwork — constitutes one of the department's major activities. Each semester, 15 to 25 productions — directed by faculty, guest directors, and advanced students — are presented in our two theaters. 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 commitment to a 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. The schedule does not allow students to take regular outside employment and part-time employment may only be undertaken with written approval from faculty members involved in the students course work, and the head of the department.

Acting Option

The acting program is designed for the student who has made the choice to seek a professional career as an actor. It is structured so that the student will be capable of entering the theatrical profession after four years of training. It focuses primarily on the creative process, but teaches a craft appropriate for all media. Courses in acting, voice, speech, movement, and/or dance are integral parts of the program at all four levels. Freshman and sophomore students do not perform publicly. The freshman year is a discovery year in which the acting process is taken apart through exercises, text work and improvisation. The fundamental elements of acting are inspected in depth as the student learns how they fit together and how it is possible to make the self fully available in the imaginary world of the play. Sophomores develop and expand these techniques through scene study and character development; exploring a wide range of classical and modern styles to develop a way of working that will support and enrich the student's natural talent. Juniors and seniors progressively test and strengthen these skills in supervised rehearsal and performance situations provided by a variety of studio and mainstage projects and productions, while continuing to develop their craft in advanced technique classes.

Music Theatre Option

The Departments of Drama offers the music theatre option for students with special skills in singing, dancing and acting. The program's rigorous curriculum includes training in the disciplines of acting, vocal music, voice and speech, movement and dance and deals with such forms as musical comedy, cabaret theatre, experimental musical theatre, and the epic musical. The curriculum in this option is demanding and adheres to the strictest requirements for a full technique in singing, dancing and acting. It is the department's belief that good music theatre must come from the combined excellence of these three disciplines. Applicants to the music theatre option should have the same potential acting talent and trainability as the acting majors. Students in this option share the same curriculum as those in the acting option plus courses particular to music theatre.

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.

To expand their interests and vision, the students in this option are encouraged to take several electives and to pursue a minor outside the drama department.

Design Option

Design students are expected to develop artistic ability in the conception and execution of scene, costume and lighting design for plays of all periods under varying theatrical conditions. Students may elect to have a focus on one or two areas but must be proficient 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 scene and costume design. Design assignments cover various styles and periods and include the preparation of models, renderings, and working drawings. Juniors and seniors take specialized courses in all areas of stage design and are expected to head studio and mainstage production crews. As part of the degree work, seniors may design sets, lights, or costumes for a master's production in the studio or a mainstage production.

Production Option

Production, in the broadest sense, is the execution of the design idea whether it be in costumes, scenery or lighting. Each student in the production option is expected to become proficient in the following areas: execution of the design, technical production and lighting. Study in basic scene design and costume design gives production students creative experience with color and understanding of the scope of design in the theatre. Any production student who demonstrates particular talent in the visual arts may progress to advanced design courses. Technical production develops proficiency in scenery construction and skill in backstage organization through planning and construction of scenery, the rigging of scenery on the stage, and the running of crews for performances. Courses in technical production prepare students for such theatre assignments as technical director, production stage manager, or scenery shop manager. Proficiency in lighting and sound design develops from study of methods and equipment. A course of study emphasizing the production of theatrical costumes is available and can be arranged for students with special skills and interest in this area. Basic courses deal with the history of costume, pattern drafting, draping, and interpreting the costume

sketch. Through practical experience, students learn basic craft skills and how to adapt them to many situations. They also learn the organizational skills necessary to run a costume shop and supervise crews.

Acting Option

Freshman Year

	Fall	Units
54-101 A1	Introduction to Acting	4
54-101 A2	Acting I	6
54-103	Voice & Speech I: Exploration/Phonetics	6
54-105 A2	Acting Lab I: Text	2
54-107 A1	Introduction to Movement	2
54-107 A2	Movement	2
54-121A1	Introduction to Directing	4
54-131A1	Introduction to Design	4
54-159	Stage Crew I	4
54-183	Fundamentals of Drama	6
76-100	Strategies for Writing	9
99-101	Computer Skills Workshop	3
		Minimum units - 52

	Spring	
54-102	Acting I	10
54-104	Voice & Speech I	6
54-106	Acting Lab I	6
54-108	Movement I	3
54-160	Stage Crew I	6
54-184	Fundamentals of Drama	6
79-xxx	History	9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 52

Sophomore Year

	Fall	Units
54-201	Acting II	10
54-203	Voice & Speech II	6
54-205	Acting Lab II: Rhythm/Styles/Text	8
54-207	Movement II	4
54-259	Stage Crew II	6
54-281	History of Drama I (2 minis)	6
xx-xxx	Non Departmental Elective	6-9
		Minimum units - 46

	Spring	
54-202	Acting II	10
54-204	Voice & Speech II	6
54-206	Acting Lab II	6
54-208	Movement II	4
54-260	Stage Crew II	6
54-282	History of Drama I (2 minis)	6
54-294	Make-Up	2
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 46

Junior Year

	Fall	Units
54-301	Acting III	9
54-303	Voice & Speech III	6
54-305	Acting Lab III	6
54-307	Movement III	4
54-311	Studio & Performance	9
54-381	History of Drama II (2 minis)	6
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 46

	Spring	
54-302	Acting III	9
54-304	Voice & Speech III	6
54-306	Acting Lab III	6
54-308	Movement III	4
54-312	Studio & Performance	9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 40

Senior Year

	Fall	Units
54-401	Acting IV	9
54-403	Voice & Speech IV (as required)	6
54-407	Movement IV or Elective	6
54-409	Theatre Lab	4
54-411	Rehearsal & Performance	15
xx-xxx	Non Departmental Elective	6-9
		Minimum units - 46

	Spring	
54-402	Acting IV	9
54-404	Voice & Speech IV (as required)	6
54-406	Acting Lab IV or Elective	6
54-408	Movement IV or Elective	6
54-410	Theatre Lab	4
54-412	Rehearsal & Performance	15
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 52

Music Theater Option

The Drama Department considers this option to be the equivalent of a double major. No non-departmental electives required.

Freshman Year

	Fall	Units
54-101 A1	Introduction to Acting	4
54-101 A2	Acting I	6
54-103	Voice & Speech I: Exploration/Phonetics	6
54-105 A2	Acting Lab I: Text	2
54-107 A1	Introduction to Movement	2
54-107 A2	Movement	2
54-119 A2	Music Theatre Workshop I	2
54-121 A1	Introduction to Directing	4
54-123	Dance I	6
54-125 A2	Music Theatre Skills I	2
54-127 A2	Piano Skills I	2
54-131 A1	Introduction to Design	4
54-159	Stage Crew I	4
54-183	Fundamentals of Drama	6
54-500	Voice	6
76-100	Strategies for Writing	9
		Minimum units - 67

	Spring	
54-102	Acting I	10
54-104	Voice & Speech I	6
54-106	Acting Lab I	2
54-108	Movement I	3
54-120	Music Theatre Workshop I	3
54-123	Dance I	6
54-125	Music Theatre Skills I	3
54-127	Piano Skills I	3
54-160	Stage Crew I	6
54-184	Fundamentals of Drama	6
54-500	Voice	6
79-xxx	History	9
99-101	Computer Skills Workshop.	3
		Minimum units - 66

Sophomore Year

	Fall	Units
54-201	Acting II	10
54-203	Voice & Speech II	6
54-205	Acting Lab II: Rhythm/Styles/Text	6
54-207	Movement II	4
54-219	Music Theatre Workshop II	3
54-223	Dance II	6
54-225	Music Theatre Skills II	3
54-227	Piano Skills II	3
54-259	Stage Crew II	6
54-281	History of Drama I (2 minis)	6
54-500	Voice	6
		Minimum units - 59

	Spring	
54-202	Acting II	10
54-204	Voice & Speech II	6
54-206	Acting Lab II	6
54-208	Movement II	4
54-220	Music Theatre Workshop II	3
54-224	Dance II	6
54-226	Music Theatre Skills II	3
54-228	Piano Skills II	3
54-260	Stage Crew II	6
54-282	History of Drama I (2 minis)	6
54-294	Make-Up	2
54-500	Voice	6
		Minimum units - 61

Junior Year

	Fall	Units
54-301	Acting III	9
54-303	Voice & Speech III	6
54-305	Acting Lab III	2
54-307	Movement III	4
54-319	Music Theatre Workshop III	4
54-323	Dance III	6
54-327	Music Theatre Literature and Repetoire	3
54-311	Studio & Performance	9
54-381	History of Drama II (2 minis)	6
54-500	Voice	6
		Minimum units - 55

	Spring	
54-302	Acting III	9
54-304	Voice & Speech III	6
54-306	Acting Lab III	2
54-308	Movement III	4
54-320	Music Theatre Workshop III	4
54-324	Dance III	6
54-328	Music Theatre Literature and Repetoire	3
54-312	Studio & Performance	9
54-500	Voice	6
		Minimum units - 49

Senior Year

	Fall	Units
54-401	Acting IV	9
54-403	Voice & Speech IV (as required)	6
54-407	Movement IV or Elective	6
54-409	Theatre Lab	4
54-411	Rehearsal & Performance	15
54-419	Music Theatre Workshop IV	4
54-423	Dance IV	6
54-500	Voice	6
		Minimum units - 56

	Spring	
54-402	Acting IV	9
54-404	Voice & Speech IV (as required)	6
54-406	Acting Lab IV or Elective	6
54-408	Movement IV or Elective	6
54-410	Theatre Lab	4
54-412	Rehearsal & Performance	15
54-419	Music Theatre Workshop IV	4
54-423	Dance IV	6
54-500	Voice	6
		Minimum units - 62

Design Option

Freshman Year

	Fall	Units
54-101A1	Introduction to Acting	4
54-107 A1	Introduction to Movement	2
54-121A1	Introduction to Directing	4
54-131 A1	Introduction to Design	4
54-131 A2	Basic Design/Drawing	8
54-161	Production Preparation	6
54-171	Drafting	4
54-173	Technical Production I	4
54-183	Fundamentals of Drama	6
76-100	Strategies for Writing	9
99-101	Computing Skills Workshop	3
		54

	Spring	
54-132	Basic Design/Drawing	12
54-162	Production Preparation I	6
54-172	Drafting	6
54-174	Technical Production I	6
54-184	Fundamentals of Drama	6
xx-xxx	Non-Departmental Elective	6-9
79-xxx	History	9
		Minimum units - 51

Sophomore Year

	Fall	Units
54-231	Stage Design	9
54-237	Scene Painting I	4
54-239	History of Architecture and Decor	6
54-245	History of Clothing	6
54-261	Production Preparation II	9
54-273	Technical Production II	9
54-281	History of Drama I (2 minis)	6
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 55

	Spring	
54-232	Stage Design	9
54-238	Scene Painting I	4
54-240	History of Architecture and Decor	6
54-245	History of Clothing	6
54-262	Production Preparation II	9
54-274	Technical Production II	9
54-282	History of Drama I (2 minis)	6
54-294	Make-up	2
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 57

Junior Year

	Fall	Units
54-251	Introduction to Lighting	6
54-283	Fundamentals of Directing	4
54-331	Scene Design I	9
54-341	Costume Design I	9
54-343	Costume Construction I	6
54-361	Production Preparation III	12
54-381	History of Drama II (2 minis)	6
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 58

	Spring	
54-252	Introduction to Lighting	6
54-284	Fundamentals of Directing	4
54-332	Scene Design I	9
54-342	Costume Design I	9
54-344	Costume Construction I	6
54-362	Production Preparation III	12
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 52

Senior Year

	Fall & Spring	Units
54-351/2	Lighting Design I	9
54-431/2	Scene Design II	9
54-441/2	Costume Design II	9

Two of the above are required

54-461/2	Production Preparation IV	15
xx-xxx	Electives	9

Electives may include the following:

54-443/4	Costume Construction II	6
54-337/8	Scene Painting II	4
OR		
54-495/6	Approved Intern Project	9/36
		Minimum units - 46

Lighting Design

Freshman Year

This follows the same requirements as the Design Option for the Freshman Fall and Spring semesters

Sophomore Year

	Fall and Spring	Units
54-231/2	Stage Design	9
54-239/40	History of Architecture and Decor	6
54-245/6	History of Clothing	6
54-251/2	Introduction to Lighting	6
54-281/2	History of Drama (2 minis)	6
54-261/2	Production Preparation II	9
54-273/4	Technical Production II	9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 57

Junior Year

	Fall and Spring	Units
54-165/6	Sound Design	6
54-277/8	Stage Management	4
54-283/4	Fundamentals of Directing	4
54-293/4	Make-up (spring only)	2
54-331/2	Scene Design I	9
54-337/8	Scene Painting I	4
54-351/2	Lighting Design I	9
54-361/2	Production Preparation II	12
54-381/2	History of Drama II (2 minis)	6
xx-xxx	Non-Departmental Elective	6
		Minimum units - 60

Senior Year

	Fall and Spring	Units
54-351/2	Lighting Design II	9
54-341/2	Costume Design I	9
54-461/2	Production Preparation IV	15
xx-xxx	Electives	15
		Minimum units - 48

Directing Option

Freshman Year

	Fall	Units
54-101A1	Introduction to Acting	4
54-101A2	Acting I	6
54-105	Acting Lab I	2
54-107 A1	Introduction to Movement	2
54-121D1	Introduction to Directing	7
54-121A2	Directing I	6
54-131 A1	Introduction to Design	4
54-157	Production I	6
54-183	Fundamentals of Drama	6
76-100	Strategies for Writing	9
99-101	Computer Skills Workshop	3
xx-xxx	Non-departmental Elective	6-9
		Minimum units - 61

	Spring	
54-102	Acting I	12
54-105	Acting Lab I	2
54-122	Directing I	12
54-157	Production I	6
54-184	Fundamentals of Drama	6
54-188	Introduction to Playwriting	3
79-104	History	9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 56

Sophomore Year

	Fall	Units
54-209	Director's Workshop	6
54-221	Directing II	6
54-245	History of Clothing	4
54-257	Production II	6
54-277	Stage Management	4
54-281	History of Drama I (2 minis)	6
54-xxx	One elective	6-9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 50

	Spring	
54-210	Director's Workshop	6
54-222	Directing II	6
54-246	History of Clothing	4
54-258	Production II	6
54-278	Stage Management	4
54-282	History of Drama I (2 minis)	6
79-200	Society and the Arts	9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 47

Junior Year

	Fall	Units
54-231	Stage Design	6
54-239	History of Architecture & Decor	4
54-321	Directing III	9
54-357	Production III	10
54-381	History of Drama II (2 minis)	6
54-383	Critical Writing	4
54-xxx	One elective	6-9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 51

	Spring	
54-232	Stage Design	4
54-240	History of Architecture & Decor	4
54-322	Directing III	9
54-358	Production III	10
54-383	Critical Writing	4
54-xxx	One elective	6-9
xx-xxx	Non-Departmental Elective	12-18
		Minimum units - 49

Senior Year

	Fall	Units
54-409	Theatre Lab	4
54-421	Directing IV: Camera Techniques	9
54-457	Production IV	10
54-475	Theatre Management	6
54-481	Dramatic Theories	9
54-xxx	One elective	6-9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 50

	Spring	
54-410	Theatre Lab	4
54-422	Directing IV:	9
54-457	Production IV	10
54-481	Dramatic Theories	9
54-xxx	One elective	6-9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 50

Production Option

Freshman Year

	Fall	Units
54-101A1	Introduction to Acting	4
54-107 A1	Introduction to Movement	2
54-121A1	Introduction to Directing	4
54-131 A1	Introduction to Design	4
54-131 A2	Basic Design/Drawing	8
54-173	Technical Production I	4
54-171	Drafting/AutoCAD	4
54-161	Production Preparation I	6
54-183	Fundamentals of Drama	6
76-100	Strategies for Writing	9
99-101	Computing Skills Workshop	3
		54

	Spring	
54-132	Basic Design/Drawing	12
54-172	Drafting/AutoCAD	6
54-162	Production Preparation I	6
54-174	Technical Production I	6
54-184	Fundamentals of Drama	6
79-xxx	History	9
xx-xxx	Non-Departmental Elective	6-9
		51

Sophomore Year

	Fall and Spring	Units
21-105	Pre-Calculus (first semester)	6
54-231/2	Stage Design	9
54-239/40	History of Architecture and Decor	6
54-251/2	Introduction to Lighting	6
54-261/2	Production Preparation II	9
54-263/4	Welding	4
54-281/2	History of Drama I (2 minis)	6
54-273/4	Technical Production II	9
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 61

Junior Year-Technical Production Emphasis

	Fall and Spring	Units
54-165/6	Sound	6
54-283/4	Fundamentals of Directing	4
54-361/2	Production Preparation III	12
54-373/4	Technical Production III	9
54-381/2	History of Drama II (2 minis)	6
xx-xxx	Non-Departmental Elective	6-9
		Minimum units - 43

Senior Year-Technical Production Emphasis

	Fall and Spring	Units
54-461/2	Production Preparation IV	15
54-473/4	Technical Production IV	9
Electives which might include:		18
54-351	Lighting Design I	
57-337	Sound Recording I	
48-120	Computer Modeling	
48-210	Materials and Assembly I	
70-xxx	Business Accounting	
		Minimum units - 42

Junior Year - Lighting & Sound Design
(curriculum to be individually tailored)

	Fall	Units
48-120	Computer Modeling	9
54-165	Sound II	6
54-351	Lighting Design I	9
54-361	Production Preparation III	12
54-381	History of Drama II (2 minis)	6
54-475	Theatre Management	6
57-337	Sound Recording I	6
		Minimum units - 54

	Spring	
48-120	Computer Modeling	9
54-352	Lighting Design I	9
54-362	Production Preparation III	12
54-382	History of Drama II (2 minis)	6
57-338	Sound Recording I	6
xx-xxx	Non -Departmental Elective	6-9
		Minimum units - 48

Senior Year - Lighting and Sound Design
(curriculum to be individually tailored)

	Fall and Spring	Units
54-451/2	Lighting Design II	9
54-461/2	Production Preparation IV	15
57-xxx	Sound Recording II	6
xx-xxx	Non -Departmental Elective	18
		Minimum units each semester - 48

General Electives

The following are suggested department electives for Drama students. All other students may elect these courses only by permission of the instructor and after consulting with the head of the Drama Department.

54-173/4	Technical Production I	6
54-187/8	Introduction to Playwriting	3
54-231/2	Stage Design	6
54-239/40	History of Architecture and Decor	6
54-245/6	History of Clothing	6
54-283/4	Fundamentals of Directing	4
54-309/10	Theatre Lab	4
54-331/2	Scene Design I	9
54-341/2	Costume Design I	9
54-343/4	Costume Construction II	6
54-372	Special Scenic Crafts	9
54-409/10	Theatre Lab	4
54-431/2	Scene Design II	9
54-441/2	Costume Design II	9
54-443/4	Costume Construction II	6
54-451/2	Lighting Design III	6
54-475	Theatre Management	6
62-155/156	Advanced Playwriting	9

Electives for Non-Drama Department Students

(Permission of instructor required.)

54-161/2	Production Preparation I	6
54-183/4	Fundamentals of Drama	6
54-187/8	Introduction to Playwriting	3
54-239/40	History of Architecture and Decor	6
54-245/6	History of Clothing	6
54-251/2	Introduction to Lighting	6
54-281/2	History of Drama I (2 minis)	6
54-283/4	Fundamentals of Directing	4
54-351/2	Lighting Design I	9
54-381/2	History of Drama II (2 minis)	6
54-475	Theatre Management	6

Faculty

BARBARA BENZ ANDERSON, Professor of Drama/Design — M.F.A., Yale University; Carnegie Mellon, 1968—.

CLETUS ANDERSON, Professor of Drama/Design — Head of Design and Production - M.F.A., Yale University; Carnegie Mellon, 1968—.

NATALIE BAKER, Adjunct Lecturer in Voice & Speech — B.F.A. Carnegie Mellon; Carnegie Mellon, 1992—.

DICK BLOCK, Associate Professor of Drama /Design — M.F.A., Northwestern University; Carnegie Mellon, 1988—.

BARBARA CARRYER, Lecturer in Movement — B.A., Mills College; The Jacques Lecoq Mime & Movement Theatre School; Carnegie Mellon, 1989—.

TIM CARRYER, Assistant Professor of Movement — B.A., Reed College; The Jacques Lecoq Mime & Movement Theatre School; Carnegie Mellon, 1988—.

JAMES CATON, Lecturer in Dance — Carnegie Mellon, 1988—.

JUDITH CONTE, Senior Lecturer in Dance — B.F.A., University of Wisconsin/ Milwaukee; Carnegie Mellon, 1978—.

THOMAS DOUGLAS, Adjunct Lecturer in Voice — M.M. Duquesne University; Carnegie Mellon 1991—.

TIMOTHY FRICKER, Lecturer in Production/Technical Director — M.F.A. Yale University; Carnegie Mellon 1993—.

ARTHUR GIRON, Professor of Drama; Head of Playwriting — M.A. Hunter College; Carnegie Mellon, 1982—.

JED HARRIS, Lecturer in Directing/Drama Literature — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991—.

GEOFFREY HITCH, Lecturer in Directing — M.F.A. Carnegie Mellon; Carnegie Mellon 1992—.

LYNNE INNERST, Lecturer in Voice and Speech — M.F.A., University of Southern California; Carnegie Mellon, 1991—.

BRIAN JOHNSTON, Associate Professor of Dramatic Literature — M.A. Honors, Cambridge University, England; Carnegie Mellon, 1986—.

GARY KLINE, Lecturer in Voice — B.F.A., Carnegie Mellon; Carnegie Mellon, 1990—.

MLADEN KISELOV, Associate Professor in Directing/Acting — Honors Graduate, Moscow Theatre Institute; Carnegie Mellon, 1992—.

GREGORY LEHANE, Associate Professor of Directing; Head of Directing — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991—.

CINDY LIMAURO, Associate Professor of Drama/Lighting — M.F.A., Florida State; Carnegie Mellon, 1987—.

BARBARA MacKENZIE WOOD, Associate Professor of Drama — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1986—.

DON MARINELLI, Associate Professor of Drama; Associate Head, Department of Drama — Ph.D., University of Pittsburgh; Carnegie Mellon, 1981—.

ANTHONY LORING McKAY, Associate Professor of Drama; Associate Head of Acting — B.F.A. Carnegie Mellon University; Carnegie Mellon, 1985—.

GLENN MERWEDE, Associate Technical Director — M.F.A. Penn State University; Carnegie Mellon 1993—.

AKRAM MIDANI, Professor of Drama — M.A., School of Education, New York University; Carnegie Mellon, 1978—.

JANET MORRISON, Associate Professor of Drama/Acting — B.A., San Francisco State; Carnegie Mellon, 1985—.

ANNE MUNDELL, Lecturer in Design — M.F.A. Brandeis University; Carnegie Mellon, 1989—.

ELISABETH ORION, Professor of Drama/Acting; Head, Department of Drama — Honors Graduate, Central School of Dramatic Art, London; Carnegie Mellon, 1977—.

GLYNN PAGE, Senior Lecturer in Voice — Abilene Christian University and Indiana University; Carnegie Mellon, 1988—.

ROBERT LEE PARKS, Associate Professor of Drama Emeritus — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1963—.

VICTORIA SANTA CRUZ, Professor of Drama — Founder, Ballet Folklorico de Peru; Carnegie Mellon, 1982—.

TIMOTHY SATERNOW, Visiting Assistant Professor of Design — M.F.A. Yale University; Carnegie Mellon, 1992—.

DON WADSWORTH, Associate Professor of Drama/Voice & Speech — M.F.A., University of Pittsburgh; Carnegie Mellon, 1989—.

Department of Music

Marilyn Taft Thomas, Head
Office: The College of Fine Arts 105

The Department of Music at Carnegie Mellon is a "Conservatory in a University Setting". A comprehensive curriculum is offered in an environment rich with diverse musical experiences and academic opportunities.

The Department is committed to developing each student's full range of talents. A strong classical and contemporary program provides a solid background for professional careers in music, while the possibility of combining a music degree with minors or majors in other disciplines expands students' future career options.

Each student receives the highest level of individualized instruction from professional musicians and master teachers, many from the renowned Pittsburgh Symphony Orchestra. The Cuarteto Latinoamericano, Carnegie Mellon's resident string quartet, has toured extensively through Western and Eastern Europe, the United States, and Latin America. Members of the quartet perform, teach, and coach a repertoire that includes not only the traditional classics but also modern works from all over the world. The full time faculty includes specialists in Music History, Theory, Counterpoint, Analysis, Composition, Computer Music, Eurhythmics, Solfege, Pedagogy, Music Education, Accompanying, Chamber Music, Jazz, and Conducting.

Performance is the heart of the Department. Students participate in ensembles with expert professional guidance. Performing ensembles include the Carnegie Mellon Philharmonic Orchestra, Wind Ensemble, Jazz Ensemble, Concert Choir, Repertory Chorus, Jazz Choir, Contemporary Ensemble, Flute Ensemble, Percussion Ensemble, and numerous chamber groups.

With an intense program in composition and a university environment enriched by computer technology, the Department of Music places a strong emphasis on contemporary music. All members of the composition faculty are professional composers, who share the creative evolution of their own works in a master/apprentice relationship. Students compose works for all types of instrumental and vocal groupings, culminating in an orchestral piece during the senior year. All student compositions are performed by one of the Department's ensembles, often conducted by graduate conducting majors or by the composers themselves.

Facilities

The teaching facilities of the Department of Music are located on the main and mezzanine floors of the College of Fine Arts, and on the first floor of Margaret Morrison Hall. All teaching, rehearsal, and practice rooms are equipped with the finest Steinway pianos. Students also have access to a state-of-the-art computer and electronic studio and recording studio. Performances take place in Mellon Institute, 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.

Department of Music Options

The Department of Music offers a Bachelor of Fine Arts in the following areas:

- Composition
- Performance (Piano, Organ, Voice, Instrumental)

To earn a Bachelor's degree in either of these options, a candidate must satisfactorily fulfill all the requirements of the Department of Music.

Within the options listed above students may elect specializations in the following areas:

- Music Teaching Certification
- Dalcroze Eurhythmics Certification
- Piano Pedagogy Certification
- Accompanying Minor
- Conducting Minor
- Jazz Performance Minor
- Music Technology Emphasis

Music Teaching Certification

Music Teaching Certification is a five-year program. Starting in the sophomore year, BFA candidates for this program will have to complete the Music Teaching Certification curriculum in addition to their required courses for a performance degree.

Dalcroze Eurhythmics Certification

This program is designed to prepare teachers in the Dalcroze approach to music learning. The course of study includes eurhythmics, Dalcroze solfege, piano improvisation and movement. This program is recommended particularly to students who would like to teach children, and to those who want to obtain more experience in this field.

Note: Dalcroze Eurhythmics Certification may be obtained in one semester or in two summers. Certification will not be granted until undergraduate work is complete.

Piano Pedagogy Certification

A two-year program leading to certification in piano pedagogy is available. This program 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

This course of study is for the pianist who is interested in developing skills for accompanying either vocalists or instrumentalists. In a six-semester cycle of accompanying instruction, students master essential skills of sight-reading and transposition, observe Department staff accompanists at work, and explore repertoire as they gain practical experience accompanying vocal diction or literature and repertoire classes, recitals, juries and master classes.

Conducting Minor

Students who are interested in acquiring conducting skills, in anticipation of either a music education career or graduate study in conducting, may choose to pursue this program. It includes required courses in basic conducting techniques for both choral and instrumental ensembles, analysis, arranging, and orchestration, and elective courses in instrumental and vocal methods, diction, literature and repertoire, and history.

Jazz Performance Minor

Jazz is an integral part of the curriculum in the Carnegie Mellon Department of Music. With an emphasis on developing the "complete musician," all performance majors are encouraged to study jazz along with their classical training. Course offerings include two Jazz Ensembles, Jazz Choir, Jazz Piano, Jazz Chamber Music, Jazz Improvisation, Jazz Ear Training, Jazz History, and Jazz Orchestration. Additional electives in recording technology, contemporary music, and electronic and computer music enhance the students' understanding of modern performance techniques.

Music Technology Emphasis

A student may elect to take a series of courses in 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.

Minors for Music Students

Well-planned interdisciplinary activities combined with a firm commitment to professionalism serve the dual purpose of enriching and strengthening the professional area and providing a variety of graduate career alternatives. See page 71 for a list of available minors.

Performances and Activities of the Department of Music

The Department 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 semester to the students and the community.

Public Performance Requirements for BFA Candidates

Candidates for the Bachelor of Fine Arts degree are required to give public performances in their junior and senior years.

All students are required to participate in assigned performing ensembles during their residence in the Department of Music.

Music Curriculum

The music curriculum is based on the following five building blocks:

Studio

Theory

History

Ensemble

Academics

1. Studio - This is the heart of the department. Students receive individualized instruction in their major area of study: performance or composition.

2. Theory - This course of study is designed to develop listening skills, to acquire theoretical knowledge, to recognize structural techniques and manipulate technological resources. It includes courses in sight-reading, ear-training, eurhythmics, contrapuntal techniques, harmony, analysis of musical forms, 20th century techniques, orchestration, score reading, and computer and electronic music for compositional and educational purposes.

3. History - The courses included in this block 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 Orchestra, Wind Ensemble, Jazz Ensemble, Concert Choir, Repertory Chorus, Jazz Choir, Opera/Music Theatre Workshop, Contemporary Ensemble, Flute Ensemble, Percussion Ensemble, and various chamber groups.

5. Academics - According to the university policy, all students are required to complete a core curriculum in the following disciplines: English, History and Computer Skills. The Department of Music also requires one General Studies course (outside of the Department) 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 Department are permitted to take additional courses beyond the number required for graduation. There is no charge for extra credits taken at Carnegie Mellon.

Credits - The total number of units required for graduation is 396. Three units equal one credit.

Piano

Freshman Year

	Fall	Units
57-501	Studio	9
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-151	16th Century Counterpoint	6
57-173	Survey of Western Music History	9
57-181	Solfege I	6
57-161	Eurhythmics I	3
76-xxx	Designated Writing course	9
		51

	Spring	
57-501	Studio	9
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-152	Harmony I	6
57-182	Solfege II	6
57-162	Eurhythmics II	3
57-xxx	History of Music Course	9
57-101	Music Computing Skills Workshop	9
		51

Sophomore Year

	Fall	Units
57-501	Studio	9
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-153	Harmony II	6
57-183	Solfege III	6
57-163	Eurhythmics III	3
57-xxx	History of Music Course	9
xx -xxx	General Studies Course	6
xx -xxx	Elective	3
		51

	Spring	
57-501	Studio	9
57-4xx	Major Ensemble	6
57 -xxx	Performance Elective	3
57-154	18th Century Counterpoint	6
57-184	Solfege IV	6
57-164	Eurhythmics IV	3
57 -xxx	History of Music Course	9
79-200	Society and the Arts	9
		51

Junior Year

	Fall	Units
57-501	Studio	12
57-4xx	Major Ensemble	6
57 -xxx	Performance Elective	3
57 -xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

	Spring	
57-501	Studio	12
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

Senior Year

	Fall	Units
57-501	Studio	12
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

	Spring	
57-501	Studio	12
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

Organ

Freshman Year

	Fall	Units
57-502	Studio	9
57-4xx	Major Ensemble	6
57-191	Keyboard Studies I	3
57-151	16th Century Counterpoint	6
57-173	Survey of Western Music History	9
57-181	Solfege I	6
57-161	Eurhythmics I	3
76-xxx	Designated Writing course	9
		51

	Spring	
57-502	Studio	9
57-4xx	Major Ensemble	6
57-192	Keyboard Studies II	3
57-152	Harmony I	6
57-182	Solfege II	6
57-162	Eurhythmics II	3
57-xxx	History of Music Course	9
57-101	Music Computing Skills Workshop	9
		51

Sophomore Year

	Fall	Units
57-502	Studio	9
57-4xx	Major Ensemble	6
57-291	Keyboard Studies III	3
57-153	Harmony II	6
57-183	Solfege III	6
57-163	Eurhythmics III	3
57-xxx	History of Music Course	9
xx -xxx	General Studies Course	6
xx -xxx	Elective	3
		51

	Spring	
57-502	Studio	9
57-4xx	Major Ensemble	6
57-292	Keyboard Studies IV	3
57-154	18th Century Counterpoint	6
57-184	Solfege IV	6
57-164	Eurhythmics IV	3
57-xxx	History of Music Course	9
79-200	Society and the Arts	9
		51

Junior Year

	Fall	Units
57-502	Studio	12
57-4xx	Major Ensemble	6
57-459	Score Reading/Keyboard Harmony I	6
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	3
		48

	Spring	
57-502	Studio	12
57-4xx	Major Ensemble	6
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	9
		48

Senior Year

	Fall	Units
57-502	Studio	12
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

	Spring	
57-502	Studio	12
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

Voice

Freshman Year

	Fall	Units
57-500	Studio	9
57-4xx	Major Ensemble	6
57-191	Keyboard Studies I	3
57-152	Harmony I	6
57-173	Survey of Western Music History	9
57-181	Solfege I	6
57-161	Eurhythmics I	3
57-111	Dance I	3
82-161	Elementary Italian	9
57-220	English Diction	3
		57

	Spring	
57-500	Studio	9
57-4xx	Major Ensemble	6
57-192	Keyboard Studies II	3
57-153	Harmony II	6
57-202	Opera History	9
57-182	Solfege II	6
57-162	Eurhythmics II	3
57-112	Dance II	3
76-xxx	Designated Writing course	9
57-221	Italian Diction	3
		57

Sophomore Year

	Fall	Units
57-500	Studio	9
57-4xx	Major Ensemble	6
57-291	Keyboard Studies III	3
57-183	Solfege III	6
57-163	Eurhythmics III	3
57-211	Dance III	3
57-240	Acting I	6
57-431	Lit & Rep I (Italian)	3
82-101	Elementary French	9
99-101	Computer Skills Workshop	3
		51

	Spring	
57-500	Studio	9
57-4xx	Major Ensemble	6
57-292	Keyboard Studies IV	3
57-184	Solfege IV	6
57-164	Eurhythmics IV	3
57-212	Dance IV	3
57-241	Acting II	6
57-432	Lit & Rep II (French)	3
57-222	French Diction	3
79-200	Society and the Arts	9
		51

Junior Year

	Fall	Units
57-500	Studio	12
57-4xx	Major Ensemble	6
57-325	Opera/Music Theatre Workshop I	6
57-315	Dance V	3
57-339	Acting III	6
57-433	Lit & Rep III (Music Theatre)	3
82-121	Elementary German	9
xx -xxx	Elective	6
		51

	Spring	
57-500	Studio	12
57-4xx	Major Ensemble	6
57-326	Opera/Music Theatre Workshop II	6
57-316	Dance VI	3
57-340	Acting IV	6
57-434	Lit & Rep IV (Music Theatre)	3
57-223	German Diction	3
xx -xxx	Elective	6
		45

Senior Year

	Fall	Units
57-500	Studio	12
57-4xx	Major Ensemble	6
57-425	Opera/Music Theatre Workshop III	6
57-415	Dance VII	3
57-439	Acting V	6
57-435	Lit & Rep V (German)	3
xx -xxx	Elective	6
		42

	Spring	
57-500	Studio	12
57-4xx	Major Ensemble	6
57-426	Opera/Music Theatre Workshop IV	6
57-416	Dance VIII	3
57-440	Acting VI	6
57-436	Lit & Rep VI (English/Contemporary)	3
xx -xxx	Elective	6
		42

Instrumental

Freshman Year

	Fall	Units
57-xxx	Studio	9
57-4xx	Major Ensemble	6
57-191	Keyboard Studies I	3
57-151	16th Century Counterpoint	6
57-173	Survey of Western Music History	9
57-181	Solfege I	6
57-161	Eurhythmics I	3
76-xxx	Designated Writing course	9
		51

	Spring	
57 -xxx	Studio	9
57-4xx	Major Ensemble	6
57-192	Keyboard Studies II	3
57-152	Harmony I	6
57-182	Solfege II	6
57-162	Eurhythmics II	3
57-xxx	History of Music Course	9
57-101	Music Computing Skills Workshop	9
		51

Sophomore Year

	Fall	Units
57 -xxx	Studio	9
57-4xx	Major Ensemble	6
57-291	Keyboard Studies III	3
57-153	Harmony II	6
57-183	Solfege III	6
57-163	Eurhythmics III	3
57-xxx	History of Music Course	9
xx -xxx	General Studies Course	6
xx -xxx	Elective	3
		51

	Spring	
57 -xxx	Studio	9
57-4xx	Major Ensemble	6
57-292	Keyboard Studies IV	3
57-154	18th Century Counterpoint	6
57-184	Solfege IV	6
57-164	Eurhythmics IV	3
57-xxx	History of Music Course	9
79-200	Society and the Arts	9
		51

Junior Year

	Fall	Units
57 -xxx	Studio	12
57-4xx	Major Ensemble	6
57 -xxx	Performance Elective	3
57 -xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

	Spring	
57 -xxx	Studio	12
57-4xx	Major Ensemble	6
57 -xxx	Performance Elective	3
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

Senior Year

	Fall	Units
57 -xxx	Studio	12
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

	Spring	
57 -xxx	Studio	12
57-4xx	Major Ensemble	6
57-xxx	Performance Elective	3
57-xxx	Music Support Courses (Theory/History)	12
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

Composition

Freshman Year

	Fall	Units
57-521	Studio	9
57-4xx	Major Ensemble	6
57-191	Keyboard Studies I	3
57-151	16th Century Counterpoint	6
57-173	Survey of Western Music History	9
57-181	Solfege I	6
57-161	Eurhythmics I	3
76-xxx	Designated Writing course	9
		51

	Spring	
57-521	Studio	9
57-4xx	Major Ensemble	6
57-192	Keyboard Studies II	3
57-152	Harmony I	6
57-182	Solfege II	6
57-162	Eurhythmics II	3
57-xxx	Music History Course	9
57-101	Music Computing Skills Workshop	9
		51

Sophomore Year

	Fall	Units
57-521	Studio	9
57-4xx	Major Ensemble	6
57-291	Keyboard Studies III	3
57-153	Harmony II	6
57-183	Solfege III	6
57-163	Eurhythmics III	3
57-257	Orchestration I	6
xx -xxx	General Studies Course	9
xx -xxx	Elective	3
		51

	Spring	
57-521	Studio	9
57-4xx	Major Ensemble	6
57-292	Keyboard Studies IV	3
57-154	18th Century Counterpoint	6
57-184	Solfege IV	6
57-164	Eurhythmics IV	3
57-258	20th Century Techniques	6
79-200	Society and the Arts	9
xx -xxx	Elective	3
		51

Junior Year

	Fall	Units
57-521	Studio	12
57-4xx	Major Ensemble	6
57-332	Introduction to Conducting	3
57-xxx	Music Theory Course	6
57-271	Orchestration II	6
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

	Spring	
57-521	Studio	12
57-4xx	Major Ensemble	6
57-336	Instrumental/Choral Conducting	3
57-xxx	Music Theory Course	6
57-272	Orchestration III	6
xx -xxx	General Studies Course	9
xx -xxx	Elective	6
		48

Senior Year

	Fall	Units
57-521	Studio	12
57-4xx	Major Ensemble	6
57-459	Score Reading and Keyboard Harmony	6
57-xxx	Music Support Course (Theory/History)	6
57-347	Electronic and Computer Music	6
xx -xxx	General Studies Course	9
xx-xxx	Elective	3
		48

	Spring	
57-521	Studio	12
57-4xx	Major Ensemble	6
57-xxx	Music Support Course (Theory/History)	6
57-349	Supervised Theory Teaching	6
xx -xxx	General Studies Course	9
xx -xxx	Elective	9
		48

Music Teaching Certification

Sophomore Year

	Fall	Units
85-101	General Psychology	9
57-607	Vocal Methods	3
	Spring	
57-331	Principles of Education	9
57-608	Observation	3

Junior Year

	Fall	Units
85-xxx	Psychology elective	9
57-360	Brass Methods	3
57-361	Percussion Methods	3
57-391	Secondary Piano V	3
	Spring	
xx -xxx	Humanities elective	9
57-362	Woodwind Methods	3
57-363	String Methods	3
57-392	Secondary Piano VI	3

Senior Year

	Fall	Units
xx -xxx	Science/Math elective	9
57-334	Fundamentals of Marching Band	3
57-332	Introduction to Conducting	6
	Spring	
57-375	Music in the Elementary Schools	6
57-356	Guided Teaching in the Elementary Schools	3
57-333	Band and Choral Arranging	6
57-336	Instrumental/Choral Conducting	6

Fifth Year

	Fall	Units
57-107	Secondary Instrument (Fretted)	6
57-376	Music in the Secondary Schools	6
57-355	Guided Teaching in the Secondary Schools	3
xx -xxx	Professional Education Course	9
	Spring	
57-604	Practice Teaching	24

Dalcroze Eurhythmics Certification

	36 Units
Eurhythmics	12
Dalcroze Seminar	3
Piano Improvisation	12
Creative Movement	3
Dalcroze Pedagogy/Practice Teaching	6

A Minor in Conducting for Students in the Department of Music

Admission Requirements

The student must apply to enter the program in the office of the advisor for music minors (CFA 162).

Required Courses		42 Units
57-191	Keyboard Studies I	3
57-192	Keyboard Studies II	3
57-257	Orchestration I	6
57-271	Orchestration II	6
57-332	Introduction to Conducting	3
57-333	Band and Choral Arranging	6
57-336	Instrumental/Choral Conducting	3
57-408	Form and Analysis	6
57-459	Score Reading and Keyboard Harmony	6

Electives — 12 units

Electives must be chosen from the following courses or performance opportunities:

57-107/108	Alexander Technique	6
57-107/108	Composition	3
57-154	16th Century Counterpoint	6
57-202	Opera History	9
57-221	Italian Diction	3
57-222	French Diction	3
57-223	German Diction	3
57-225	Contemporary Ensemble	3
57-228	Chamber Music	3
57-258	Twentieth Century Techniques	6
57-260	Introduction to Schenker Analysis	6
57-272	Orchestration III	6
57-291	Keyboard Studies III	3
57-292	Keyboard Studies IV	3
57-335	Analysis Seminar	6
57-343	Brass Methods	3
57-346	String Methods	3
57-391	Keyboard Studies V	3
57-392	Keyboard Studies VI	3
57-431	Italian Literature and Repertoire	3
57-432	French Literature and Repertoire	3
57-435	German Literature and Repertoire	3
57-607	Vocal Methods	3

Minimum required for Conducting minor: 54 units

A Minor in Jazz Performance for Students in the Department of Music

Admissions Requirements

1. The student must apply to enter the program in the office of the Director of Student Services.
2. The student must have passed Solfege I and Theory I.
3. The student must perform an audition. For the audition, the student should perform two contrasting pieces and demonstrate the potential for the development of improvisatory skills.

Required Courses		48 units
57-319	Jazz Piano (2 semesters)	6
57-328	Jazz Chamber Music (2 semesters)	6
57-499	Jazz Studio (4 semesters)	24
57-453/454	Jazz Improvisation (2 semesters)	6
57-xxx	Jazz Ensemble or Jazz Choir (2 semesters)	6

Electives — 6 units

Electives must be chosen from the following courses:

57-450	Jazz Ear Training	6
57-451	Jazz Orchestration	6
57-452	Jazz Orchestration II	6
57-457	Jazz History	6
57-458	Jazz History II	6

Minimum required for Jazz Performance minor: 54 units

A Minor in Accompanying for Piano Majors in the Department of Music

Admission Requirements

The student must apply to enter the program in the office of the advisor for music minors (CFA 162).

Required Courses		**36 units**
57-381	Accompanying I	6
57-382	Accompanying II	6
57-383	Accompanying III	6
57-384	Accompanying IV	6
57-385	Accompanying V	6
57-386	Accompanying VI	6

Electives **18 units**

Electives must be chosen from the following courses:

57-202	Opera History	9
57-220	English Diction	3
57-221	Italian Diction	3
57-222	French Diction	3
57-223	German Diction	3
57-332	Introduction to Conducting	6
57-336	Instrumental/Choral Conducting	6
57-431	Italian Literature and Repertoire	3
57-432	French Literature and Repertoire	3
57-433	Music Theater Literature and Repertoire I	3
57-434	Music Theater Literature and Repertoire II	3
57-435	German Literature and Repertoire	3
57-436	English/Contemporary Literature and Repertoire	3
57-459	Score Reading and Keyboard Harmony	6
57-607	Vocal Methods	3

Minimum required for Accompanying minor: 54 units

Faculty

DENNIS ABELSON, Artist Lecturer in French Horn — B.M., Duquesne University; Carnegie Mellon, 1987—.

ALBERTO ALMARZA, Instructor of Flute Ensemble — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991—.

EDUARDO ALONSO CRESPO, Director of Contemporary Ensemble — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1989—.

ATAR ARAD, Artist Lecturer in Viola; Carnegie Mellon, 1994—.

JULIUS BAKER, Artist Lecturer in Flute — B.M., Curtis Institute; Carnegie Mellon, 1990—.

LEONARDO BALADA, Professor of Composition — Diploma, The Juilliard School of Music; Carnegie Mellon, 1970—.

ANTHONY BIANCO, Artist Lecturer in String Bass; Carnegie Mellon, 1945—.

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—.

MYRON BLOOM, Artist Lecturer in French Horn; Carnegie Mellon, 1993—.

JANET BOOKSPAN, Visiting Professor of Opera — B.A., Emerson College; Carnegie Mellon, 1990—.

REBECCA BOWER, Artist Lecturer in Trombone; Carnegie Mellon, 1993—.

DAVID BUDWAY, Artist Lecturer in Jazz Piano — M.M., Duquesne University; Carnegie Mellon, 1986—.

MAUREEN BUDWAY, Artist Lecturer in Jazz Choir — B.M., Duquesne University; Carnegie Mellon, 1989—.

ANDRES CARDENES, Professor of Violin; Carnegie Mellon, 1989—.

RAYMOND CHICK, Instructor in Music Technology — B.A., University of Pittsburgh; Carnegie Mellon, 1988—.

DENIS COLWELL, Assistant Department Head, Director of Wind Ensemble; Carnegie Mellon, 1980—.

CYNTHIA DE ALMEIDA, Artist Lecturer in Oboe — M.M., Temple University; Carnegie Mellon, 1991—.

DAVID DEVEAU, Artist Lecturer in Piano; Carnegie Mellon, 1993—.

JOHN DIIANNI, Artist Lecturer in Percussion; Carnegie Mellon, 1989-.

DWAYNE DOLPHIN, Artist Lecturer in Jazz Bass; Carnegie Mellon, 1990—.

THOM DOUGLAS, Assistant Conductor of Choirs; Carnegie Mellon, 1991—.

SUMNER ERICKSON, Artist Lecturer in Tuba; Carnegie Mellon, 1982—.

JAMES FERLA, Artist Lecturer in Guitar — M.A., University of Pittsburgh; Carnegie Mellon, 1977—.

GARY FIENBERG, Director of Jazz Ensembles — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1992—.

HARRY FRANKLIN, Professor of Piano — Diploma, The Juilliard School of Music; Carnegie Mellon, 1957—.

NANCY GALBRAITH, Assistant Professor of Composition — M.M., West Virginia University; Carnegie Mellon, 1984—.

ELDEN GATWOOD, Artist Lecturer in Oboe — M.S., The Juilliard School of Music; Carnegie Mellon, 1988—.

PAUL GERLACH, Director of Kiltie Band — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1982—.

NANCY GOERES, Artist Lecturer in Bassoon — B.M., Boston University; Carnegie Mellon, 1988—.

SIDNEY HARTH, Visiting Professor — B.M., Cleveland Institute of Music; Carnegie Mellon, 1962—.

DANIEL HEIFETZ, Artist Lecturer in Violin; Carnegie Mellon, 1993—.

ROSEANNA IRWIN, Coach/Accompanist — M.M., Duquesne University; Carnegie Mellon, 1990—.

JUAN PABLO IZQUIERDO, Director of Orchestral Studies — Composition, University of Chile; Carnegie Mellon, 1990—.

ANNABELLE JOSEPH, Associate Professor of Music — D.A., Carnegie Mellon University, Carnegie Mellon, 1986—.

CHRISTOPHER JOSEPHS, Instructor of Acting; Carnegie Mellon, 1991—.

ERIC KLOSS, Artist Lecturer in Jazz Saxophone — Bachelor of Philosophy, Duquesne University; Carnegie Mellon, 1988—.

ANNE ELGAR KOPTA, Associate Professor of Voice; Carnegie Mellon, 1987—.

BEATRICE KREBS, Professor Emerita of Voice — Diploma, Hochschuele für Musik; Carnegie Mellon, 1963—.

KENNETH LANGEVIN, Senior Lecturer in Music History — Ph.D., Cornell University; Carnegie Mellon, 1988—.

CARLA LAROCCA, Instructor of Secondary Piano — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1991—.

MIMI LERNER, Artist-in-Residence in Voice — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1993—.

HANNA WU LI, Associate Professor of Piano Pedagogy — M.M., Northwestern University; Carnegie Mellon, 1969—.

LARRY MARIETTA, Artist Lecturer in German Diction — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1985—.

BYRON McCULLOH, Artist Lecturer in Trombone — B.M., Eastman School of Music; Carnegie Mellon, 1969—.

JAMES McINTOSH, Artist Lecturer in Bagpipes; Carnegie Mellon, 1990—.

ANNE MARGUERITE MICHAUD, Artist Lecturer in Harp — B.M., The Juilliard School of Music; Carnegie Mellon, 1988—.

FRANCISCO JAVIER MONTIEL, Artist-in-Residence in Viola, Cuarteto Latinoamericano; Carnegie Mellon, 1987—.

ROBERT MOYER, Guest Lecturer in Music Education — M.M, Indiana University of Pennsylvania; Carnegie Mellon, 1987—.

JOSEPH NEGRI, Artist Lecturer in Jazz Guitar — B.F.A., Carnegie Mellon University; Carnegie Mellon, 1988—.

MYRTLE NIM, Music Librarian — M.L.S., University of Pittsburgh; Carnegie Mellon, 1964—.

NATALIE OZEAS, Associate Department Head, Director of Music Education — M.F.A., Carnegie Mellon University; Carnegie Mellon, 1989—.

GLYNN PAGE, Artist Lecturer in Music Theatre; Carnegie Mellon, 1977—.

ROBERT PAGE, Director of Choral Studies — M.M., Indiana University; Carnegie Mellon, 1976—.

ANTHONY PASQUARELLI, Artist Lecturer in Trumpet; Carnegie Mellon, 1957—.

ROBERT ROCCO, Coach/Accompanist — M.M.A., Yale University; Carnegie Mellon, 1989—.

MARGARET ROSS, Artist Lecturer in Song Literature — Ph.D., University of Pittsburgh; Carnegie Mellon, 1987—.

MARTA SANCHEZ, Professor of Eurhythmics — Ph.D., University of Pittsburgh; Carnegie Mellon, 1957—.

IRENE SCHREIER, Artist Lecturer in Piano and Theory — Diploma, Konservatorium Luzern; Carnegie Mellon, 1985—.

RICCARDO SCHULZ, Instructor in Recording Technology — M.A., University of Pittsburgh; Carnegie Mellon, 1988—.

FRANCO SCIANNAMEO, Artist Lecturer in String Literature; Carnegie Mellon, 1991—.

ETHAN STANG, Artist Lecturer in Flute — Certificate, U.S. Navy School of Music; Carnegie Mellon, 1980—.

LEWIS STROUSE, Assistant Professor of Music Education; Carnegie Mellon, 1992—.

MARILYN TAFT THOMAS, Head — Ph.D., University of Pittsburgh; Carnegie Mellon, 1981—.

GEORGE THOMPSON, Instructor of Dance; Carnegie Mellon, 1989—.

THOMAS THOMPSON, Artist Lecturer in Saxophone — M.M., Northwestern University; Carnegie Mellon, 1986—.

JEFFREY TURNER, Artist Lecturer in String Bass; Carnegie Mellon, 1989—.

REZA VALI, Associate Professor of Theory and Computer Music — 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; Carnegie Mellon, 1992—.

EARL WILD, Distinguished Artist-in-Residence; Carnegie Mellon, 1993—.

COLETTE WILKINS, Artist Lecturer in French Diction — Diploma, National Conservatoire de Versailles; Carnegie Mellon, 1987—.

DONALD WILKINS, Professor of Organ — M.A., Harvard University; Carnegie Mellon, 1966—.

ANNE MARTINDALE WILLIAMS, Artist Lecturer in Cello — Diploma, Curtis Institute of Music; Carnegie Mellon, 1987—.

CHRISTOPHER WU, Artist Lecturer in Violin; Carnegie Mellon, 1992—.

ISAIAS ZELKOWICZ, Artist Lecturer in Viola — M.M., The Juilliard School; Carnegie Mellon, 1981—.

RALPH ZITTERBART, Associate Professor of Piano — M.F.A., Carnegie Tech; Carnegie Mellon, 1963—.

JOSEPH ZUBACK, Artist Lecturer in Euphonium — B.S., Duquesne University; Carnegie Mellon, 1988—.

The College of Humanities and Social Sciences

The College of Humanities and Social Sciences

Peter N. Stearns, Dean
Office: Baker Hall 260

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, and Statistics. The College also houses a number of theoretical and applied research centers, as well as the Carnegie Mellon University Press. Current College enrollment is about 1200, about 900 of whom are undergraduates. The College accounts for approximately one-fourth of the university's undergraduate population, and is staffed by approximately 120 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 classroom teaching. All faculty engage in both teaching and research. Undergraduates, therefore, benefit from contact in the classroom with highly accomplished faculty researchers and creative artists.

For example, beginning with the College's General Education 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 may 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 generally no more than fifteen students. 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 year honors program) that students can pursue with regular faculty.

Liberal/Professional Education

Edward Fiske, Education Editor of The New York Times, 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 quite 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.

Majors, Double Majors, Minors, and Graduate Degree Options

H&SS offers a wide range of innovative, demanding majors (twenty-four in all, plus a student-defined major option), and a comparable number of minors. In addition, H&SS students may also apply for admission to one of a number of five-year programs that result in both a bachelor's and master's degree. These provide an H&SS student with a great deal of flexibility and choice in designing a program of study.

For convenience of classification, some of the majors are here termed "disciplinary," while others are termed "professional." The former possess less of the career-specific foci of the latter, while the latter also generally require a few more courses than the former. Beyond these distinctions, however, majors in these two categories share other characteristics. For example, as offered at Carnegie Mellon in H&SS, both types of majors are often *interdisciplinary* in that they bring together insights and methodologies from several fields.

The following chart lists H&SS major programs:

H&SS Major Programs

Disciplinary Majors	Professional Majors	Department
Economics	Managerial Economics	Economics
Literary and Cultural Studies	Professional Writing	English
Creative Writing	Technical Writing	
Rhetoric		
Social History	History and Policy	History
Anthropology and History		
European Studies*		
French		Modern Languages
German		
Spanish		
Philosophy	Logic and Computation	Philosophy
	Computational Linguistics	
Psychology		Psychology
Cognitive Science		
Social and Decision Sciences	Information and Decision Systems	Social and Decision Sciences
Political Science	Policy and Management	
Statistics		Statistics
Student-Defined Major	Student-Defined Major	H&SS Dean's Office

* Only as part of a double major combination

Second Majors

Many students pursue second majors or minors, in some cases partly attained in other Carnegie Mellon colleges. A "second major" (sometimes called a "double major") refers to the completion by a student of the full requirements for a major program in addition to those required for the first, or primary, major. In general, requirements for a second major are the same as those for a primary major. "Minors" are like "majors" in that they consist of coherent programs of study in a discipline, or across disciplines. Minors differ from majors in the breadth and depth reflected in the number of courses required.

All H&SS major programs are available as second majors. Moreover, in cooperation with the Mellon College of Science (MCS), second majors are also available to H&SS students in Biological Sciences, Chemistry, Physics and Mathematics. Students from outside H&SS are also eligible to attain a second major in programs offered by the College. In such cases, non-H&SS students would be required to complete only those courses in the H&SS General Education program that are prerequisites to courses required for the H&SS major in question.

Minor Programs

All of the University's colleges offer minor programs, generally available to students across the University. Each college's collection of minors is described in their section of this catalog. All H&SS minors are available to undergraduate students from any college of the University.

In H&SS, minors are divisible into two categories: (1) "departmental minors," which are fully housed in a single H&SS academic department, and (2) "interdisciplinary [or 'interdepartmental'] minors," which are sponsored more broadly by the College and housed in the H&SS Dean's Office (in care of its Academic Advisory Center). Minors offered by H&SS are listed below, divided into these two groups.

H&SS Departmental Minors

Minor	Department
English	English
History	History
European Studies	History, in cooperation with Modern Languages
French	Modern Languages
German	Modern Languages
Spanish	Modern Languages
Japanese	Modern Languages
Second Language Acquisition	Modern Languages
Teaching English to Speakers of Other Languages	Modern Languages
Philosophy	Philosophy
Ethics	Philosophy
Logic and Computation	Philosophy
Computational Linguistics	Philosophy
Psychology	Psychology
Political Science	Social & Decision Sciences
Information & Decision Systems	Social & Decision Sciences
Public Management	Social & Decision Sciences
Statistics	Statistics

H&SS Interdisciplinary Minors

Environmental Studies
Film and Media Studies
Gender Studies
International Affairs
Minority Studies
Religious Studies
Sociology
Health Professions (in cooperation with the Mellon College of Science)
Teacher Certification (Early Childhood, Elementary, or Secondary; in cooperation with Chatham College)

Fifth-Year Graduate Degree Options

A number of five-year programs are available to H&SS students that lead to both an undergraduate and graduate degree. One is the "3-2" program offered through the Graduate School of Industrial Administration (GSIA), which begins in the fourth year and leads to a Master of Science in Industrial Administration after the fifth year. The other is the "3-1-1" program offered through the H. John Heinz III School of Public Policy and Management. This also begins in the fourth year, and leads after the fifth year to a Master of Science in Public Management and Policy. These options are discussed in detail in the GSIA and Heinz School sections of the catalog.

Two other five-year bachelor's/master's options are offered through the Philosophy Department, in conjunction with the programs in Logic and Computation, and Computational Linguistics. Similar in design to the GSIA and Heinz programs, these allow qualified students to begin graduate work during their fourth year, complete their undergraduate degree after the fourth year, and after a fifth year receive a master's degree in either Logic and Competition, or Computational Linguistics. These options are described in detail in the Philosophy Department section of this catalog.

Finally, students in selected majors who pursue the H&SS minor in Secondary School Teaching and Teacher Certification may also consider the 2-3 Program in Secondary School Teaching which, after a fifth year of study, would result in a Master of Arts degree in one of the following fields: History, English, French, Spanish, or Psychology.

Bachelor of Arts (B.A.) vs. Bachelor of Science (B.S.)

Bachelor of Arts (B.A.) degrees granted by the College generally stress a stronger background in such areas of the humanities as English, history, philosophy, languages, or the arts. Most of the College's B.A. programs require no statistics beyond the one-semester General Education statistics course (36-201, Statistical Reasoning), and no calculus. Exceptions to this rule are the B.A. programs in Economics and Psychology, both of which require a two-semester sequence in calculus, as well as at least a second statistics course (36-202). B.A. candidates in Economics also have additional humanities requirements. (See the Economics Department section for these requirements.)

In contrast, Bachelor of Science (B.S.) degrees are offered in areas requiring special technical, quantitative or scientific competencies beyond those required in the H&SS General Education Program. To provide background for such programs and to insure basic proficiency in these areas, B.S. degrees granted through the College require additional courses in calculus and statistics, and in some instances, additional courses in the physical, natural, and computational sciences.

To underscore these distinctions, the College requires two additional courses for H&SS degree candidates, with options that vary depending on one's degree (B.A. vs. B.S.). This requirement and its options are described in greater detail following the presentation of the H&SS General Education Program (below).

The H&SS General Education Program: Organizing Ideas, Salient Features

All H&SS students complete a 12-course General Education program, accomplished largely in the first two years. The H&SS General Education Program emphasizes basic analytical categories combined with a wide range of choice in specific courses that exemplify these categories. It is designed to expose students to a variety of subjects and methodologies, and thereby broaden their horizons and range of possible subsequent major choices — not only within H&SS, but also in science, the arts and technology.

Unlike most conventional general education programs, the H&SS program goes beyond simple exposure to subjects. The H&SS General Education program also focuses on the analytical styles appropriate to solving different kinds of problems, with attention to both the strengths and limitations of each style. The styles, or modes, of thought stressed are diverse and transferable, and thus designed to open doors to new learning, teach how to compare basic assumptions in preparation for more specialized learning later, and stimulate intellectual awareness.

The program is flexible, and designed to be accomplished largely in the first two years of study. For students who decide early about majors, the program allows for entry into one's chosen major as early as the end of the first year. For those who make this choice later, the program allows for more extended exploration, and selection of and entry into one's major as late as the end of the second year.

Common, Distributional, and Degree Requirements

The H&SS General Education Program consists of 12 courses: four "Common Course Requirements" (i.e., courses that all students take "in common," all of which are to be completed in the first year [two in the Fall, and two in the Spring]); and eight "Distributional Course Requirements," "distributed" across six course categories. In addition, there is a two-course college requirement fulfilled according to the degree (Bachelor of Science or Bachelor of Arts) to be received.

Common Course Requirements

The General Education's Common Course Requirements seek to prepare H&SS students to participate in the intellectual discourse of the University, and of society at large. They seek to enable students to become informed, literate, reflective, and active participants in the worlds within which they will live and work for the rest of their lives, and beginning right now. Further, they provide a foundation for many of the courses that H&SS students will enter later in their undergraduate career. Hence, these courses are positioned in the first year for all H&SS students.

There are four Common Course Requirements, consisting of one course per requirement. Where a requirement presents more than one choice, students must choose from the designated list.

1. World Cultures

This requirement seeks to help students be able to recognize cultures that have shaped and continue to shape the human experience. It also seeks to enable students to analyze materials that provide clues to how these cultures work. The course required in this category introduces several distinct but analytically related cultural realms. It seeks to illustrate the connections between seemingly unrelated areas of study such as language and technology, or health practices and kinship. Most important, it seeks to help students to not only understand cultural differences that exist in the world, but also to value these differences.

79-104	Introduction to World History

2. Writing and Expression

Broadly considered, language is a tool that we use 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 way that writing constitutes thinking. It is designed to foster improvement in both written and oral communication skills to superior levels of effectiveness.

76-100	Introduction to English Studies: Argument
OR	
76-101	Introduction to English Studies: Interpretation

3. Introduction to Intelligence

We live in a world where we must interact with both naturally and artificially intelligent systems, with both human and non-human agents such as computers and robots. The more one understands the issues surrounding these systems, the more one can participate in the discourse of the university, and the world beyond. This requirement seeks to introduce basic skills and concepts about intelligence, formal computations, decision making and adaptive behavior in human and non-human systems.

80-106/ 85-106/ 88-106	Introduction to Intelligence (course is cross-listed in each of three departments: Philosophy, Psychology, and Social and Decision Sciences)

OR

One course from Distributional Course Requirement category 1 ("Cognition, Choice and Behavior")

OR

One course from Distributional Course Requirement Category 2 ("Economic, Political and Social Institutions")

4. Statistical Reasoning

Numerical data surrounds us — from baseball box scores to the gross national product; from crime statistics to demographic trends. Statistical methodology and practice allow us to quantify data in order to draw conclusions. This requirement is designed to teach what kind of data is quantifiable, how to gather data, what methods to use when evaluating data, and how to test hypotheses when using quantitative analysis.

36-201	Statistical Reasoning

NOTE: All H&SS students must also complete one University requirement: 99-101 or 99-102, Computing Skills Workshop (a 3-unit course designed to orient new students to the University's educational computing environment and resources).

Distributional Course Requirements

In order to successfully meet the challenges ahead in one's personal, social, political and professional life, students will need more than the specialized training that they will receive in their major field of study. Students will need broad exposure to and appreciation of other disciplines, the intellectual problems confronted by these disciplines, their approaches to solutions, and their practices within which they frame problems and solutions.

There are eight Distributional Course Requirements, spread across six course categories. All students take two courses from one category (Science and Technology), one from each of the other five, and one additional course from one of the first five categories. NOTE: Some of the courses listed in Distributional Categories 1 through 4 also serve as requirements in one or more of the College's majors and minors. Students may double count no more than one such course both for a General Education and a major or minor requirement. Any courses taken to fulfill Distributional Categories 5 and 6 that are also required by the student's major or minor may be double-counted without restriction.)

1. Cognition, Choice and Behavior

This requirement presents courses that examine the process of individual thinking, decision making and behavior from a variety of disciplinary perspectives (e.g., psychology, decision science, linguistics, and philosophy) and through a model-based reasoning approach.

80-150	The Nature of Reason
80-180	The Nature of Language
80-182	Language and Thought
80-242	Conflict and Dispute Resolution
85-100	Cognitive Processes: Theory and Practice
85-102	Introduction to Psychology
85-150	Introduction to Social Problems
85-211	Cognitive Psychology
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Introduction to Personality

2. Economic, Political and Social Institutions

This requirement presents courses that analyze, through model-based reasoning, the processes by which institutions organize individual preferences and actions into collective outcomes. Choices draw on such disciplines as political science, economics, history, and statistics.

36-203	Sampling, Surveys, and Society*
73-100	Principles of Economics
73-110/88-110	(cross-listed) Social Decision-Making: A Laboratory Approach
79-114	Causal Models and Historical Explanation*
79-115	Education and Inequality
80-136	Social Structure, Public Policy, and Ethical Dilemmas
88-104	Decision Processes in American Political Institutions
88-109	Institutions and Individuals

* Prerequisite: one statistics course.

3. Creative Production and Reflection

This requirement seeks to foster creativity and provide exposure to artistic and intellectual products such as paintings, drama, literature, music, scientific experiments, expository writing, and foreign languages. Further, it also seeks to stimulate critical reflection on the process of creating, and why one makes the creative productions one makes. Disciplines contributing courses to this category include English (creative writing), philosophy (aesthetics, philosophy of art), the fine arts, and modern languages.

NOTE: Some of the courses on this list are offered for less than nine units. Students must take a minimum of nine units to fulfill the minimum mandatory requirement in this category for all students, and at least nine additional units if an additional General Education Distributional Course is chosen from this category.

48-095	Architecture for Non-Majors
51-170	Graphic Design Fundamentals
51-180	Industrial Design Fundamentals
51-210	Beginning Photography
51-220/224	Darkroom I-II (4.5 units each)
51-233	Typography
57-417	Concert Choir (6 units)
57-418	Symphonic Wind Ensemble
57-419	Repertory Chorus (6 units)
57-430	Philharmonic Orchestra (6 units)
60-101	Concept Studio I
60-110	Electronic Media Studio I (10 units)
60-130	Three-Dimensional Media Studio I (10 units)
76-206	The Craft of Creative Writing
80-120	Reflections on Science

80-241	Ethical Judgments in Professional Life
80-260	Philosophy and Art
82-101	Elementary French I
82-102	Elementary French II
82-103	Self-Paced French
82-121	Elementary German I
82-122	Elementary German II
82-123	Self-Paced German
82-131	Elementary Chinese I
82-132	Elementary Chinese II
82-141	Elementary Spanish I
82-142	Elementary Spanish II
82-143	Self-Paced Spanish
82-161	Elementary Italian I
82-162	Elementary Italian II
82-163	Self-Paced Italian
82-171	Elementary Japanese I
82-172	Elementary Japanese II
82-191	Elementary Russian I
82-192	Elementary Russian II

4. Cultural Analysis

This requirement seeks to build on the Common Course Requirement in World Cultures, and foster deeper understanding of the role culture plays in shaping individual and social behaviors. Choices in this category include courses in history, modern languages, English (literary and cultural studies), philosophy, and anthropology.

76-201	Cultural Practices and Literary Production
76-240	What Is Cultural Studies?
79-110	Dynamics of Cultural Change
79-111	Cultural and Cross-Cultural Perspectives on the Environment
79-112	Race, Nationality, and the Development of American Cultures
79-113	Culture and Identity in American Social Life
79-116	Debates and Controversies: Cultural Differences in Action
79-200	Society and the Arts
80-100	What Philosophy Is
80-183	Language, Culture and Thought
82-107	Reflections of French Culture in Film
82-193	The Faust Legend from Europe to Russia
82-409	French Literature of the Nineteenth Century
82-412	Twentieth-Century French Theater
82-413	Twentieth-Century French Novel
82-414	Modern French Poetry
82-415/416	Studies in French Literary and Cultural Studies
82-427	The New Germany
82-428	German Classical Literature
82-429	German Literature of the Nineteenth Century
82-430	German Literature of the Twentieth Century
82-431	Postwar German Literature
82-436	Studies in German Literature
82-441	Survey of Spanish Literature
82-451	Introduction to Latin American Literature and Culture
82-455/456	Studies in Spanish and Latin American Literature
82-465/466	Surrealism in France and Spain
82-491	Literature, Politics and Film in Russia and East Europe Today
82-492	The Historical Imagination in Nineteenth Century Russian Literature

5. Mathematical Reasoning

This requirement seeks to engender an appreciation for the power and utility of mathematical reasoning by having students take at least one course suited to their background and interests. H&SS students enter the university with different training in mathematics, and with comparably different ideas about how to make use of the mathematical experiences that the university offers. With this in mind, this requirement offers options in several courses, including calculus, modern mathematics, mathematical logic, and mathematical models.

21-110	Recreational Mathematics
21-111	Calculus I
21-121	Calculus 1
21-112	Calculus II
21-122	Calculus 2
21-127	Introduction to Modern Mathematics
80-110	The Logic of Mathematics: Proofs and Counterexamples
80-113	Mathematical Models of Worlds and Minds

6. Science and Technology

This requirement seeks to engage students in both exposure to (substance), and the experience of (methods), the sciences through two courses drawn from the fields of biological sciences, chemistry, physics, computer science, and engineering.

Mellon College of Science Courses:

03-121	Modern Biology
03-122	Organismic Botany (prerequisite: 03-121)
03-130	Biology of Organisms (prerequisite: 03-121)
03-240	Cell Biology (prerequisite: 03-121)
09-103	Atoms, Molecules and Chemical Change
09-104	Fundamental Aspects of Organic Chemistry and Biochemistry (prerequisite: 09-103)
09-105	Modern Chemistry I
09-106	Modern Chemistry II (prerequisite: 09-105)
33-101	Concepts of Modern Physics
33-111	Physics for Science Students I
33-112	Physics for Science Students II
33-113	Physics of Musical Sound
33-115	Introductory Physics I
33-116	Introductory Physics II (prerequisite: 33-115)
33-124	Introduction to Astronomy

Carnegie Institute of Technology (engineering) Courses:

NOTE: Though these courses have no formal prerequisites, they assume a strong background in high school science (especially physics and chemistry) and mathematics.

06-100	Introduction to Chemical Engineering
12-101	Innovation and Design in Civil Engineering
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

School of Computer Science Courses:

15-211	Fundamental Structures of Computer Science I (prerequisites: 15-127, 21-127)
15-212	Fundamental Structures of Computer Science II (prerequisite: 15-211)

Additional College-Level Degree Requirements

Two additional courses are required for all H&SS students, depending on the degree (Bachelor of Arts [B.A.] or Bachelor of Science [B.S.]) that they will receive. In addition to general guidelines and specific course lists presented below, students should contact the H&SS Academic Advisory Center for the most current lists of courses suitable for these categories.

NOTE: Any courses taken to fulfill this College-level degree requirement that are also required by the student's major or minor may be double-counted without restriction.

B.A. students have two options for this requirement:

1. Modern Languages

a) Two sequential intermediate or higher-level courses (minimum of 18 units) in French, German, Italian or Spanish.

OR

b) Two sequential courses (any level; 18 units minimum) in Chinese, Japanese or Russian

2. Fine Arts

At least two sequential courses (minimum 18 units) in architecture, art, design, or music, as outlined below:

Architecture

48-096	Architecture for Non-Majors (required)

Plus one of the following:

48-140	Introduction to Architectural History
48-241	Introduction to Islamic Architecture
48-247	Architecture of Frank Lloyd Wright
48-261	18th Century European Architecture
48-271	Architecture of Europe and the United States
48-330	Drawing I
48-331/335	Drawing II

Art/Electronic and Time-Based Media

60-110	Electronic Media Studio I
60-410 through 60-419	Advanced Electronic and Time-Based Work (specific topics vary)

Art/Sculpture

60-130	Three-Dimensional Media Studio I
60-430 through 60-439	Advanced Sculpture, Installation and Site Specific (SIS) Work (specific topics vary)

Art/Art History

Two courses numbered 60-6xx (art history courses)

Design/Photography

51-220/224	Darkroom I and II (5 units each)
OR	
51-210	Beginning Photography
PLUS	
51-310	Advanced Photography

Design/Design History

51-201	Design History I
51-300	Design History II

Music/Harmony (all three courses 6 units each; all three required)

51-151	16th Century Counterpoint
57-152	Harmony I
57-153	Harmony II

Music/Music History

57-173	Survey of Western Music History (required)

plus one of the following:

57-203	Medieval, Renaissance and Baroque Music History
57-204	18th and 19th Century Music History
57-205	20th Century Music History

Music/Solfege (all three courses 6 units each; all three required)

57-181	Solfege I
57-182	Solfege II
57-183	Solfege III

B.S. students have the following two options for this requirement:

1. Quantitative Methods

Two courses in mathematics or statistics, beyond those taken to fulfill General Education requirements.

2. The Natural, Physical or Computer Sciences

Two sequential courses in biology, chemistry, physics or computer science.

NOTE: If taken at entry level, these courses must be sequential. If, however, students seek to fulfill this requirement through courses in a science beyond entry-level sequences, the courses taken need not be sequential as long *as they have the entry-level sequence as prerequisites.*

Special Achievement Programs in Science and the Arts

In addition to their home college major, H&SS students also have the opportunity to concentrate in a science or a fine art, and be officially recognized for this concentration upon graduation.

Students will be recognized by the *Science Achievement Program* if they satisfactorily complete one of the minors offered by the departments in the Mellon College of Science. Students will be recognized by the *Arts Achievement Program* who successfully complete one of the minors offered in architecture, design, music, art, or theatre arts in the College of Fine Arts.

H&SS Degree Requirements (Summary)

General Education Requirements	(min.) 108 units
Supplementary College Degree Requirements	(min.) 18 units
Major Requirements	(varies)
Free Electives	(varies)
Units Required for Graduation	**(min.) 360 units**

Special Services, Programs and Research Centers

The educational programs in H&SS are complemented by a number of services, special programs, research centers, and computing facilities. Some of these are housed in the College, while others reside elsewhere in the University, but with accessibility for H&SS students. Some of the most prominent of these are described below.

Academic Advisory Center

Joseph E. Devine, Associate Dean
Center Office: Baker Hall 161

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 declaration of, and entry into, a major program. As departmental "home base" for these students, the AAC provides information, advice, and counsel about scheduling, College General Education requirements, the various majors and minors available, and the adjustments involved in the transition to university life and study. The Center's 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 General Education program, and preparing for various academic and professional choices soon to follow. In addition, the AAC provides information about various relevant scholarships, internships, post-graduate fellowships, and the like. The AAC is a walk-in center, although individual appointments can be made on request. The AAC's hours are 8:30 a.m. to 5:00 p.m., Monday through Friday.

The Honors Program

Office of the Dean
Baker Hall 260

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 "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 testify 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.

Pre-Law Advising

Joseph Devine, Associate Dean
Office: H&SS Academic Advisory Center, Baker Hall 161

Many Carnegie Mellon students and alumni/ae, from virtually every college of the University, are interested in law school and careers in the law. The University's Pre-Law Program is housed in the Academic Advisory Center of the College of Humanities and Social Sciences (Baker Hall 161). In conjunction with the student-run Pre-Law Club, it consists of a wide range of support services, coordinated centrally, that are designed to assist students and alumni/ae in engaging the complex questions associated with decisions about law school and careers in the law, and in successfully negotiating the sequence of tasks in selecting, applying and gaining admission to law school. Though no single major, or subset of majors, is considered "best" for students interested in law school, advice *is* offered about course work that exposes students to relevant law-related areas, and that refines skills that pertain to the demands of law school.

Internships

H&SS recognizes the value of work-related experiences for its majors in the College's different departments. Students may have these experiences in a variety of ways, depending on the discipline and the department:

1. Through non-credit part-time work and/or summer jobs.

2. Through departmentally conducted project courses, which earn academic credit.

3. Through credit-bearing internships both on and off campus.

Internships-for-credit are "courses" in the conventional sense in that they are programs of study organized by (or at least with) a faculty member, and for which students receive a grade and credit. Such internships are *un*conventional in that they involve a significant "experiential," real-world component in a setting outside of the traditional classroom. Students may use internships to help achieve the stated purpose of their programs and to complement their classroom-based courses. However, such internships-for-credit must be more than just an experience in the "real world." As legitimate "courses," they must also constitute a learning experience based on careful academic preparation. (See the H&SS catalog section entitled "Academic Standards, Actions and Regulations" for additional information about College internship policies.)

Conceivably, an internship could be appropriate for any H&SS major. Some majors incorporate internships into their program requirements, while others consider internships optional. Recent internships have been arranged for H&SS students with such off-campus businesses and organizations as Westinghouse Electric, PPG Industries, The Pittsburgh Press, WPXI television, Duquesne Systems, the Graphic Arts Technical Foundation, the Carnegie Institute, the American Civil Liberties Union, KDKA Television and Radio, Ketchum Communications, Inc., Equibank, South Side Chamber of Commerce, Penn Southwest, Inc., the Three Rivers Poetry Journal, Catholic Charities, Western Psychiatric Institute and Clinic, Allegheny General Hospital, Creamer Dickson Basford, and various federal legislative groups, agencies, and interest groups (through, for example, the Washington Semester program). Internships have also been arranged on-campus with such university offices as Admissions, Alumni Relations, Public Relations, the Registrar, the Career Center, the Children's School, Campus Security, the University Health Center, Physical Plant, Sports Information, Estate Planning, the Carnegie Mellon University Press, the Robotics Institute, the Center for the Design of Educational Computing, the Software Engineering Institute, the Center for Art and Technology, and the School of Computer Science.

While the College's academic departments help students in generating internship ideas, students are responsible for finding an interested faculty member who will help plan for and supervise an internship-for-credit. In preparation for the hands-on internship experience, students are normally required to master a set of appropriate readings (to be generated in consultation with the internship advisor). During the actual internship, the student meets at regular intervals with the faculty advisor to report on the progress of the internship and to plan a paper that will summarize the experience, relate it to the theory and principles enunciated in the readings, and evaluate the internship. As a rule, the faculty advisor evaluates the paper, and then submits a grade and a written report based on the field supervisor's evaluation of the student's on-site work and on the advisor's evaluation of the student's written work. Grading criteria are essentially the same as those used in regular courses.

Washington Semester Program

Eugene D. Levy, Advisor
Office: Baker Hall 242A

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 Washington for a study of American government in action. The study is carried out through a seminar, an individual research project, and an internship in government or with a government-related organization. These provide a realistic picture of the process of government far richer than can be gained in a solely academic environment. In addition to the program in government, there are similar programs in journalism, foreign policy, and economic policy.

Study Abroad

Office of International Education
Emily Blanchini, University Study Abroad Advisor
Warner Hall 219

Each year a number of H&SS students embark on Study Abroad programs. Such programs vary greatly in length, location, structure and timing in a student's academic career. Some programs are for the summer, others for a full semester or a full academic year. While many are in English-speaking countries, many others are not. In the latter category, most programs offer the choice of studying in the native language, or studying in English while taking courses to learn the host country language. Some programs are sponsored and administered by American colleges and universities, while other programs require direct contact between student and host country institution. Information about such programs is available in the University's Office of International Education, located in Warner Hall 219.

Carnegie Mellon's Modern Languages Program sponsors three summer programs of its own: one in Madrid, Spain, at the Estudio Internacional Sampere; one in Rothenburg, West Germany, at the Goethe Institute; and one in southern France at Aix-en-Provence/ Avignon.

H&SS students pursuing such programs generally do so in their junior or senior year (or in the summer preceding one of these years), though earlier participation is possible depending on language needs and ability. Information available in the Office for International Education assists students in selecting accredited programs. Students must also work closely with their major or department advisor in attending to other steps and procedures, including selection of courses of study, obtaining recommendations and endorsements, etc. If students intend to apply any courses taken through such programs to College or major requirements, or even to have them count as electives, advance approval is required.

Heinz 3-1-1 Program

H. John Heinz III School of Public Policy and Management
Office of Admissions: Hamburg Hall 1110

The 3-1-1 Program is a cooperative program between the H. John Heinz III School of Public Policy and Management and Carnegie Mellon's undergraduate colleges. It provides a unique opportunity for qualified students to pursue both their undergraduate degree and a Master of Science degree in Public Management and Policy. Students apply during the junior year. If accepted, graduate course work begins in the fourth year, simultaneously with completion of undergraduate requirements. 3-1-1 students obtain their bachelor's degree after four years and, if they elect to continue in the program, the master's degree after five years. This condenses into five years what would otherwise take six years to complete.

The Heinz masters program curriculum consists of a common core, several concentration areas, a summer internship, and elective courses. Students choose one of the following concentration areas: policy analysis; financial management and analysis; information systems; management; urban planning; and economic development. The goal of the program is to prepare individuals for professional careers in management and public policy analysis. While the program is oriented toward the public sector, graduates have found their skills in high demand in both public and private sector positions. Alumni work in government, in non-profit organizations, in consulting firms, and in the private sector. Many have gone on to law school, medical school, or Ph.D. programs.

The Heinz School also offers joint degree programs with Carnegie Mellon's Graduate School of Industrial Administration, the Department of Architecture, the College of Fine Arts, and the University of Pittsburgh Law School. Students in the Heinz masters program are eligible for undergraduate financial aid during their fourth year and for graduate student financial aid during their fifth year. Students must apply for admission to the 3-1-1 Program during their junior year.

NOTE: H&SS students interested in the Heinz 3-1-1 Program must still complete all H&SS College General Education requirements for undergraduates. In addition, they must make arrangements with their undergraduate major department regarding the completion of major requirements.

Educational Computing

Matthew McNally, Director of Computing
Office: Baker Hall 138

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 most of which are also connected to the University's centrally supported systems. 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, the School of Computer Science, the Statistics Department, the Psychology Department, and the Laboratory for Computational Linguistics.

Carnegie Mellon University Children's School

Sharon Carver, Director
Office: Margaret Morrison Carnegie Hall 17

The Children's School is an innovative facility designed to provide a "structured learning environment" for children ages 3, 4, and 5. The children are selected from a large number of applicants to provide a mix in terms of sex, race, and family socioeconomic status. The educational approach followed in the school reflects a growing understanding of the importance of individual motivation and curiosity in learning. The school also provides, within a child-oriented framework, a teacher education facility for students enrolled in the cooperative Chatham/Carnegie Mellon University Teacher Education Programs. In addition, the school provides both an in-service training base for Pittsburgh-area teachers and a campus testing area for research in child development, education and psychology.

The Center for the Study of Writing

Linda Flower and John R. Hayes, Co-Directors
Baker Hall 243B

The Center for the Study of Writing constitutes a major research initiative (with the University of California at Berkeley) supported by a grant from the Office of Educational Research and Improvement. The main research goal of this Center is to help build an integrated social-cognitive theory of writing, and in the process reconceptualize writing research and consolidate two of its most important gains: (1) understanding the underlying cognitive processes in writing, and (2) understanding the social context in which writing occurs. As a national research center, the Center not only conducts but encourages outside research in writing, and functions as a resource center for researchers, teachers, administrators, and policy makers. The research teams created by the Center bring together major writing researchers from the fields of education, rhetoric, psychology, linguistics, English, anthropology and computer science.

Communications Design Center

John R. Hayes and Erwin R. Steinberg, Co-Directors

The Communications Design Center provides interdisciplinary teams of faculty and graduate students to solve communications problems in business, industry, and government. The Center bases its work on recent research into reading, writing, and document design, and has special expertise in communications problems that require the integration of visual and verbal text, and user testing to improve the text from the user's perspective.

Recent projects have included teaching managers in the public and private sectors to write more clearly, developing and testing standards for the Army STARS program (Software Technology for Accurate Reliable Systems), investigating how people learn skills from instructional texts, rewriting the operating manuals for the electronic equipment of a major electronics firm, and improving the routine letters that a utility company sends to its customers.

Laboratory for Computational Linguistics

David Evans, Director
Baker Hall 139

The Laboratory for Computational Linguistics is administered jointly by the Departments of Philosophy and Computer Science. This laboratory is equipped with a number of Hewlett-Packard Advanced Workstations, which have been specially designed for artificial intelligence programming, and also suitable for other computational applications. The laboratory facilities are available for research computing by linguists, philosophers, psychologists, computer scientists, and other members of the University community. The machines are also available for student research projects associated with the Philosophy Department's Logic and Computation and Computational Linguistics majors.

Language Learning and Resource Center

Christopher Jones, Director
Porter Hall 225 C

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 Carnegie Mellon's Language Learning 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. Use of the Center is required in most lower-level Modern Language courses to help develop speaking and listening skills.

Carnegie Mellon University Press

Gerald Costanzo, Director
Office: Baker Hall 233

Established in 1975, the University Press has published some eighty titles in contemporary poetry including Thomas and Beulah by Rita Dove, which won the 1987 Pulitzer Prize for Poetry. In recent years the Press offerings have expanded to include literary criticism, art history, economics, music, social history, novels, and short fiction. A number of undergraduate students serve internships with the Press each year, many of whom have gone on to careers in publishing.

Pittsburgh Center for Social History

History Department
Baker Hall 240

The Pittsburgh Center for Social History is the creation of the History Departments of both Carnegie Mellon University and the University of Pittsburgh. The separate work of these two departments in the research and teaching of social history (which focuses on the interaction between ordinary people and social processes) has been widely recognized as highly innovative. The purpose of the Center is to unite and build on the strengths and achievements of these two departments, to encourage the steady expansion of topics open to inquiry and methodologies used by social historians, and to promote the application of social history's insights to relevant contemporary policy issues. Center activities include seminars and publications on the theory and practice of social history, thematic biennial conferences on specific themes in social history that transcend particular periods or areas, working papers on the relationship between social history and regional policy concerns, and new collaborative research projects in social history, of either a comparative or applied nature. In addition to the members of these two departments, participation in Center activities is extended to interested scholars in related disciplines and other institutions in the region.

The Journal of Social History

Peter N. Stearns, Editor
Journal Office: Baker Hall 240

The Journal of Social History is a major scholarly research journal for social historians, and for scholars in related disciplines. The major purpose of The Journal is to provide a refereed forum for the presentation and review of important new work by this community of scholars. Parenthetically, The Journal has acted as an important educational resource and outlet for undergraduate and graduate students in the History Department's major programs.

Statistical Center for Quality Improvement

Statistics Department, Carnegie Mellon University
Department of Statistics and Mathematics, University of Pittsburgh

The Statistical Center for Quality Improvement was founded jointly by the Statistics Department of Carnegie Mellon University and the Department of Statistics and Mathematics of the University of Pittsburgh. The purpose of the Center is twofold: first, to research problems in modern reliability theory, statistical modeling, and advanced computing as these relate to industrial problems of productivity, manufacturing reliability, quality, and competitiveness; second, to facilitate the transfer of this knowledge and methodology from academia to industry. The Center is a uniquely cooperative research enterprise involving a wide range of scientists, engineers, and managers from both academic and industrial settings. The work of the Center illustrates two regional features that are uniquely advantageous for such an endeavor: first, the mixture in the region's industrial base of both basic and emerging "high tech" industries, and second, the well-established Pittsburgh tradition of academic and industrial cooperation.

The Environmental Institute

Edward S. Rubin, Institute Director
Carnegie Institute of Technology
Baker Hall 128A

The Environmental Institute at Carnegie Mellon was created in 1991 to focus attention through research and teaching on environmental concerns that are dramatically transforming the way we all do business. Issues such as global warming, acid rain, smog, toxic pollutants, and hazardous waste disposal have become major factors in technology and public policy developments, signaling a new era in the way we must think about the impacts of human activity, and the design and deployment of technology. The Environmental Institute coordinates and promotes new research and educational programs across a broad spectrum of technical, economic and policy-related studies. The Institute's activities are organized into six major program areas: Air Quality Engineering and Science, Energy-Environmental Studies, Global Climate Change, Risk Analysis and Communication, Solid and Hazardous Waste Management, and Water Quality Engineering and Science. While based primarily in engineering and science, all of the Institute's programs involve strong interdisciplinary links with the social sciences. Faculty, research staff and students of the Institute are drawn from academic departments throughout the University. A faculty Steering Committee guides and coordinates all major program areas, and oversees the Institute's emphasis on the integration of knowledge and perspectives across disciplines.

Academic Standards, Actions and Regulations

Academic Standards

Grading Practices

General undergraduate grading regulations are detailed on page 48.

Conditional Grades: additional clarifications - The I and X grades are inappropriate at mid-semester. When a conditional grade is given, the instructor must stipulate the time when and the manner in which the work is to be completed. Further, instructors must indicate what the "default grade" will be in the event that the student completes no additional work by the time a final grade must be submitted.

Students have up to one full semester to resolve conditional grades. (Instructors have the option of imposing deadlines of less the one full semester.) Unless a permanent grade is substituted based on the completion of outstanding work, conditional grades revert to the appropriate default grade based on work completed in the course at the end of the semester in which the course was taken. If the instructor or facilities for completing the work are unavailable, or the student is not enrolled for the following semester, permission may be given by the College to extend the conditional grade.

Grade Changes or Appeals

Grade changes other than conversions of temporary, or conditional, grades to permanent grades must occur by the end of the second week of the semester which follows the semester for which the original grade was recorded. All changes after that must be petitioned to and approved by the College Council of the college responsible for the course. Changes of conditional grades to permanent grades must occur within one semester after receipt of the conditional grade (See "Conditional Grades" above, and on page 48).

In instances where a grade is being appealed, students should follow appeal procedures described in the Student Handbook.

Cheating and Plagiarism

The College wholeheartedly supports the University statement on cheating and plagiarism that appears in Section I, Academic Regulations, of the Student Handbook. Violations are dealt with by the affected department; severe penalties may result.

It is the student's responsibility to be cognizant of the regulations concerning cheating and plagiarism, and the serious implications of any infraction thereof.

Transfers Into H&SS

Undergraduate students in other Carnegie Mellon colleges who wish to transfer into H&SS during the first or sophomore year without entering an H&SS major should apply in the H&SS Academic Advisory Center, BH 161. Approved transfer will be into the college rather than into a specific department.

Any student beyond the first year wishing to transfer into an H&SS department must request approval of both the college and of the department into which s/he seeks entry. Initial requests for all transfers into H&SS should be directed to the H&SS Academic Advisory Center, BH 161.

Decisions regarding such transfer requests will be based on evidence of adequate prior academic performance and on the applicant's prospects for success in the H&SS major requested.

Academic Actions

In order to maintain good academic standing, students in the College must reach or exceed minimum quality point averages (for each semester and cumulatively), and also maintain adequate progress toward completing graduation requirements. Quality point averages for good academic standing are 1.75 in the freshman year and 2.00 thereafter.

When a student fails to meet minimum performance criteria, an "academic action" normally results. Depending on the circumstances, one of three actions are taken: probation, suspension, or drop. These academic actions are recommended by the College's departments at the end of each semester and imposed by the College Council. They are based on the guidelines described below.

Probation: The student's performance either for the semester or cumulatively fails to meet the minimum standard. The term of "academic probation" is one semester, and signifies to the student the College's insistence that academic performance return to at least minimum acceptable levels. A student is removed from probation, and returned to good academic standing, when both the semester and cumulative quality point averages meet or exceed stated minimums.

Suspension: Academic suspension is the usual action when a student fails to meet the minimum semester and cumulative requirements for two consecutive semesters. In general, a freshman will be suspended if the semester and overall QPA are below 1.75; for sophomores, juniors, and seniors, if these are below 2.00. Failure to maintain adequate progress toward graduation may also be a contributing factor in such decisions.

The minimum period of suspension is two semesters. At the end of that period, a student may seek readmission (on final academic probation); he or she must, however, receive clearance to return from the H&SS Dean's office. In order to receive this clearance, the student must (1) formally request this clearance in writing, describing in detail the relevant activities pursued during the suspension period; (2) provide transcripts from other colleges and universities if courses have been taken while on suspension*; (3) provide evidence of satisfactory on-the-job performance if the student has worked while on suspension; and (4) furnish the names and addresses of three individuals with whom he or she has worked or studied, to whom the College will write with a request for a letter of reference on the student's behalf. When clearance to return is granted by the Dean's Office, the student must file a Returning Student Form with the Registrar. (NOTE: Students on suspension are considered to be on "leaves of absence" [albeit mandatory], and are governed by College and university policies concerning leaves of absence and withdrawals. See subsequent discussions of "Leave of Absence and Withdrawal from the College.")

*Students should note that there are College limits on the number of courses that can be taken while on suspension for which a student could receive transfer credit. See policy statements on this subject in the Student Handbook.

Drop: The student is dropped from, and not permitted to re-enroll in, the College. This normally results when a student, already on final academic probation, continues to perform at levels less than the minimums set by the College for good academic standing, and who shows no indication of being able to reach an acceptable level of performance or maintain steady progress toward completing graduation requirements.

If students have been suspended or dropped, they are required to leave the campus (including dormitories and fraternity 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 for the duration of the period of the action.

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.

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&SS 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 at the time final grades are recorded. Students who attain a semester QPA between 3.50 and 3.74 are named to the Dean's List, with Honors; students who attain at least a 3.75 are named to the Dean's list, with High Honors.

Other Regulations Affecting Student Status

Course Overloads

A normal schedule is considered to be five full courses, or 45 factorable units of course work per semester (this unit number may vary slightly on occasion, due to courses with higher unit values). Overload regulations are detailed on page 48.

Pass/Fail Physical Education and Military Science Courses

A maximum combination of nine units of credit for Physical Education and Military Science courses that are offered pass/fail may be counted for credit toward graduation as free electives in any H&SS program. All Physical Education and most Military Science courses are offered on a pass/fail basis, and hence are not included when calculating a student's QPA.

Course Failures and Course Repetitions

Students who fail required courses must repeat and pass them (or take and successfully complete another approved course that fulfills the requirement). If a failed course is a prerequisite to more advanced course work within a particular course sequence, the failed course must in general be repeated before moving on to the higher level course.

Failed courses that are repeated and passed, or courses that are passed but repeated in order to obtain a higher grade, are not replaced on the student's record; both course grades remain on the record, and are included in calculating the student's official QPA. The College may exclude the units and quality points for the lower grade in calculations to determine eligibility for Dean's List, University Honors, and the like.

Adding and Dropping Courses

The final date to add courses is the one stipulated for each semester on the university calendar — usually 10-14 days after classes begin. The final date to add half-semester mini-courses is the last class day of the second week of the course.

Normally, the deadline for dropping courses without special petition is two weeks following the day mid-semester grades are due in the Registrar's office. In any case, a full-time student will be expected to not drop below a load of at least 36 units (a normal load is 45 units). For information about add/drop procedures, see page 46.

Drops Requiring Petitions: Required courses generally cannot be dropped, and always require a petition in order for an exception to be made. In addition, after the drop deadline for a given course, students with normal course loads (45 factorable units) seeking to drop a course (required or not) will generally not be allowed to do so. Exceptions to this rule can only be made by way of a written petition to the H&SS College Council (in care of the H&SS Academic Advisory Center). The petition should be typed (or legibly printed) on one of the College's petition forms (available in the H&SS Academic Advisory Center), and should include the following:

An explicit statement of the request;

A statement that reflects that the student has analyzed the request for implications and possible consequences, and that the student has formulated some strategies for addressing these implications (e.g., Is the course required? — for the General Education Program? As a prerequisite for subsequent required courses? As a requirement for a major? Will a unit deficiency result by dropping the course? How and when will these be made up? When will the course be repeated, if necessary? Etc.);

An add/drop form should be attached to the petition fully completed (including instructor's signature and advisor's signature) and needing only a co-signing from the Dean's office (required by the Registrar after the drop deadline).

NOTE: If College Council approval to drop a course for any reason is given after the drop deadline, the course will appear on the student's grade report and transcript followed by a "W," signifying "withdrawal."

Special Case: Students with overloads. Students with course overloads may drop an "overload course" after the normal deadline and up to and through the last day of classes for the semester, excluding reading and final examination periods. Students who exercise this option after the drop deadline must petition College Council in order to have the drop approved. NOTE: This option applies only to "overload" courses and not to "required" courses that are part of an overload schedule.

Special Case: Mini-Courses. The final date to add half-semester mini-courses is the last class day of the second week of the course. The final day to drop half-semester mini-courses (without petition) is the last class day of the fourth week of the course.

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. For departments that choose to offer internship credit, the following guidelines address particular issues:

1. *Definition of an Internship-for-credit* : An internship-for-credit is a supervised professional work experience with clear links to a student's academic program performed primarily or totally outside a regular course and for which a student may be able to earn academic credit.

2. *Departmental Policy/Practices Statement*:: Each department in the College (and the Academic Advisory Center) that allows its majors to earn academic credit for an internship should have available for its majors a statement that describes its internship policies and practices. This statement should address the following items:

a. How Internships are arranged and approved: Each department should have a coordinator (or a committee) that approves and monitors the quality of internships.

b. Academic credits for an Internship: 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 (7-10 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)

No H&SS student may earn more than 18 units of internship credit during a semester.

c. Total Internship credits (units) allowable for graduation: No H&SS student may count more than 27 units of internship credits toward fulfilling graduation requirements.

d. Requirements and grades for an Internship: An internship-for-credit is a graded experience. Each department, through its monitor or monitoring committee, will determine appropriate criteria for the grade in an internship.

e. Retroactive credit for 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.

f. Simultaneous credit and pay for an internship on campus or off campus: Some internship sponsors offer payment to an intern in addition to whatever academic credit the University offers. Although a student may earn both credit and pay for an internship, no department is obligated to find paid internships for its majors.

3. *Liability Insurance* : The University's liability insurance for students does not cover a student while he or she is doing an off-campus internship.

4. *Exceptions to the Guidelines for Internship Credits*: Exceptions to the guidelines require a petition and approval by both the student's department and the College (i.e., the Academic Advisory Center).

Non-CMU Courses

Under no circumstances will H&SS students be permitted to earn elsewhere more than half of the 360 units required for graduation. In general, and commencing with their matriculation to Carnegie Mellon as degree candidates, H&SS students may take a maximum of five courses (or their unit-equivalent) elsewhere and receive transfer credit for these courses. Furthermore, a maximum of three of these five courses may be applied to College General Education requirements. H&SS academic departments may not exceed these College limits, but may impose stricter limits for major requirements. For students entering the College as internal transfers, these limits apply retroactively to their matriculation to Carnegie Mellon as degree candidates.

Courses taken elsewhere must be taken for a grade (NOT Pass/Fail or Audit) in order to receive transfer credit. Transfer credit will be granted only for courses in which a grade of C or better (NOT including C-

minus) is earned. Only units (not grades or quality points) transfer for such courses, and as such they do not affect one's Carnegie Mellon quality point average. Approval to take and receive credit for all such courses must be obtained in advance through established procedures. Information about these procedures, and appropriate forms, are available in the College's Academic Advisory Center.

Exception: External Transfer Students. For students entering the College as external transfers, these same limits apply commencing with matriculation to the College. If the transfer credit total reaches 180 units, however, no additional transfer credit will be allowed.

Exception: Students on Academic Suspension. H&SS students on academic suspension are permitted to take elsewhere and receive credit for a maximum of three courses per semester, and no more than a total of five courses, while on suspension. These limits may be lower if a student has already received credit for courses taken elsewhere. Approval to receive credit for courses taken while on an academic suspension must be obtained in advance through established procedures. Information about these procedures, and appropriate forms, are available in the College's Academic Advisory Center.

Exception: Special Programs. These limits generally do not apply to credit received through the Advanced Placement or International Baccalaureate programs, to courses taken during the academic year as part of the Pittsburgh Consortium for Higher Education, to courses taken as part of the Washington Semester program, or to courses taken as part of approved Study Abroad programs. Other unique program opportunities away from the university may warrant similar relaxation of these restrictions. All such exceptions must be made via written petition to the H&SS College Council, submitted c/o the H&SS Academic Advisory Center.

Double-Counting Courses

"Double-counting" refers to instances when the attempt is made to have a course taken to fulfill one requirement count simultaneously toward a requirement in another major or minor program. While the College encourages interdisciplinary 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." These are rather singular mechanisms for students to use in defining the primary foci of their studies. To preserve the integrity of these definitions, the College permits double-counting requirements for its students on a very limited basis, and generally only in those instances when the course(s) in question represent only a small portion of the second program. When it is allowed, it is viewed not as "double-counting," but rather as a waiver of the course requirement in question in 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.

Leave of Absence and Withdrawal from the College

Students should first note the differences between a "Leave of Absence" and a "Withdrawal," the consequences of each, and the circumstances under which a "Leave of Absence" reverts to a "Withdrawal." A "Leave of Absence" implies the intention (and offers the option) to return to the university, whereas a "Withdrawal" implies no intention (and offers no automatic option) to return. Students who withdraw and subsequently seek to return must reapply through the Admissions Office. Furthermore, students who take a leave but are gone for more than four years, or who become full-time students elsewhere, revert to "withdrawals" and must reapply through the Admissions Office if they wish to return. This policy also applies to students on academic suspension, who are initially considered to be on "leaves of absence" from the College.

A student who withdraws or takes a leave of absence from the College at any time up to and including the last day of classes for a semester or summer session (and excluding the reading and final examination periods) does so with the understanding that no grades will be recorded for that semester or session. (Exception: Grades of "W" ["withdrawal"] will be recorded if the leave or withdrawal takes place after the official course drop deadline [see "Adding and Dropping Courses"].) Leaves or withdrawals taken after the last day of classes for a semester or summer session result in the recording of final grades for that semester or session.

Students taking a leave of absence or withdrawing must file an official Leave of Absence/Withdrawal Form with the Registrar before the leave or withdrawal officially takes effect. The form requires the approval of the student's department and (if during the academic year) his or her Dean. In addition, if the student is under 18 years of age, the signature of his or her parent or guardian is also required. At the time of withdrawal the university will notify the student's parents by letter, except in the case of a student over 21 years of age. In some instances the College may choose to state special readmission conditions. Procedures for withdrawals/leave of absence are detailed on page 52.

Graduation Requirements

Eligibility for graduation through H&SS requires that a student (1) complete all College General Education requirements, (2) complete all course requirements in his or her primary major (including any minimum QPA performance standards set by academic departments for courses taken in their majors), (3) achieve a cumulative quality point average of at least 2.00 for all courses taken after the freshman year, (4) complete at least 360 units (with at least the appropriate minimum taken and completed at Carnegie Mellon [See "Non-CMU Courses," above]), (5) be recommended for a degree by the faculty of the College, (6) meet all financial obligations to the university, and (7) qualify for graduation in no more than eight years after matriculating as a degree candidate.

Modification of Requirements. Any H&SS student who wishes to have any part of these graduation requirements modified must petition the H&SS College Council in writing for approval. For its part, the College reserves the right to modify these academic standards, actions, and regulations. Any such changes will, where possible, be reflected in the most current edition of the Carnegie Mellon Student Handbook (updated annually).

Graduation with University Honors; Graduation with College Honors

H&SS students who achieve an overall QPA of at least 3.50 will be recommended for graduation "With University Honors."

H&SS students who successfully complete a senior honors thesis under the auspices of the H&SS Senior Honors Program qualify for graduation with "H&SS College Honors."

Other Major, Double Major, and Minor Options

A number of other major and minor options (both inside and outside the College) are available to H&SS students. Those offered by H&SS are also available to all Carnegie Mellon undergraduate students, including the H&SS Student-Defined Major Program (if pursued as a second major by non-H&SS students).

The H&SS Student Defined Major Program

H&SS Academic Advisory Center
Office: Baker Hall 161

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 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. These courses should be categorized in two ways: first, 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). 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 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. 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 161.

Second Majors in Other Carnegie Mellon Colleges

A number of second major options outside of the College are available to H&SS students. These are described in detail in the sections of this catalog corresponding to the sponsoring departments.

Second Majors for H&SS Students in the Mellon College of Science

A special set of second major options for H&SS students has been arranged with the Mellon College of Science. Heeding C.P. Snow's warning about the dangers of "two cultures" (one scientifically and technologically literate and the other generally not), the academic core of university-level general education combines the humanities, the behavioral and social sciences, and the natural sciences. With a basic foundation of knowledge, methods, and perspectives in the liberal arts and the sciences, students can more readily understand and grapple with complex problems in the modern world that overlap these domains.

This approach is clearly evident in H&SS. The College's General Education Program emphasizes at various points the need to understand modern scientific and technical knowledge and methods of inquiry. Similarly, many H&SS major programs further embrace the potential for rigorous integrated studies in both the humanities and the sciences. In this spirit, H&SS offers its students the opportunity to participate in a joint double major program with the Mellon College of Science (MCS), making it possible to receive an H&SS major and one of four MCS majors (Biological Sciences, Chemistry, Physics, and Mathematics). Three of these majors (Biological Sciences, Chemistry and Physics) offer B.A. as well as B.S. tracks, while the fourth (Mathematics) offers only a B.S. track.

Relatedly, the Mellon College of Science also offers minors in Biological Sciences, Chemistry, Mathematics and Physics.

Curriculum details for these second major and minor options are presented in the Mellon College of Science departmental descriptions in this catalog. For the most current version of these requirements, interested students are encouraged and invited to visit the relevant MCS department(s) and meet with the appropriate faculty advisor.

Minors

Every Carnegie Mellon college offers one or more minors that are available to H&SS students (and to all Carnegie Mellon students). These are described in detail in the sections of this catalog corresponding to the sponsoring departments or college.

H&SS Minors

H&SS offers an array of minors that are available to students from all units of the University. Certain H&SS minors are essentially self-contained in a given department, and are offered directly through the sponsoring department. Such "disciplinary" or departmental minors are listed below:

- English (with tracks in Literary and Cultural Studies, Creative Writing, Professional/Technical Writing, and Rhetoric; offered through the English Department)
- History (offered through the History Department)
- European Studies (offered through the History Department in cooperation with Modern Languages)
- French (offered through the Modern Languages Department)
- German (offered through the Modern Languages Department)
- Spanish (offered through the Modern Languages Department)
- Japanese (offered through the Modern Languages Department)
- Second Language Acquisition (offered through the Modern Languages Department)
- Teaching English to Speakers of Other Languages (offered through the Modern Languages Department)
- Philosophy (offered through the Philosophy Department)
- Ethics (offered through the Philosophy Department)
- Logic and Computation (offered through the Philosophy Department)
- Computational Linguistics (offered through the Philosophy Department)
- Psychology (offered through the Psychology Department)
- Information and Decision Systems (offered through the Social and Decision Sciences Department)
- Political Science (offered through the Social and Decision Sciences Department)
- Public Management (offered through the Social and Decision Sciences Department)
- Statistics (offered through the Statistics Department)

Other H&SS minors draw on courses from a number of departments, and hence are interdisciplinary, or "interdepartmental." H&SS "interdepartmental minors" are available in the following areas:

- Environmental Studies
- Film and Media Studies
- Gender Studies
- Health Professions (pre-med)
- International Affairs
- Minority Studies
- Religious Studies
- Sociology
- Teacher Certification (Early Childhood)
- Teacher Certification (Elementary)
- Teacher Certification (Secondary)

Completion of the requirements for any of these minors is noted on one's final transcript.

The minors described and outlined here are those H&SS "interdepartmental minors" listed above. Other H&SS departmental minors offered directly through an academic department are described, and curriculum requirements listed, in that H&SS department's section of this catalog.

Any student pursuing an H&SS departmental minor should formally confirm this with the department through which the minor is offered. Student progress through the minor's requirements will be monitored through this department. Similarly, any student pursuing an H&SS interdepartmental minor should formally confirm this with the H&SS Academic Advisory Center (AAC). Student progress through the minor's requirements will be monitored through the AAC. Any student pursuing any of these minors should visit the H&SS Academic Advisory Center if additional information is needed about minor advisors, certification and registration procedures, modifications in requirements, restrictions governing the option to double-count minor requirements with other College or program requirements, and the like.

H&SS Interdepartmental Minors

The interdepartmental minors described here are programs whose content and components span two or more academic departments. They reflect an attempt by the College to suggest to students one or more ways in which courses can be combined across disciplines in the humanities, behavioral sciences, and social sciences to form coherent patterns of study. Some (for example, Health Professions, and Teacher Certification) have a professional focus to them, while others (e.g., Sociology, Gender Studies, and Film and Media Studies) have a more general focus. These minors are available to all Carnegie Mellon students.

The Minor in Environmental Studies

Faculty Advisor: Joel Tarr
Office: Baker Hall 236C

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

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)	

Required Courses — 18 units

66-210	Science and Technology for the Environment
80-244	Management, Environment, and Ethics

Intermediate (Distributional) Requirements — 27 units

Choose three courses in at least two areas. Only one of the three can be an introductory course (as indicated below by an asterisk).

Science and Technology

12-101*	Innovation and Design in Civil Engineering
12-635	Water Quality Engineering
12-636	Environmental Engineering: Air Pollution
19-101*	Introduction to Engineering and Public Policy
19-321	Law and Technology
19-420	Chemical Technologies, the Environment, and Society
19-422	Radiation, Health, and Policy
19-448	Science, Technology and Ethics
24-297	Energy-Environmental Systems
42-604	Biological Transport

Social Sciences

73-357	Regulation: Theory & Policy
73-358	Economics of the Environment and Natural Resources
73-359	Benefit-Cost Analysis
88-220	Policy Analysis I
88-221	Policy Analysis II
88-340	Law and Public Policy
88-425	Regulatory Processes

Humanities

76-322	Reading the Built Landscape
79-224	Technology and Values
79-226*	Technology in Western Civilization
79-230	Population and History
79-247	History of the American Landscape
79-271	Medicine and History
79-284	Critical Issues in American Environmental History
79-329	Environmental Issues and Policy

Advanced Course — (minimum) 9 units

(NOTE: 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	
79-448	History and Policy Project Course (pre-approved sections)

The Minor in Film and Media Studies

Faculty Advisor: Paul Smith
Office: Baker Hall 245D

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).

NOTE: Courses taken to fulfill requirements in other major or minor programs may not be applied to the Film and Media Studies minor requirements (and vice versa).

Curriculum

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.

Prerequisite Course — 9 units

76-101 Introduction to English: Interpretation

Introductory Course — 9 units

76-239 Introduction to Media Studies
PLUS (optional)
Filmmaking 1, offered through Pittsburgh Filmmakers (recommended [but not required] at this level)

Intermediate Courses — 27 units

76-339 Advanced Media Studies

PLUS 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.) NOTE: Courses in group 2 cannot be double-counted for an English Department major and the Film and Media Studies minor. Hence, students pursuing this minor whose major (primary or double) is in an English Department program must choose from course groups 1 and 3 below.

1. Film and the Study of Society

79-219	Picturing Others: Ethnographic Films
79-220	Contemporary America in Film
79-248	American Politics Through Fiction and Film
79-260	Crime & Justice in Film (sometimes offered for 6 units)
79-288	The American West in Film (6 units)
79-289	The 1920s and 1930s in Film
79-293	World War II and the Cold War in Film
82-491	Literature, Politics and Film in East Europe and Russia Today

NOTE: Other 300- or 400-level courses in English, History and Modern Languages courses can be counted in this category when their primary topic is film and media. Please consult the minor faculty advisor.

2. Film, Sign Systems, and Cultural Context

76-240	What is Cultural Studies?
76-294	Literary and Cultural Studies Core

NOTE: Courses listed in this group cannot be double-counted for both an English Department major and the Film and Media Studies minor.

3. Filmmaking

76-269	Survey of Forms: Screenwriting
Filmmaking 2	(through Pittsburgh Filmmakers)

Advanced Course — 9 units

Students take one advanced course in which they concentrate on film, either directly or as a tool of social and cultural analysis. In focusing on film directly, students may take a course in critical approaches to film, or use film as the basis for advanced work in an approved course.

76-439	Advanced Seminar in Media Studies
76-469	Screenwriting Workshop
Filmmaking 3	(offered through Pittsburgh Filmmakers)

The Minor in Gender Studies

Faculty Advisor: Judith Modell
Office: Baker Hall 371

The study of gender, with particular focus on women but increasingly with attention to concepts of masculinity as well as femininity, has become a significant area of interdisciplinary research and teaching. The H&SS minor in Gender Studies combines course work primarily in English, history and anthropology, but also economics, psychology and philosophy.

NOTE: 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

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.

Introductory Courses — 18 units

Choose one of the following:

76-241	Introduction to Gender Studies

PLUS one of the following:

79-262	Women in the Western Tradition
or	
79-263	Women in American History

Intermediate Courses — 27 units

Choose 27 units' of course work from the following list. (All courses are 9 unit-courses, unless otherwise indicated.)

73-340	Labor Economics
76-242	Sex and Gender
76-353	Reading Feminisms
76-349	Feminist Historical Criticism
79-210	Women in Japan
79-221	A History of American Urban Life
79-232	Role of Men in the Modern World (6 units)
79-233	The Making of the Modern Family (6 units)
79-235	Sex and Death (6 units)
79-236	Work and Leisure (6 units)
79-262	Women in the Western Tradition*
79-263	Women in American History *
79-264	Gender Roles and Social Change
79-273	Family and Population
85-221	Principles of Child Development

* If not taken as an introductory course.

Advanced Course — 9 units

Each student in the Gender Studies minor will take one advanced course in which they complete an analytical project using gender as a primary focus. This project may be achieved as part of taking one of the following courses:

76-433	Advanced Studies in European Literature and Culture
76-434	Advanced Studies in World Literature and Culture
76-435	Advanced Studies in American Literature and Culture
79-402	Research Seminar in Anthropology and History
79-404	The Social History of Gender Relations in America
79-444	Research Seminar in Social History
85-446	Psychology of Gender

As an alternative, students may choose another 9-unit course from the "Intermediate Course" list above and, by arrangement with the instructor, complete the gender-related project described above.

The Minor in Health Professions

Many changes are anticipated in health policies and services through the end of this century. The Health Professions minor gives H&SS students the opportunity to prepare for a career in one of the health professions at the same time as they are obtaining a broad-based liberal education. The curriculum enables pre-medical and pre-dental students to take all of the science requirements for medical or dental school. It also offers a broad and relevant base of scientific knowledge to those students interested in future study and/or employment in health-related fields such as nursing, physical therapy, patient advocacy, genetic counseling, environmental health, pharmacology, and health care administration. With a Health Professions minor, sources of employment might include biomedical research companies, pharmaceutical companies, environmental research companies, health maintenance organizations, health insurance companies, hospital administration, public health departments (county, state or federal), biostatistics, environmental health groups, ambulatory and long care health administration, genetic engineering, health agencies (e.g., the American Cancer Society), and health-related work in developing countries.

Prerequisite Courses: 20 units

21-121	Calculus 1 (Fall, freshman year)
21-122	Calculus 2 (Spring, freshman year)

Required Courses: 115 units

09-105	Modern Chemistry I (Fall, freshman year)
09-106	Modern Chemistry II (Spring, freshman year)
33-111	Physics for Science Students I (Fall, sophomore year)
03-121	Modern Biology (Fall, sophomore year)
33-112	Physics for Science Students II (Spring, sophomore year)
09-131	Experimental Techniques in Chemistry I (Spring, sophomore year)
09-117	Organic Chemistry I (Fall, junior year)
03-130	Biology of Organisms (Fall, junior year)
09-218	Organic Chemistry II (Spring, junior year)
33-123	Physics III: Electricity and Magnetism (Spring, junior year)
09-132	Experimental Techniques in Chemistry II (Spring, junior year)
03-124	Modern Biology Lab (Spring, Senior year)

The Minor in International Affairs

Faculty Advisor: Erick Langer
Office: Baker Hall 254B

The International Affairs minor is intended to allow students to explore issues in international relations, United States international policies, and international cultures. It is designed for students with international interests of various sorts, including business and management, political science and history. The International Affairs minor is offered jointly by the departments of Social and Decision Sciences, History, and Modern Languages.

All students in the program are encouraged to spend a semester of study abroad. Requirements in the minor will be adapted accordingly.

Curriculum

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.

Courses taken to fulfill requirements in other major or minor programs may not be applied to the International Affairs minor requirements (and vice versa). Exception: 79-104, Introduction to World History.

Prerequisites:

79-104	Introduction to World History	9 units

Required Courses

1. United States Foreign Policy **9 units**

Choose one course:

79-227	Recent American Foreign Policy
79-380	Problems in National Security Since 1945
88-332/79-201	Global Security and Science
88-329	Recent American Foreign Policy

2. Issues in Contemporary International Affairs **9 units**

This set of courses deals with selected major issues of a particular region, such as Europe, China, the former Soviet Union, and Latin America. These issues might include relations with the United States, relations among ethnic and social groups, environmental concerns, economic policies, and the role of the military. Historical analysis will be brought to bear to create a more profound understanding of the current problems and perspectives of the region under study. Specific course descriptions will be issued each term, depending on the area of the world involved and on the salient international issues.

Choose one course:

79-276	Modern China
79-309/88-318	The Politics of Contemporary Latin America
79-320/82-410	Issues in Contemporary European Civilization
88-326	Issues in International Affairs
88-333	The Cold War in Historical Perspective

3. Regional History, Politics, and Cultures **18 units**

Choose two courses, for a minimum of 18 units (Note: Where possible two courses focusing on one major region of the world are recommended):

Europe	
79-204	Collapse and Renewal of Europe
79-215	Dynamics of European Society
79-228	Religion and Society: The European Experience
79-281	Irish History
79-285	Europe in International Affairs
79-292	Modern Germany
79-297	War and Revolution: Europe in the 20th Century
79-298	British History
79-320	Issues in Contemporary European Civilization (if not taken as part of course group 2)
79-343	The Mediterranean World: History and Ethnography
79-348	European Cities
88-331/79-421	Europe in Transition
China	
79-206	Chinese Culture and Society
79-277	China Today
79-282	East Asians in Film
Japan	
79-210	Women in Japan
79-214	Modern Japan, 1868 to the Present
79-282	East Asians in Film
Russia	
79-231	Russian History From the First to the Last Tsar
79-245	Survey of Soviet History: From Lenin to Gorbachev
79-324	Current Issues in the Former Soviet Union
88-320	U.S./Soviet Relations: From Confrontation to Cooperation
88-328	Stalin and Stalinism
Latin America	
79-223	Modern Latin America
79-278	Gauchos and Indians in Latin America
79-279	Origins of Conflict in Central America
Middle East	
79-283/88-334	Foreign Policy Issues in the Middle East
Africa	
79-207	History of Africa
79-208	History of South Africa

4. Modern Language and Language-Integrated Courses **(minimum) 18 units**

Courses in this category must be at the intermediate level (200-level or above, except in the case of Chinese, Japanese or Russian where students will be permitted to take two courses at the elementary level if they have never studied these languages before. (Note: elementary courses in Chinese, Japanese and Russian award 12 units per semester; thus the requirement will be for 24 units.) Students will be placed into the appropriate level language course.

Modern Language courses in this category include:

French	
82-201	Intermediate French I
82-202	Intermediate French II
82-301	Advanced French: Grammar and Stylistics
82-302	*Advanced Writing as Communication: French
82-303	*Advanced Written French
88-304	*Introduction to French and Francophone Culture
82-305	*Contemporary Spoken French
82-409	French Literature of the Nineteenth Century
82-412	Contemporary French Theatre
82-413	Contemporary French Novel
82-415/416	Studies in French Literature
82-455/456	Surrealism in France and Spain

German	
82-221	Intermediate German I
82-222	Intermediate German II
82-321	Advanced German Grammar and Stylistics
82-322	*Advanced Writing as Communication: German
88-323	*Advanced German Grammar, Stylistics, and Writing
82-324	*Contemporary Spoken German
82-325	*Introduction to German Studies
82-427	*The New Germany
82-428	German Classical Literature
82-429	German Literature of the Nineteenth Century
82-430	German Literature of the Twentieth Century
82-435/436	Studies in German Literature
Chinese	
82-131	Elementary Chinese I
82-132	Elementary Chinese II
82-231	Intermediate Mandarin Chinese I
82-232	Intermediate Mandarin Chinese II
Spanish	
82-241	Intermediate Spanish I
82-242	Intermediate Spanish II
82-341	Advanced Spanish Grammar and Stylistics
88-342	*Advanced Writing as Communication: Spanish
82-343/344	*Hispanic Language and Culture A and B
82-345	*Introduction to Spanish Literary and Cultural Studies
82-441	*Survey of Spanish Literature and Culture
82-442	*Analysis of Spoken Spanish
82-451	*Introduction to Latin American Literature and Culture
82-455/456	Studies in Spanish and Latin American Literature
82-465/466	Surrealism in France and Spain
Italian	
82-261	Intermediate Italian I
82-262	Intermediate Italian II
Japanese	
82-171	Elementary Japanese I
82-272	Intermediate Japanese II
82-272	Intermediate Japanese II
82-371	*Advanced Japanese Conversation and Composition I
82-372	*Advanced Japanese Conversation and Composition II
Russian	
82-191	Elementary Russian I
82-192	Elementary Russian II
82-291	Intermediate Russian I
82-292	Intermediate Russian II
82-391	*Advanced Russian
88-399	*Special Topics: Russian
82-491	*Literature, Politics and Film in East Europe and Russia Today

*asterisked courses are particularly appropriate for the minor.

In addition to the Modern Languages courses listed above, students with appropriate proficiency in a modern language will be permitted to select from among courses which integrate language study into a discipline specific courses. As a rule these courses will be taught in English, but will include a required component of reading and writing in the student's language of specialization. This group of courses includes the following:

History*	
79-204	Collapse and Renewal of Europe
79-215	Dynamics of European Society
79-223	Modern Latin America
79-292	Modern Germany
79-309	The Politics of Contemporary Latin America
79-320	Issues in Contemporary European Civilization
79-242	Comparative Issues in U.S. and Latin American History

* If these courses are taken to satisfy the language component of the minor, they will not count toward the requirement in history and cultures.

The Minor in Minority Studies

Faculty Advisor: Joe Trotter
Office: Baker Hall 246C

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

Every student will be required to take the core course (79-113, Culture and Identity in American Society [9 units]). This course is offered one semester each year, and introduces the themes, approaches and methods that are crucial for this minor. The core course is followed by a selection of intermediate courses (36 units), and by an advanced seminar (9 units) 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.

Total: 54 units

NOTE: 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

79-113	Culture and Identity in American Society

Intermediate Courses — 36 units

Students must complete a total of 36 units at the intermediate level. 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.

76-240	What Is Cultural Studies?
76-346	Readings in Emergent Literatures
79-202	Introduction to Anthropology
79-265	Immigration and Ethnicity in American History
79-257	African-American History I
79-258	African-American History II

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.

73-340	Labor Economics
79-223	Modern Latin America
79-264	Gender Roles and Social Change
80-240	Contemporary Ethical Issues
85-241	Social Psychology
85-441	Social Psychology of Social Problems
88-312	Political Psychology and Sociology
88-322	Elections, Interest Groups, and Public Policy

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.

76-240	What Is Cultural Studies?
76-339	Advanced Studies in Media
79-202	Introduction to Anthropology
79-219	Picturing Others: A Course in Ethnographic Film
79-323	Visual Anthropology

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.

79-207	History of Africa
79-208	History of South Africa
79-223	Modern Latin America
79-257	African-American History I
79-258	African-American History II

Advanced Course — 9 units

76-437	Cultures, Values and Texts
76-446	Advanced Seminar in Emergent Literatures and Cultures

(Consult the faculty minor advisor regarding other appropriate advanced course options.)

The Minor in Religious Studies

Faculty Advisor: David Miller
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

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. Note that a number of relevant courses at other Pittsburgh-area institutions have been identified as relevant for this minor. These courses are available to Carnegie Mellon students during the academic year through cross-registration.

NOTE: 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.

66-250	Introduction to Religion

Distribution Requirements — 18 units

Choose one course from each of two of the four disciplinary clusters 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.

A. Historical approaches

79-228	Religion and Society: The European Experience
79-229	Religion and Society: The American Experience

B. Anthropological approaches

79-211	Festivals and Ceremonies
79-307	Ritual, Performance and Time

C. Philosophical approaches

80-265	Philosophy of Religion*

* Students who want to choose philosophy as one of the disciplinary approaches should contact and alert the Philosophy Department at the beginning of the academic year (or as soon as possible), because departmental decisions to offer this course are based partly on anticipated demand. If 80-265 is not offered in a given year, however, students may fulfill this option by cross-registering for the University of Pittsburgh's course PHIL 0473, Philosophy of Religion.

D. Textual approaches

60-670	Art and Religion
76-230	Biblical and Mythological Backgrounds of English Literature
76-497	Pagan Rhetoric and Christian Literature

Elective Courses — (minimum) 27 units

Choose 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.

Courses at Carnegie Mellon University

66-301	Science and Christianity
66-302	Religions of the World's People
66-315	The Holocaust in Historical Perspective
76-332	Politics and Poetics of the English Revolution
79-238	Early Christianity
79-295	Witchcraft and Dissent in the Middle Ages
79-296	Witchcraft and Social History

Courses at the University of Pittsburgh

PHIL 0473	Philosophy of Religion
SOC 0039	Sociology of Religion
RELGST 1750	Psychology of Religion
RELGST 0505	Religion and Culture in East Asia
RELGST 1520	Buddhist Civilization
HIST 0756	Introduction to Islamic Civilization
RELGST 1620	Women in Religion
PS 1440	Religion and Politics in the Middle East
JS 0205	Modern Judaism
RELGST 1100	Israel in the Biblical Age
JS 1270	Modern Jewish Thought
JS 1258	Modern Jewry
RELGST 0425	Popular Religion in America
RELGST 0435	Religious Themes in American Literature
BLK 0407	The Black Church
PS 1475	Religion and Politics

Course at Chatham College

PHI 276	Art, Meaning and Religion

Courses at the Pittsburgh Theological Seminary

HM 25	Theology and Film
WS 17	History of Church Music
TH 14	Process Theology
TH 42	Feminist Theologies
TH 50	Creation, Cosmology and Evolution
Et 23	Social Teachings of the Christian Church
ET 39	Christian Ethics and Politics
OT 28	Biblical Archeology
CH 18	The History of Christian Philosophy
CH 29	Puritanism
CH 37	Religious Thought of the 19th Century
CH 45	Revivalism and Fundamentalism

Courses at Duquesne University

Theology 280	Religious Experience
Theology 470	Christian Mysticism

Courses at Carlow College

TH 400	Contemporary Christian Theology
TH 449	Modern Catholicism
TH 483	Christian Spirituality of Women

The Minor in Sociology

Faculty Advisor: John Modell
Office: Porter Hall 223H

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 their ability to change over time. Students choose among selected topics including demography, social psychology, political sociology, sociology of organizations, technology and society, sociology of health, and the family. This background should 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. This background in empirical tools and social theory will enable students to enter professional careers involving social analysis, data analysis of groups and organizations, and population analysis within journalism, political institutions, the government, and the corporate environment as well as graduate studies in sociology, social history, anthropology, and social science.

Curriculum

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 requirements as outlined below.

NOTE: The "required" courses listed below 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 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.

Only 9 units of courses in the minor can double count with requirements for any other minor or major. Exceptions in rare cases may be made but they must be approved by the sociology minor faculty advisor.

Required Courses **36 units**

88-240 Empirical Research Methods I*

* Prerequisites: 36-201/202, or 36-211/212, or 36-225/226.

PLUS three of the following courses:

79-213 Sociology as History
88-260 Organizations
88-316 Social Theory and Analysis
88-317 Social Structure and Human Development

Elective Courses **18 units**

Choose two courses from Cluster 1 or one course from Cluster 1 and one course from Cluster 2.

1. Social and Political Perspectives

88-312 Political Psychology and Sociology
88-313 Introduction to Models of Political Science
88-338 Health Care Policy
88-367 Computers in Organizations
79-221 A History of American Urban Life
79-226 Technology in Western Civilization
79-230 Population and History
79-234 The Development of the Modern Mind
79-359 Technology and Organization
79-384 Classics of the Social Sciences

2. Social and Anthropological Perspectives

79-202 Introduction to Anthropology
79-239 Child Welfare and Social Reform
79-247 History of the American Landscape
79-264 Gender Roles and Social Change
79-265 Immigration and Ethnicity in American History
79-273 Family and Population
79-303 Peasants in History
79-307 Ritual, Performance and Time
79-402 Research Seminar in Anthropology and History
85-241 Social Psychology
85-441 Social Psychology of Social Problems
88-309 Altruism and Selfishness
88-342 Market Organization and Business Behavior

The Minor in Teacher Certification: Early Childhood Education and Elementary School Teaching

Faculty Advisor: Sharon Carver
Office: Carnegie Mellon Children's School, Margaret Morrison Carnegie Hall, Room 17-D

In addition to their major, students in all departments may prepare for Pennsylvania certification in Early Childhood Education (nursery school through grade 3) and Elementary School Teaching (kindergarten through grade 6) in innovative programs offered cooperatively by Carnegie Mellon and Chatham College. Students normally enter these programs in the second semester of the freshman year and spend part of each semester thereafter working with children and teachers in Pittsburgh public schools and in the Carnegie Mellon Children's School, a modern pre-school located on campus.

NOTE: Each of the Chatham College Education courses listed below has a field placement requirement which involves observation in a school. Before participating students can enter a school they must have Pennsylvania Act 33 and Act 34 clearances (criminal record checks). Normally, several weeks after submitting this form are required before receiving clearance. Participating students should obtain Act 33 and Act 34 clearance before each Chatham Education course begins. Clearance forms can be obtained from any Pennsylvania State police barracks.

General Requirements **84 units***

Students who desire to teach should make application in the second semester of their freshman year. Students who are prepared to teach in early childhood and elementary school are required to have an area of concentration in an academic subject.

*Converted from Chatham credits to Carnegie Mellon units.

Courses for Early Childhood Education

(Taken at Chatham College; course numbers taken from Chatham College Catalog)

Education 102 Perspectives on Education
Education 201 Expressive Arts
Education 208 Communication Skills in Education
Education 211 Early Childhood Curriculum
Education 215 The Young Child
Education 322 Teaching in an Urban Setting
Education 414 Early Childhood Student Teaching and Seminar

Courses for Elementary School Teaching

(Taken at Chatham College; course numbers taken from Chatham College Catalog)

Education 102 Perspectives on Education
Education 201 Expressive Arts
Education 208 Communication Skills in Education
Education 212 The Elementary Curriculum
Education 213 The Elementary School Child
Education 322 Teaching in an Urban Setting
Education 413 Elementary Student Teaching and Seminar

The Minor in Secondary School Teaching and Teacher Certification

Faculty Advisor: Joseph Devine
Office: Baker Hall 161

In addition to their major, Carnegie Mellon undergraduates who are majoring in an area that corresponds to a Pennsylvania secondary school teaching subject (and also offered for certification by Chatham College) may prepare for Pennsylvania certification in Secondary Education through the minor in Secondary School Teaching and Teacher Certification. This program combines the Carnegie Mellon undergraduate major with appropriate courses and field experiences offered by Chatham College, through an approved exchange arrangement between Carnegie Mellon and Chatham.

Students normally enter this program in the freshman year. (It is still possible to complete this program if begun after freshman year, but no later than Fall semester of the junior year.) The Education portion of the minor curriculum is described below, and conforms to Pennsylvania state certification requirements for secondary school teaching. Course work in the major can be tailored to best serve students' interest in secondary school teacher certification by consultation with the appropriate department faculty advisor, as noted below:

Biological Sciences: Edward Weisberg
Chemistry: Gary Patterson
English: Jane Bernstein
French: Beryl Schlossman
History: Eugene Levy
Mathematics: Russell Walker
Psychology: Kenneth Kotovsky
Spanish Kenya Carmen Dworkin y Mendez

Curriculum

Course and practicum requirements for the minor in Secondary School Teaching and Certification consist of six Chatham College courses, which convert to 84 Carnegie Mellon units. Students seeking Pennsylvania secondary school certification are required to have a major in an academic subject that conforms to a secondary school teaching subject area.

NOTE: Each of the Chatham College Education courses listed below has a field placement requirement which involves observation in a school. Before participating students can enter a school they must have Pennsylvania Act 33 and Act 34 clearances (criminal record checks). Normally, several weeks after submitting this form are required before receiving clearance. Participating students should obtain Act 33 and Act 34 clearance before each Chatham Education course begins. Clearance forms can be obtained from any Pennsylvania State police barracks.

Course Requirements **84 units***
(Taken at Chatham College; course numbers taken from Chatham College Catalog)

*Converted from Chatham credits to Carnegie Mellon units.

Psychology 325	Tests and Measurements (prerequisite: an introductory Psychology course, or instructor permission)
Education 102	Perspectives on Education (includes 1/2-day per week field experience; not open to first-semester freshmen)
Education 222	Principles of Secondary Education (includes 1/2-day per week field experience; pre- or co-requisite: Education 102)
Education 321	Teaching Methods for the Secondary and Adult Level (includes 1/2-day per week field experience; pre- or co-requisite: Education 222)
Education 322	Teaching in an Urban Setting (includes 1/2-day per week field experience; prerequisite: Education 102 and instructor permission)
Education 423	Secondary Student Teaching (prerequisite: Department Chairperson permission)

Additional requirements

Students in certain majors, seeking certification in corresponding subject areas, have one or more additional requirements as outlined below:

Those seeking certification in:	are required to:
English	take an approved Linguistics course
Spanish	take an approved Phonetics course
Social Studies	major in one of the following programs: History, Political Science, Psychology, or Economics; *and* take at least one course in each of the other areas outside of their major

2-3 Masters Program in Secondary School Teaching

To advance the professional training of teachers, Carnegie Mellon University and Chatham College have established a three-year program open to qualified juniors. This program is available to students at either institution, through which students would obtain their bachelor's degree and Pennsylvania certification in secondary school teaching in four years, and a Master of Arts degree from Carnegie Mellon in one of the following fields after a fifth year: History, English, French, Spanish, and Psychology. Comparable Master's options may also be available in selected fields in the Mellon College of Science.

Interested students should indicate their intention to apply for this program during their sophomore year, so that they can begin taking appropriate courses (both in the major, and in the Secondary School Teacher Certification program). Specific programs will offer different combinations of major, teacher certification and Master's courses during the junior, senior and graduate (fifth) years, with close advising of students in each program. Master's-level courses in each Carnegie Mellon department are carefully designed to provide graduate training relevant to the teaching areas of the secondary schools.

Entry Procedures

Chatham or Carnegie Mellon students interested in this program should state their interest by the end of the sophomore year. Interested students apply for entry by the end of the junior year. Admissions committees from the participating Carnegie Mellon departments will meet to review applicants, and will include one member of the Chatham College faculty from each respective area.

For further information (including Masters-level curriculum requirements, and suggested undergraduate course sequences), interested students should contact one of the following Carnegie Mellon representatives:

For students in the humanities, behavioral sciences, or social sciences:

Joseph Devine, Associate Dean of H&SS
Office: Baker Hall 161

For students in the physical, natural, or mathematical sciences:

Eric Grotzinger, Associate Dean of MCS
Office: Scaife Hall 115

Department of Economics

Stephen E. Spear, Department Head
Department Office: GSIA 139

Economics has long played an important role in teaching and research at Carnegie Mellon University. The Economics Department is one of the few small, personalized departments ranked among the top research departments of Economics at colleges and universities in the United States. The Department of Economics offers B.S. and B.A. degrees in Economics and a B.S. degree in Managerial Economics. Qualified students in either major may participate in the Honors Program in Economics and may also consider a number of advanced degree options made available through the department and through the Graduate School of Industrial Administration or the H. John Heinz III School of Public Policy and Management.

The Major in Economics

The goal of economics is to understand the forces that determine the allocation of scarce resources among individuals in a society, both at a given time and through time. This is accomplished by first studying how individuals and groups of individuals (consumers, firms, government agencies, universities, etc.) determine their actions in response to the incentives and constraints they face. Economic analysis then proceeds to examine how the interaction of these agents in markets and political processes determines the way resources are allocated and distributed in the economy. Important areas of investigation deal with issues regarding specific markets, economy-wide employment and inflation levels, taxation and government activities, labor market policies, energy and pollution, and economic growth. Whatever the immediate focal point for reading and discussion, economics courses typically share a common concern with helping students combine rigorous analysis with relevance to current issues. The more advanced economic analysis presented in the upper-level courses makes use of techniques from mathematics and statistics.

The professional economist requires a broad knowledge of the world as well as the tools with which to apply this knowledge. The curriculum in Economics reflects both of these requirements. The H&SS General Education Program introduces the student to ideas in the humanities, arts, and sciences. The courses in mathematics and statistics provide the requisite methods of analysis, and the economics courses integrate this material into a fundamental understanding of decision making and resource allocation in our economy.

The careers of Economics majors tend to follow one of three patterns. Economics provides excellent preparation for post-graduate professional training, especially in law, business administration, and public administration. The broad understanding of important economic issues and the strategies for solving problems that students of economics obtain provide a background preferred by many graduate schools over the narrower training of pre-professional undergraduate curricula. A second path leads directly to employment with business, government agencies, or consulting firms. This path may lead to a career as an economic analyst. In addition, many firms offer management training programs which the Economics major can enter upon graduation. Finally, some Economics majors elect to pursue a Ph.D. in Economics. The tracks within the Economics major enable students to develop programs oriented to their particular career goals.

Curriculum

The Economics Department offers the Economics major as either a B.A. or a B.S. degree. Most individuals who major in Economics have not made that decision at the time they first enroll at the university. Only after their first exposure to economic analysis in the introductory course, 73-100, Principles of Economics, do many students elect to major in Economics. Students who do not follow the curriculum initially should not be hesitant about considering Economics as a major. Each major arranges his or her curriculum individually through consultation with a faculty adviser.

The required courses develop the economic concepts and analytical methods that are fundamental to the study of problems in economics. Flexibility in choice of electives permits the student to build on this foundation and pursue particular issues in depth. By careful selection of electives, the student can study several facets of a particular problem area and, at the same time, gain sophistication in application of economic reasoning.

All students wishing to major in Economics (as either a B.A. or a B.S.) are strongly advised to complete their introductory calculus sequence in the freshman year. B.S. candidates in Economics are also required to take 21-257, Optimization for the Social Sciences, and are urged to do so during the sophomore year. In addition, all Economics major candidates are advised to take, if they are able, 21-121 (Calculus) and 21-259 (Calculus in Three Dimensions) in place of 21-111/112 as their introductory calculus sequence.

All prospective Economics majors complete two introductory statistics courses — one as part of the H&SS General Education Program, and the second as a major requirement. Two sequences are available: 36-201 (Statistical Reasoning) and 36-202 (Introduction to Statistical Methods), or 36-225-36-226 (Introduction to Probability and Statistics I-II). Prospective majors should complete the first (General Education) statistics course in the fall, and the second in the spring, of the first year. Students who take 36-201/202 should also plan to take the two-course sequence in Econometrics (73-260/360). Alternatively, students who elect to take the 36-225/226 statistics sequence can skip the first semester of Econometrics I (73-260).

In general, the more advanced calculus and statistics sequences provide better preparation for the more quantitative portions of the Economics curriculum. Students considering advanced degrees in Economics may wish to enhance their programs with additional courses in Mathematics. Prospective candidates should consult the Mathematics and Statistics departments, as well as their Economics advisor, for more information and details about these options.

In addition to lower division H&SS General Education requirements, all Economics majors must satisfy requirements in the following areas:

Mathematics and Statistics Prerequisites — 38 units

21-111	Calculus I or 21-121 Calculus (preferred)*
21-112	Calculus II or 21-259 Calculus in Three Dimensions (preferred)*
21-257	Optimization for the Social Sciences (B.S. only) **
36-202	Introduction to Statistical Reasoning* (prerequisite: 36-201) or 36-226 (Introduction to Probability and Statistics II [preferred; prerequisite: 36-225])

* to be taken in freshman year, if possible.

** to be taken in sophomore year, if possible, after completing 21-112 or 21-259.

Economics Requirements — 72 units

73-100	Principles of Economics*
73-250	Intermediate Microeconomics
73-300	Intermediate Macroeconomics
73-260	Econometrics I (may be waived with 36-225/226)
73-360	Econometrics II

Plus four additional upper-level Economics electives (73-3xx or above).

* May be taken as part of the H&SS General Education Program.

Humanities Requirements (B.A. only) — 27 units

A three-course depth sequence in English, history, or philosophy. B.A. candidates must see their Economics advisor to plan an integrated sequence.

Economics, B.A. and B.S.
(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Intermediate Micro-economics** 73-250	Intermediate Macro-economics 73-300	Economics Elective 73-xxx	Economics Elective 73-xxx
Econometrics I 73-260	Econometrics II 73-360	Economics Elective 73-xxx	Elective
Elective	Economics Elective 73-xxx	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective or Humanities Course (B.A.)	Elective or Humanities Course (B.A.)	Elective or Humanities Course (B.A.)

* NOTE: This "suggested" curriculum schedule is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

**Students planning on majoring in Economics may wish to consult their Economics Department advisor about taking Principles of Economics (73-100) before the middle of the sophomore year and Intermediate Microeconomics (73-250) before the start of the junior year.

Degree Requirements

H&SS General Education requirements	(min.) 108 units
H&SS College Degree requirement	(min.) 18 units
Mathematics & Statistics requirements (B.S.)	38 units
Mathematics & Statistics requirements (B.A.)	29 units
Economics Major requirements	72 units
Humanities requirements (B.A. only)	27 units
Free Electives (B.S.)	(max.) 124 units
Free Electives (B.A.)	(max.) 91 units
Degree Requirements (minimum)	**360 units**

Double Majors
All Economics Department requirements for the double major in Economics (B.A. or B.S.) are the same as those for students obtaining the major in Economics.

The Major in Managerial Economics
The Managerial Economics major is designed for students who plan to pursue advanced professional education, particularly in law, business, or public administration. This major also provides excellent preparation for students who plan to pursue a career in business or public administration immediately upon graduation.

The program in Managerial Economics has been designed with two broad objectives in mind. One objective is to equip the student with the methods of economic analysis and the skills required to use those methods to analyze problems and make decisions. The other objective is to enable the student to understand the functioning both of the aggregate economy and also of individual markets in the economy. These two goals are complementary.

The Managerial Economics major provides a particularly desirable background for students planning to pursue advanced professional education in law, business, or public administration. In law, economic issues arise in the study of contracts, property rights, antitrust policy, regulation, and a host of other areas. Because legal and economic issues are intimately related, the conceptual framework and methodology learned in the study of economics prove to be excellent preparation for the study of law. Economics is also an integral part of most advanced degree programs in business and public administration. In addition, the methodology of economics increasingly serves as the foundation for the study of important functional areas of management including finance, accounting, and marketing. Consequently, the analytic training and broad conceptual framework obtained through the study of economics provide ideal preparation for advanced professional education in business and public administration.

Curriculum
All students wishing to major in Managerial Economics are strongly advised to complete their introductory calculus sequence in the freshman year, and 21-257, Optimization for the Social Sciences, during the sophomore year. In addition, all Managerial Economics major candidates are advised to take, if they are able, 21-121 (Calculus) and 21-259 (Calculus in Three Dimensions) in place of 21-111/112 as their introductory calculus sequence.

All prospective Managerial Economics majors complete two introductory statistics courses — one as part of the H&SS General Education Program, and the second as a major requirement. Two sequences are available: 36-201 (Statistical Reasoning) and 36-202 (Introduction to Statistical Methods), or 36-225-36-226 (Introduction to Probability and Statistics I-II). Prospective majors should complete the first (General Education) statistics course in the fall, and the second in the spring, of the first year. Students who take 36-201/202 should also plan to take the two-course sequence in Econometrics (73-260/360). Alternatively, students who elect to take the 36-225/226 statistics sequence can skip the first semester of Econometrics I (73-260).

In general, the more advanced calculus and statistics sequences provide better preparation for the more quantitative portions of the Managerial Economics curriculum. Students considering advanced degrees in Economics may wish to enhance their programs with additional courses in Mathematics. Prospective candidates should consult the Mathematics and Statistics departments, as well as their Economics advisor, for more information and details about these options.

In addition to lower division H&SS General Education requirements, all Managerial Economics majors must satisfy requirements in the following areas:

Mathematics and Statistics Prerequisites — 38 units

21-111	Calculus I or 21-121 Calculus (preferred)*
21-112	Calculus II or 21-259 Calculus in Three Dimensions (preferred)*
21-257	Optimization for the Social Sciences (B.S. only) **
36-202	Introduction to Statistical Reasoning* (prerequisite: 36-201) or 36-226 ((Introduction to Probability and Statistics II [preferred; prerequisite: 36-225])

* to be taken in freshman year, if possible.

** to be taken in sophomore year, if possible, after completing 21-112 or 21-259.

Economics Requirements — 72 units

73-100	Principles of Economics*
73-250	Intermediate Microeconomics
73-300	Intermediate Macroeconomics
73-260	Econometrics I (may be waived with 36-225/226)
73-360	Econometrics II

Plus four additional upper-level Economics electives (73-3xx or above).

* May be taken as part of the H&SS General Education Program.

Industrial Management Requirements — 27 units
Choose three of the following:

70-122	Introduction to Accounting
70-311	Organizational Behavior I
70-312	Organizational Behavior II
70-381	Marketing
70-481	Marketing Research I
70-391	Finance I
70-393	Financial Analysis and Security Trading I
70-394	Financial Analysis and Security Trading II
70-491	Finance II
70-371	Production I
70-451	Management Information Systems
70-471	Production II

Managerial Economics, B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Intermediate Micro-economics** 73-250	Intermediate Macro-economics 73-300	Economics Elective 73-xxx	Economics Elective 73-xxx
Econometrics I 73-260	Econometrics II 73-360	Economics Elective 73-xxx	Elective
IM Elective**+	Economics Elective 73-xxx	IM Elective**	IM Elective**
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" curriculum schedule is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program can be completed in as few as two years; not that it must be. Students may enter their major, and begin major course requirements, as early as the start of the sophomore year, and in some instances in the first year. Students should consult their advisor when planning their program.

++Students planning on majoring in Managerial Economics may wish to consult their Economics Department advisor about taking Principles of Economics (73-100) before the middle of the sophomore year and Intermediate Microeconomics (73-250) before the start of the junior year.

**These 70-xxx electives must be drawn from the "Industrial Management Requirements" list presented in the Managerial Economics "Curriculum" section above.

Degree Requirements

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Mathematics & Statistics requirements		38 units
Major requirements		99 units
Free Electives	(max.)	97 units
Degree Requirements (minimum)		**360 units**

Double Majors

All Economics Department requirements for the double major in Managerial Economics are the same as those for students obtaining the major in Managerial Economics. Students whose primary major is in the Department of Industrial Management who wish to carry a double major in the Department of Economics, and students whose primary major is in the Department of Economics who wish to carry a double major in Industrial Management, should note the following: students are not allowed to count towards the degree in Managerial Economics any courses which are required for the degree in Industrial Management. It is advisable, therefore, for students who wish to pursue both majors to select Economics rather than Managerial Economics.

The Honors Program

The Honors Program in the College of Humanities and Social Sciences provides recognition of outstanding students in all H&SS departments, including the Economics Department. By participation in the program, students have the opportunity to develop their skills in applying economic analysis through completion of an honors thesis. By completing the thesis during the senior year, the student earns 18 units of credit and qualifies for graduation with "College Honors." To qualify for the Honors Program and the honors degree the student must maintain a quality point average of 3.5 in the major and a 3.25 overall and be invited by the college to become a participant.

Advanced Degree Programs

The Economics Department offers several options for majors planning to pursue an advanced degree. The options provide preparation for entry into advanced degree programs at Carnegie Mellon or other universities. In addition, programs developed in conjunction with the Graduate School of Industrial Administration (GSIA) and the H. John Heinz III School of Public Policy and Management enable the student to shorten by one year the period of time required to obtain an advanced degree. For additional information about these programs, refer to the GSIA and Heinz sections of this catalog.

The Ph.D. Track

Qualified students in Economics or Managerial Economics may wish to pursue the Ph.D. track in Economics. Subject to the approval of the head of the Economics Ph.D. program, students may take first-year Ph.D. courses in economics in GSIA. These courses may be applied to meet course requirements for the Economics or Managerial Economics major.

These courses provide excellent preparation for students who wish to obtain a Ph.D. in Economics or other social sciences as well as in accounting, systems, finance, and marketing. The academic record of students successfully completing these courses will provide evidence of performance that will be favorably considered should students apply for admission to the Ph.D. program in Economics, Political Economy, or other areas in GSIA, or to Ph.D. programs in H&SS or the Heinz School of Public Policy and Management. Completion of courses in the Ph.D. track would also place students in a strong competitive position when applying to graduate programs at other institutions. To qualify for the Ph.D. track, students should plan to complete the following undergraduate course sequence in mathematics and statistics:

Mathematics

21-121	Calculus
21-259	Calculus in Three Dimensions

Statistics

36-225	Probability and Statistics I
36-226	Probability and Statistics II

After completion of 73-250 (Intermediate Microeconomics), the student may apply for the Ph.D. track. If accepted, the student should then plan a program of study in consultation with the departmental adviser. Graduate courses may be substituted to meet some or all of the remaining economics course requirements for the Economics or Managerial Economics major.

Faculty

RICHARD M. CYERT, Professor of Economics and Industrial Administration — Ph.D., Columbia University; Carnegie Mellon, 1948—.

W. ROBERT DALTON, Adjunct Professor of Industrial Administration — Ph.D., University of Missouri; Carnegie Mellon, 1985—.

DENNIS N. EPPLE, Professor of Economics — Ph.D., Princeton University; Carnegie Mellon, 1974—.

STEVEN KLEPPER, Professor of Economics and Social and Decision Sciences — Ph.D., Cornell University; Carnegie Mellon, 1980—.

PRAVEEN KUMAR, Associate Professor of Economics and Finance — Ph.D., Stanford University; Carnegie Mellon, 1985—.

FINN KYDLAND, Professor of Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977—.

LESTER B. LAVE, James H. Higgins Professor of Economics — Ph.D., Harvard University; Carnegie Mellon, 1963—.

ALBERT MARCET, Adjunct Professor of Economics — Ph.D., University of Minnesota; Carnegie Mellon, 1986—.

BENNETT T. McCALLUM, H. J. Heinz Professor of Economics, Department of Economics — Ph.D., Rice University; Carnegie Mellon, 1981—.

TIMOTHY W. McGUIRE, Professor of Management and Economics — Ph.D., Stanford University; Carnegie Mellon, 1964-79, 1981—.

ALLAN H. MELTZER, John M. Olin University Professor of Political Economy and Public Policy — Ph.D., University of California, Los Angeles; Carnegie Mellon, 1957—.

ROBERT A. MILLER, Associate Professor of Economics — Ph.D., University of Chicago; Carnegie Mellon, 1982—.

KEITH T. POOLE, Professor of Political Economy — Ph.D., University of Rochester; Carnegie Mellon, 1982—.

GARY M. QUINLIVAN, Visiting Assistant Professor of Industrial Administration — Ph.D., State University of New York at Albany; Carnegie Mellon 1989—.

FREDERICK H. RUETER, Adjunct Professor of Industrial Administration — Ph.D., Carnegie Mellon; Carnegie Mellon, 1988—.

DUANE J. SEPPI, Associate Professor of Financial Economics — Ph.D., University of Chicago; Carnegie Mellon, 1986—.

KATHRYN L. SHAW, Associate Professor of Economics — Ph.D., Harvard University; Carnegie Mellon, 1981—.

RUSSELL W. SHELDON, Adjunct Professor of Industrial Administration — Ph.D., Cornell University; Carnegie Mellon, 1988—.

FALLAW B. SOWELL, Associate Professor of Economics — Ph.D., Duke University; Carnegie Mellon, 1988—.

CHESTER S. SPATT, Professor of Economics and Finance — Ph.D., University of Pennsylvania; Carnegie Mellon, 1979—.

STEPHEN E. SPEAR, Professor of Economics and Head, Department of Economics — Ph.D., University of Pennsylvania; Carnegie Mellon, 1982—.

SANJAY SRIVASTAVA, Professor of Economics and Finance — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1982—.

CHRIS I. TELMER, Assistant Professor of Financial Economics — Ph.D., Queen's University (Canada); Carnegie Mellon, 1992—.

CHENG WANG, Assistant Professor of Economics — Ph.D., University of Western Ontario (Canada); Carnegie Mellon, 1994—.

AMIR YARON, Assistant Professor of Economics and Finance — Ph.D., University of Chicago; Carnegie Mellon, 1994—.

HAROLD H. ZHANG, Assistant Professor of Economics — Ph.D., Duke University; Carnegie Mellon, 1994—.

STANLEY E. ZIN, Associate Professor of Economics and Finance — Ph.D., University of Toronto; Carnegie Mellon, 1988—.

Department of English

David Kaufer, Department Head
Kristina Straub, Associate Head
Department Office: Baker Hall 259

The Department of English offers degrees in Creative Writing, Literary and Cultural Studies, and Rhetorical Studies (with separate majors in Professional Writing, Technical Writing, and Rhetoric). Students learn in their creative writing courses how to draw upon their experiences and talents to produce literary responses to the world we live in. In their literary and cultural studies courses, they study ways in which literary and other cultural productions have been made use of across history and cultures. They learn, finally, in their rhetorical studies courses how literate activities such as writing and reading are, and have been, used to discover judgments and create arguments for use in the conduct of public life. All majors in English are structured to allow students to balance liberal and professional interests.

Undergraduates in any department within CMU have the opportunity to consider a variety of graduate programs in English. Our Masters level courses appeal to a variety of interests: students interested in a writing career in government or industry receive advanced training in our Masters in Professional Writing (MAPW) program; students with more academic interests who have yet to be introduced to literary and cultural or rhetorical studies or who are still considering doctoral work look to our Masters program both to acquaint themselves with and to prepare themselves for research careers in English; other students take advantage of the flexibility of our Masters offerings, to a large extent tailoring their own programs of study. The best of our Masters candidates may request consideration for either of the department's Ph.D. programs, and will be, in any case, well prepared for graduate work no matter where they chose to go. **Students interested in doctoral work in Rhetorical Studies or Literary and Cultural Theory should contact the Department Head directly for further information.**

Majoring in English: How the Curriculum is Structured

1. The Departmental Core — 27 units

Students majoring in any of the English Department's programs take a common core of 3 courses, one each in the disciplinary areas of the department: creative writing, literary and cultural studies, and rhetorical studies.

76-26x	Study of Forms
76-294	Literary and Cultural Studies Core
76-293	Rhetorical Traditions

2. Major Options

Students can choose one of several different majors within the department, or they can combine majors — double majoring in Professional and Creative Writing, for instance, or in Professional Writing and Literary and Cultural Studies, or in a departmental major and a second major outside the department. In addition, students can do a single major in any of the departmental areas, and add a series of courses from any combination of the other programs in the department. Detailed information on the options for majoring in English are given below under the headings:

The Major in Literary and Cultural Studies
The Majors in Rhetorical Studies
  a) The Major in Rhetoric (B.A. degree)
  b) The Major in Professional Writing (B.A. degree)
  c) The Major in Technical Writing (B.S. degree).
The Major in Creative Writing

Also consult this catalog for information on **double majoring**.

All English majors must complete the H&SS General Education requirements. In addition, all English majors take the 27-unit departmental core. English majors must then take further required courses, unique to their program(s), to complete their major. These required courses consist of selections from 3 sets of courses, listed below:

1) A set of "Courses for the Major," designed explicitly for the major (designated, for example, as "Courses for the Major in Literary and Cultural Studies", "Courses for the Major in Professional Writing", "Courses for the Major in Creative Writing" and so on). (36-54 units) [NOTE: applies to all English majors]

2) A set of "English Courses," approved by the student's advisor, and designed to complement the student's major. (36 units; this set of courses is also relevant for students who wish to double major within the English Department — see the section on double majoring below. [NOTE: this set of courses does not apply to Technical Writing majors.])

3) A set of "Non-English Courses," approved by the student's advisor, and designed to complement the student's major. (36 units) [NOTE: This set of courses does not apply to the Creative or Technical Writing majors. The Creative Writing major has no "Non-English" course requirement, while the Technical Writing major (as a B.S. degree) requires a unique and much larger number of non-English courses (in mathematics, science, technology, and design) to complete the major. See the descriptions and curriculum outlines for the Creative and Technical Writing majors for further details.]

In sum, all English majors take, within the English Department, at least 72 units of required courses beyond the H&SS General Education Program (27 units of departmental core plus 36 units in "Courses for the Major.") Majors in Literary and Cultural Studies are required to take one further course, "Cultures/Values/Texts" [9 units]. Majors in Literary and Cultural Studies, Professional Writing, and Rhetoric must take four additional English courses for a total of 99-117 English units. Majors in Literary and Cultural Studies and Professional Writing and Rhetoric are also required to take four non-English courses associated with their major for a total of 126-144 required units beyond the H&SS General Education Program.

4) Electives refer to English or non-English courses that are not required to complete the student's major, but that nonetheless count toward the minimum number of units (360) a student needs to graduate. Every English major is designed to allow students a wide range of free electives in their programs of study [approximately 68-95 units of free electives for Literary and Cultural Studies and Professional Writing, and Rhetoric, 71 units for Technical Writing majors and 126 units for Creative Writing majors. (Note: These figures, as do all the figures in this catalogue, assume each course is taken for 3 hours (9 units). Courses taken for four hours (12 units) decrease the remaining number of a student's free elective units] The English Department encourages double majoring and, for this, students need to consult closely with one's advisor about use of free electives. [See the section on "double majoring" below.]

The Major in Literary and Cultural Studies

The Literary and Cultural Studies program examines traditional literary texts as well as "texts" that many English departments are now recognizing the need to include: the work of English and American women and minorities, non-Western, non-Anglophone and post-colonial literatures, as well as non-literary texts such as television, film, advertising, popular writings, and so on. Semiotic, historical, social, and cultural approaches to "texts" have opened new directions and implications for the future of literary studies.

Students who choose this major will find an interesting interdisciplinary focus and a rigorous examination of contemporary theories and methodologies. Students learn to become expert in reading, analyzing, and interpreting "texts" of all kinds, and they learn the writing strategies and research skills necessary to produce texts of their own. Such training can prepare students not only for graduate work but also for other professions, such as the law, which require similar skills.

Curriculum

In addition to satisfying all of the H&SS General Education and College degree requirements for B.A. candidates, Literary and Cultural Studies majors must fulfill requirements in the following areas:

English Core (all required) **27 units**

76-26x	Study of Forms
76-294	Literary and Cultural Studies Core
76-293	Rhetorical Traditions

Courses for the Major in Literary and Cultural Studies - Category 1 - 36 units

Four courses: 300-level, and at least one 400-level course. With their advisors, students should select 300- and 400-level courses so as to form a concentrated grouping of courses in areas like the following: literature, literary theory or criticism, cultural studies, gender, media, cultural criticism.

Course for the Major in Literary and Cultural Studies - Category 2 - 9 units

76-437	Culture, Value, Texts

Other English Courses **36 units**

Four more courses from the department's offerings: one 200- or 300-level, two 300-level, one 400-level. Students are urged to take a wide range of courses so as to broaden their understanding of the subject. With their advisors students should select courses in literature, literary theory, literary criticism, linguistics and rhetoric.

Non-English Courses **36 units**

Literary and Cultural Studies majors are required to diversify their knowledge of other fields by taking courses outside of the English Department in the humanities, fine arts, foreign languages, social sciences, or industrial management. With their advisors they should consider grouping at least two courses in a single area, such as: history, the arts, philosophy, foreign languages, political science, and law-related studies.

Literary and Cultural Studies, B.A.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Study Forms 76-26x	LCS Course 76-xxx	LCS Course 76-3xx or 76-4xx	Elective
Rhetorical Traditions 76-293	LCS Course 76-xxx	English Course 76-xxx	LCS Course 76-3xx or 76-4xx
Literary & Cultural Studies Core 76-294	English Course 76-xxx	English Course 76-xxx	Non-English Course
Elective	Elective	Non-English Course	Culture, Value, Texts 76-437
Non-English Course	Non-English Course	Elective	English Course 76-xxx

* NOTE: This "suggested" schedule 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.

Degree Requirements

The Literary and Cultural Studies major is offered as a B.A. degree.

H&SS General Education requirements	(min.) 108 units
H&SS College Degree requirement	(min.) 18 units
Literary and Cultural Studies Major Requirements*	144 units
Free Electives	(max.) 95 units
Degree Requirements (minimum)	**360 units**

* Includes "English Core," "Other English Courses," and "Non-English Courses."

The Majors in Rhetorical Studies

Rhetoric has been a touchstone of a liberal arts education since ancient and medieval times. The study of rhetoric involves the study of literate inquiry as well as the study of communication as a problem-solving activity. Rhetorical studies seek to create knowledge about the processes and products of literate activities, particularly writing and reading but also speaking and listening. Rhetoric is studied from many vantage points: philosophical and historical theories of composing and style; historical theories of literacy; prescriptive grammar; processes of revision; linguistics and discourse analysis; socio-cognitive theories of the composing process; observation-based research on writing in specific contexts; theories of reading; document design; theories of argument; the relation of verbal and visual information; computer-aided writing and reading; and the effect of computers on composing and revision.

There are three distinct majors in Rhetorical Studies: Rhetoric, Professional Writing, and Technical Writing. NOTE: Students in one rhetorical studies major may **not** major in another.

The Major in Rhetoric

The major in Rhetoric is designed primarily for students who wish to go to graduate school to study rhetoric as an academic, research discipline. It also serves well as a liberal arts degree, since the curriculum is made up of courses not only in rhetoric (again, one of the oldest of the liberal arts) but also literature, history, philosophy, language, and linguistics. Students in this major gain significant practice in historical, empirical, cognitive, linguistic, educational, computational social approaches to the study of literate behavior. Majors learn about reading and writing as cultural activities, from ancient Greece to modern day classrooms. Rhetoric is an excellent major for pre-law students or students who want a career requiring the production and analysis of public policy arguments.

Curriculum

In addition to satisfying all of the H&SS General Education and College degree requirements for B.A. candidates, Rhetoric majors must fulfill requirements in the following areas:

English Core (all required) **27 units**

76-26x	Study of Forms
76-294	Literary and Cultural Studies Core
76-293	Rhetorical Traditions

Courses for the Major in Rhetoric **45 units**

Students draw five courses from three categories, listed below:

Courses for the Major in Rhetoric- Category 1

(both required; 18 units)

76-374	Argument
76-371	Rhetoric in Social Interaction

Courses for the Major in Rhetoric - Category 2

(Choose one; 9 units)

76-378	Rhetoric and the Writing Process
76-388	Rhetoric and the Reading Process
76-385	Introduction to Discourse Analysis

Courses for the Major in Rhetoric- Category 3

(Choose two; 18 units)

Students majoring in rhetoric must take at least two courses in the history of rhetoric beyond the "Rhetorical Traditions" core course. This list includes Historical Perspectives on Rhetorical Theory, courses that study major figures in the history of rhetoric and courses that study various theoretical issues in the history of the discipline. Orality and Literacy, Christian Rhetoric, Medieval Rhetoric, Renaissance Rhetoric, and rhetoric of the Romantic revolution also fill this requirement.

Other English Courses **36 units**

Four more courses from the department's offerings: These should include 200-, 300-, and 400-level courses with no more than one course at the 200 level. With their advisors students should select courses in literature, literary theory, literary criticism, linguistics, creative writing, and rhetoric.

Language Requirement — 18 units

Students electing the Rhetoric major must take at least two courses in a single foreign language. Students who are interested in the Rhetoric major are encouraged to fulfill this requirement as part of their course selection for the H&SS General Education program and/or College BA degree requirement.

Non-English Courses — 18 units

Rhetoric majors must take a depth sequence in social history, psychology, philosophy, social and decision sciences, modern languages, computer science or some other discipline related to rhetoric. A depth sequence involves at least two courses in one discipline other than English. The depth sequence should be chosen in close consultation with the student's advisor.

Rhetoric, B.A.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Study of Forms 76-26x	Argument 76-374	Rhetoric Course Category 3	English Course
Rhetorical Traditions 76-293	Rhetoric in Social Interaction 76-371	Elective	Elective
Literary & Cultural Studies Core 76-294	Rhetoric Course Category 3	English Course 76-3xx	Non-English Depth Course
Rhetoric Course Category 2	Non-English Depth Course	English Course	English Course
Elective	Elective	Language Requirement (if not taken in Gen Ed)	Language Requirement (if not taken in Gen Ed)

* NOTE: This "suggested" schedule 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.

Degree Requirements

The Rhetoric major is offered as a B.A. degree

H&SS General Education requirements	(min.) 108 units
H&SS College Degree requirement	(min.) 18 units
Rhetoric Major Requirements	144 units
Electives	(max.) 95 units
Degree Requirements (minimum)	**360 units**

The Major in Professional Writing

Professional Writing is a career-oriented major designed for students interested in acquiring the professional skills necessary for successful careers as writers and communications specialists in a range of fields: publishing, government, law, journalism, health care, community and non-profit groups, education, corporate communications, finance, and the arts.

Situated within Carnegie Mellon's Rhetorical Studies program, the major is designed to develop writers with both the professional skills needed to negotiate current work contexts and the perspective and flexibility to keep pace with cultural and technological changes. Professional Writing majors take the core in rhetorical studies and then a cluster of advanced writing and rhetoric courses designed to integrate theory with practice. Special topic courses— corporate communications, journalism, medical writing, software documentation, journalism, science writing — reflect the options open to professional writers. Additionally, students choose a "Professional Concentration" in a discipline related to their writing interests, e.g., graphic design, graphic communications, organizational theory, statistics, political science (including relevant courses in history and social psychology), foreign languages (at least intermediate-level courses), social science, psychology, computer science, the fine arts, and literary and cultural studies.

Various opportunities are made available to students through campus publications, internships, and other writing-related employment on and off campus to gain professional experience and to accumulate a portfolio of professional-quality writing samples. The weekly campus newspapers, The Tartan and the Student Union, both completely student-run, provide opportunities for students to publish 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 newspaper, Focus.

Professional Writing majors who maintain a B average in rhetorical studies courses generally undertake writing internships during their senior year. Available internships in advertising, medical writing, publishing, finance, technical and public service organizations, and public relations exemplify the kinds of employment options that Professional Writing majors have taken after graduation. Internships have been arranged on campus with the Alumni Association, the Sports Information Office, Public Relations, Admissions, Carnegie Mellon's Robotics Institute, the Center for the Design of Educational Computing, and the College of Computer Science. Professional Writing majors have also served as interns off campus at various Pittsburgh businesses and organizations including Westinghouse Electric, Creamer Dickson Basford, Ketchum MacLeod and Grove, KDKA television and radio, WIIC television, Catholic Charities, WQED television, and Allegheny General Hospital. In addition to providing approximately 100 hours of professional experience, these internships help students establish contacts outside the University and add professional publications to their portfolios.

Curriculum

In addition to satisfying all of the H&SS General Education and College degree requirements for B.A. candidates, Professional Writing majors must fulfill requirements in the following areas:

English Core (all required) — 27 units

76-26x	Study of Forms
76-294	Literary and Cultural Studies Core
76-293	Rhetorical Traditions

Courses for the Major in Professional Writing — 54 units

(4 courses)

Students must take the three courses listed in Category 1. Choose one course from Category 2, and an additional 18 units from Category 3.

Courses for the Major in Professional Writing - Category 1

(all required; 27 units)

76-271	Introduction to Professional and Technical Writing
76-374	Argument
76-371	Rhetoric in Social Interaction

Courses for the Major in Professional Writing - Category 2

(choose one; 9 units)

76-378	Rhetoric and the Writing Process
76-388	Rhetoric and the Reading Process
76-385	Introduction to Discourse Analysis

Courses for the Major in Professional Writing (Advanced Rhetoric and Writing) - Category 3

(Choose two; 18 units)

Professional Writing students select an additional list of two courses in rhetoric and writing. These options include but are not exhausted by:

76-378	Rhetoric and the Writing Process (if not chosen for Category 2)
76-388	Rhetoric and the Reading Process (if not chosen for Category 2)
76-385	Introduction to Discourse Analysis (if not chosen for Category 2)
76-380	Desktop Publishing
76-363	Planning and Testing Documents
76-372	Journalism I
76-425	Integrating Verbal and Visual Information
76-470	(Advanced) Professional and Technical Writing
76-472	Comparative Rhetoric
76-3xx	Special Topics Courses in Genres: Magazine Writing, Writing for the Marketplace, Medical Writing, Science Writing, Corporate Communications, Writing and Software Engineering
76-3xx	Special Topics Courses in Rhetoric
76-4xx	Writing and Working in Groups
76-301	Internship (3-18 units) (see advisor)

Other English Courses — 36 units

Four more courses from the department's offerings. These should include 200-, 300-, and 400-level courses with no more than one course at the 200 level. With their advisors students should select courses in literature, literary theory, literary criticism, linguistics, creative writing, and rhetoric.

Non-English Courses — 36 units

All Rhetorical Studies majors (exception: Technical Writing) are required to diversify their knowledge of other fields by taking courses outside of the English Department in the humanities, fine arts, foreign languages, social sciences, or industrial management. With their advisors they should consider grouping at least two courses in a single area, such as: history, the arts, philosophy, foreign languages, political science, and law-related studies. Professional Writing majors are encouraged to pick a "professional concentration" in areas related to their professional interests.

Professional Writing, B.A.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Study of Forms 76-26x	Argument 76-374	Elective	English Course
Rhetorical Traditions 76-293	Rhetoric in Social Interaction 76-371	Non-English Course	Advanced Rhetoric & Writing Course Category 3
Literary & Cultural Studies Core 76-294	Advanced Rhetoric & Writing Course Category 3	English Course	Non-English Course
Rhetoric Course Category 2	Non-English Course	English Course	English Course
Intro to Prof/Tech Writing 76-271	Elective	Non-English Course	Elective

* NOTE: This "suggested" schedule 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.

Degree Requirements

The Professional Writing program offers the B.A. degree.

H&SS General Education requirements	(min.) 108 units
H&SS College Degree requirement	(min.) 18 units
Professional Writing Major Requirements	152 units
Free Electives	(max.) 82 units
Degree Requirements (minimum)	**360 units**

The Major in Technical Writing

The Technical Writing major at Carnegie Mellon is the oldest undergraduate technical writing program in the country. Technical Writing is a career-oriented major for students interested in writing for technical fields. Technical writers design, write, and edit documents for engineering, scientific, industrial, and governmental organizations. These include technical reports, computer manuals, brochures, proposals, technical specifications, educational and training materials, and marketing or public relations releases. Often, technical writers serve as researchers, managers of writing projects, or liaison personnel among the research, production, and marketing components of an organization. For these challenging tasks, technical writers need analytic and writing skills, research and problem-solving abilities, and competence in science and technology.

The major in Technical Writing is highly structured. In the H&SS General Education Program, students begin their training in research, analysis, writing, and reading. They also begin acquiring knowledge of the physical sciences, mathematics, and statistics. Their work in the English core courses provides a background in larger issues that affect, in various ways, writers in the workplace.

Central to the program in Technical Writing are the writing courses taken beyond the H&SS General Education Program. These courses emphasize exposition, rhetorical studies, writing for specific audiences, and writing in the different forms of business and technical communication. Students who maintain a B average in writing courses usually take an internship during their senior year. The internship provides approximately 100 hours of professional experience as well as an exposure to the work technical writers will do after graduation.

Equally important to the training of technical writers are two courses in visual design and various courses in mathematics, science and technology. To fulfill their science and technology requirements, Technical Writing majors must have at least one course each in computer science, statistics, calculus, biology, chemistry, and physics; a second course in statistics or calculus; and four additional courses in any of these disciplines or in engineering. The total is eleven courses: four that are taken in (and may be simultaneously counted toward) the H&SS General Education Program (one in statistics, one in calculus, and two in physical/ natural science, engineering or computer science); two that may be simultaneously counted toward the College's 2-course science/mathematics/engineering degree requirement for B.S. candidates; and five others. In choosing their science and technical courses, students should go at least three courses deep in a single discipline; especially valuable are additional courses in computer science. This wide-ranging work in the humanities, natural sciences, technology, and social sciences helps to develop the skills, vocabularies, and methods of thinking that enable the accomplished writer to translate technical information into effective communication.

Students majoring in Technical Writing are able to draw on exceptional resources on and off campus to enhance their education. Most obvious are Carnegie Institute of Technology, Mellon College of Science, and the School of Computer Science, which offer in a highly motivated, professional atmosphere the courses the students need. Arrangements for writing internships have been made with various on- and off-campus corporations and organizations, such as Westinghouse Electric, Duquesne Systems, the Pittsburgh Press, Graphic Arts Technical Foundation, the Robotics Institute, Software Engineering Institute (SEI), the Center for the Design of Educational Computing (CDEC), and the Center for Art and Technology. Placement patterns after graduation reflect this diversity as well. Graduates of the Technical Writing program have been hired by organizations nationwide. Firms recently hiring Technical Writing graduates are AT&T, Intel, Digital Equipment, IBM, Data General, Westinghouse Electric, NCR Corporation, Apollo Computers, and Mellon Bank.

Curriculum

Because of the number of requirements in the Technical Writing major, students interested in the program are advised to begin required course work as soon as possible. In addition to satisfying all of the H&SS General Education Program and College degree requirements for B.S. candidates, Technical Writing majors must fulfill requirements in the following areas:

English Core (all required) — 27 units

76-26x	Study of Forms
76-294	Literary and Cultural Studies Core
76-293	Rhetorical Traditions

Courses for the Major in Technical Writing — 54 units

Technical Writing majors must take six "Courses For the Major" from two categories.

Courses for the Major in Technical Writing —Category 1

(both required; 18 units)

76-271	Professional and Technical Writing
76-470	(Advanced) Professional and Technical Writing

Courses for the Major in Technical Writing — Category 2

(Choose four; 36 units)

Technical writing students select an additional list of four courses in category 2, whose options include:

76-378	Rhetoric and the Writing Process
76-388	Rhetoric and the Reading Process
76-385	Introduction to Discourse Analysis
76-374	Argument
76-371	Rhetoric in Social Interaction
76-380	Desktop Publishing
76-363	Planning and Testing Documents

76-372	Journalism I
76-425	Integrating Verbal and Visual Information
76-470	(Advanced) Professional and Technical Writing
76-472	Comparative Rhetoric
76-3xx	Special Topics Courses in Genres: Magazine Writing, Writing for the Marketplace, Medical Writing, Science Writing, Corporate Communications, Writing and Software Engineering
76-3xx	Special Topics Courses in Rhetoric
76-4xx	Writing and Working in Groups
76-301	Internship (3-18 units) (see advisor)

Visual Design Courses — 9 units

(Choose one)

51-170	Graphic Design Fundamentals
70-160	Introduction to Graphics Communications I or other approved visual design course.

Science and Technology Courses — 45 units*

Technical Writing majors take a total of eleven courses in "science" and "technology," distributed as follows: at least one course each in computer science, statistics, calculus, biology, chemistry, and physics; a second course in statistics or calculus; and four additional courses in any of these disciplines or in engineering. Of these eleven courses, four may be taken in (and simultaneously counted toward) the College General Education Program (one in calculus, one in statistics, and two in a physical/natural science [or approved technology course] or computer science); two may be simultaneously applied toward the College's two-course degree requirement for B.S. candidates; the remaining five are taken as independent major requirements. In choosing their science and technical courses, students should go at least three deep in a single discipline.

* "45 units" in Science and Technology that are not being simultaneously applied toward any other College requirement (General Education or B.S. degree requirement).

Technical Writing , B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Study of Forms 76-26x	Visual Design	Biology 03-xxx	Statistics
Rhetorical Traditions 76-293	Category 2 Course	Chemistry 09-xxx	Science & Technology Requirement
Literary & Cultural Studies Core 76-294	Computer Science 15-xxx	Prof/Tech Writing 76-470	Science & Technology Requirement
Rhetoric Course Category 2	Category 2 Course	Physics 33-xxx	Science & Technology Requirement
Intro to Prof/Tech Writing 76-271	Calculus 21-xxx	Category 2 Course	Science & Technology Requirement

* NOTE: This "suggested" schedule 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.

Degree Requirements

The Technical Writing program offers the B.S. degree.

H&SS General Education requirements*	(min.)	108 units
H&SS College Degree requirement**	(min.)	18 units
Science and Technology courses in major+	(min.)	45 units
Visual Design major requirement		9 units
English requirements for the Major		90 units
Free Electives	(max.)	90 units
Degree Requirements (minimum)		**360 units**

* Including four courses (one each in statistics and calculus, and two in computer science, physical/natural science, or engineering) that can also be applied to Science and Technology requirements in the Technical Writing major.

** Both of these courses (required for all B.S. degree candidates in the College; to consist of courses in mathematics, statistics, physical/natural sciences, or computer science) may also be applied to the Science and Technology requirements in the Technical Writing major.

+ Five courses minimum; not including units for four courses taken to fulfill Science and Technology requirements in the H&SS General Education Program, and the two courses taken to fulfill the College degree requirement for B.S. candidates.

The Major in Creative Writing

In the Creative Writing program, students develop their talents in writing fiction, poetry, and other imaginative forms. While studying with faculty members who are practicing poets and fiction writers, Creative Writing majors explore the resources of their imaginations, sharpen their critical and verbal skills, and develop a professional attitude about their writing. Students also have the opportunity to work with other nationally known poets and fiction writers through the department's Visiting Writers series and part-time faculty appointments. Specially gifted students may write a Senior Project under the supervision of a faculty member.

Beginning with the H&SS General Education requirements, the curriculum for Creative Writing majors is designed to broaden the students' intellectual backgrounds, encourage their analytical abilities, and give them substantial exposure to their cultural heritage. English courses outside the Creative Writing major provide additional practice in the careful reading, writing and understanding of creative texts.

Students interested in the Creative Writing program are encouraged to take two introductory creative writing courses, Study of Forms: Fiction (76-260) and Poetry (76-265), in the sophomore year. In the junior and senior years, Creative Writing majors take four workshops in fiction, poetry, screenwriting, essay and biography; at least two workshops must be taken in a single form. In the writing workshops, students develop their critical and verbal abilities through close analysis of poems, stories, and other literary forms. Their work is critiqued and evaluated by peers and the faculty.

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 chapbooks of poems, scholarly works, and books of poetry by young American poets. Students may submit their work for publication to the Oakland Review, a Carnegie Mellon University-sponsored annual journal, and to *Dossier* (the literary supplement to the weekly student newspaper, The Tartan), the weekly student newspaper. Creative Writing majors have served on The Tartan staff as editor, business manager, and reporters. They also have opportunities to read their works in a series of readings by student writers and nationally known poets and novelists in a coffeehouse setting. Additionally, the Creative Writing program (through the English Department and in cooperation with the 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 Prize for poetry.

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 valuable experiences for planning their future. After graduation, most Creative Writing majors have gone on to graduate writing programs or to writing careers in publishing, public relations, or advertising.

Curriculum

English Core (all required) — 27 units

76-26x	Study of Forms
76-294	Literary and Cultural Studies Core
76-293	Rhetorical Traditions

Courses for the Major in Creative Writing:

Prerequisites for Workshop Courses: — 9 units

Creative Writing majors must take Study of Forms: Fiction (76-260) or Poetry (76-265) before taking creative writing workshops in those forms. The Study of Forms course taken in this category must be in addition to the Study of Forms course taken in the English core.

Creative Writing Workshops — 36 units

Four creative writing workshops, at least two in a single genre:

76-461	Fiction Workshop
76-462	Fiction Workshop
76-365	Beginning Poetry Workshop
76-465	Advanced Poetry Workshop
76-466	Advanced Fiction Workshop
76-467	Autobiography Workshop
76-468	Novel Workshop
76-469	Screenwriting Workshop
76-3xx/76-4xx	Elective Workshops (various forms)

Other English Courses — 36 units

Four more courses from the department's offerings: one 200- or 300-level, two 300-level, one 400-level. Students are urged to take a wide range of courses so as to broaden their understanding of the field. With their advisors students should select courses in literature, literary theory, literary criticism, linguistics, and rhetoric.

Creative Writing, B.A.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Study of Forms:Fiction 76-260 or Poetry 76-265**	Study of Forms 76-26x	English Course 76-xxx	English Course 76-xxx
Rhetorical Traditions 76-293	Elective	English Course 76-xxx	Creative Writing Workshop 76-36x/46x
Literary & Cultural Studies Core 76-294	English Course 76-xxx	Creative Writing Workshop 76-36x/46x	Elective
Elective	Creative Writing Workshop 76-36x/46x	Creative Writing Workshop 76-36x/46x	Elective
Elective	Elective	Elective	Elective*

NOTE: This "suggested" schedule 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.

** It is suggested for prospective Creative Writing majors that, if possible, these Survey of Forms courses be taken before the junior year.

Degree Requirements

The Creative Writing program offers the B.A. degree.

H&SS General Education requirements	(min.) 108 units
H&SS College Degree requirement	(min.) 18 units
Professional Writing Major Requirements	108 units
Free Electives	(max.) 126 units
Degree Requirements (minimum)	**360 units**

Double Majors

A double major enables students to supplement their primary studies with a coherent investigation of other theories and ways of viewing the world. It also enables students to acquire skills in at least two areas of study and to integrate vocabularies, analytical methods, and problem-solving techniques.

The English Department accommodates various double major arrangements. They fall into three categories: (1) English majors who fulfill the requirements of two or more English Department major programs (e.g., Literary & Cultural Studies and Professional Writing, Professional Writing and Creative Writing); (2) English majors who fulfill requirements for a second major in another department in addition to their major program in the English Department (e.g., Literary & Cultural Studies and Social History, Professional Writing and Psychology); and (3) majors from other departments who fulfill requirements for one or more English programs in addition to their major program within their own department (e.g., Applied History and Professional Writing, Chemistry and Technical Writing, Art and Creative Writing, History and Literary & Cultural Studies).

Double Majors in English Programs

Students majoring in two or more English Department programs must fulfill the "Courses for the Major" requirements of both programs. The English Core is common to all programs. Each of the majors requires a particular set of Courses for the Major. To double major, students use English course requirements (from set 2 of required courses [see "Majoring in English: How the Curriculum is Structured," section 2]) and free electives to complete the "Courses for the Major" for the second major. Thus, for example, a student double majoring in Professional Writing (1st major) and Literary & Cultural Studies (2nd major) would be required to fulfill the requirements of Professional Writing AND complete all the courses in the "Courses for the Major" for Literary & Cultural Studies. English majors planning to double major in two or more English programs should notify their advisor as soon as possible so that they can be sure to fulfill the requirements in each program. Students in one rhetorical studies major may Not major in another.

English Majors Double Majoring in Another Department

English majors who also want to fulfill a major in another department should contact the Associate Department Head or Coordinator for Undergraduate Studies for that other department to file a double major application form and be assigned an advisor from their second major department. They should also notify their English Department advisor of their intent to double major in another department.

Students in Other Departments Double Majoring in English

Students in other departments who want to double major in English should contact either the Coordinator for Undergraduate Studies or the Associate Department Head to file a double major application form and to work out specific program requirements for their English major. Any course that fulfills requirements in both departments need not be duplicated for the requirement in the English program. For example, a Biological Sciences major who wants to double major in Technical Writing can count science courses required for the Biological Sciences major to fulfill the science and technology requirements in the Technical Writing major program; such a student, however, would still have to satisfy the specific distribution of Science and Technical courses that the Technical Writing major requires, in addition to taking the program's required English Core courses (3), Advanced Writing courses (5), a rhetoric or linguistics course (1), and visual design course (1).

Minor in English

The English Department also offers a minor in English, with concentration options that correspond to the Department's major options. The minor requires a minimum of five courses (min. 45 units), plus completion of (or credit for) the University's designated writing requirement. The minor in English is available to any undergraduate student at the University.

Curriculum

Prerequisite — 9 units

Designated writing course (or equivalent in transfer, AP, or IB credit)

Second-Level Courses — 18 units

Choose two courses from one of the following concentrations:

A. Creative Writing

76-26x	one "Study of Forms" course (required)

PLUS one of the following

76-239	Introduction to Film Studies
76-241	Introduction to Gender Studies
76-26x	a second "Study of Forms" course
76-293	Rhetorical Traditions
76-294	Literary and Cultural Studies Core

B. Literary and Cultural Studies

76-294	Literary and Cultural Studies Core (required)

PLUS one of the following

76-239	Introduction to Film Studies
76-241	Introduction to Gender Studies
76-26x	a "Study of Forms" course
76-293	Rhetorical Traditions

C. Professional & Technical Writing

One 200- or 300-level professional writing course (required)

PLUS one of the following

76-239	Introduction to Film Studies
76-241	Introduction to Gender Studies
76-26x	a "Study of Forms" course
76-293	Rhetorical Traditions
76-294	Literary and Cultural Studies Core

D. Rhetoric

76-293	Rhetorical Traditions (required)

PLUS one of the following

76-239	Introduction to Film Studies
76-241	Introduction to Gender Studies
76-26x	a "Study of Forms" course
76-294	Literary and Cultural Studies Core

Advanced Concentration — 36 units

Three advanced English courses (300- or 400-level or, by permission, an additional 200-level course) to form coherence and depth in a designated area. The Advanced Concentration should follow second-level preparation, and is chosen in consultation with the Department's undergraduate advisor. In addition to the concentrations suggested below, students may work with the department undergraduate advisor to develop a self-defined concentration.

Some suggested areas of concentration:

Fiction
- Two fiction workshops
- One literature course stressing fiction(or an additional workshop)

Poetry
- Two poetry workshops
- One literature course stressing poetry (or an additional workshop)

Literary and Cultural Studies
- Two 300-level Literary & Cultural Studies courses
- One 400-level seminar

Professional and Technical Writing
- Two 300- or 400-level writing courses
- One rhetoric/linguistics course

Rhetoric
- Three of the following:

76-371	Rhetoric in Social Interaction
76-374	Argument
76-378	Rhetoric and the Writing Process
76-385	Introduction to Discourse Analysis
76-388	Rhetoric and the Reading Process

The Honors Program

The Honors Program recognizes outstanding performance by students majoring in any of the English Department's undergraduate degree programs. By participating in the program, students develop their skills and apply their knowledge in an honors project. The honors project is completed during the senior year. By completing the 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 his or her department to become a participant.

Faculty

CRYSTAL BARTOLOVICH, Assistant Professor of English and Literary and Cultural Studies — Ph.D , Emory University, Carnegie Mellon , 1993—.

JANE BERNSTEIN, Assistant Professor of English and Creative Writing — M.F.A., Columbia University; Carnegie Mellon, 1991 —.

GERALD P. COSTANZO, Professor of English and Creative Writing — M.A., M.A.T., Johns Hopkins University; Carnegie Mellon, 1970—.

BEEKMAN W. COTTRELL, Professor of English (Emeritus) — Ph.D., Columbia University; Carnegie Mellon, 1953—.

JAMES DANIELS, Associate Professor of English and Creative Writing — M.F.A., Bowling Green State University; Carnegie Mellon, 1981—.

DAVID P. DEMAREST, JR., Associate Professor of English — Ph.D., University of Wisconsin; Carnegie Mellon, 1964—.

SHARON DILWORTH, Assistant Professor of English and Creative Writing — M.F.A., University of Michigan; Carnegie Mellon, 1989—.

RICHARD LEO ENOS, Professor of English and Rhetoric — Ph.D., Indiana University; Carnegie Mellon, 1979—.

LINDA FLOWER, Professor of English and Rhetoric, Co-Director of Center for the Study of Writing — Ph.D., Rutgers University; Carnegie Mellon, 1980—.

LOIS JOSEPHS FOWLER, Professor of English — Ph.D., University of Pittsburgh; Carnegie Mellon, 1962—.

JOLENE GALEGHER, Associate Professor of English and Rhetoric — Ph.D. Northwestern University; Carnegie Mellon, 1992—.

KEYA GANGULY, Assistant Professor of English and Literary and Cultural Studies—Ph.D. University of Illinois, Carnegie Mellon, 1991—.

CAMILLA GRIGGERS, Assistant Professor of English and Literary and Cultural Studies — Ph.D., University of Florida; Carnegie Mellon, 1989—.

JOHN AUGUSTINE HART, Associate Professor of English (Emeritus) — Ph.D., Yale University; Carnegie Mellon, 1946—.

ANN L. HAYES, Professor of English — M.A., Stanford University; Carnegie Mellon, 1958—.

PAUL HOPPER, Professor of English, Rhetoric and Linguistics — Ph.D., University of Texas; Carnegie Mellon, 1990—.

GRANVILLE H. JONES, Associate Professor of English — Ph.D., University of Pittsburgh; Carnegie Mellon, 1960-64, 1966—.

DAVID S. KAUFER, 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—.

PEGGY A. KNAPP, Professor of English — Ph.D., University of Pittsburgh; Carnegie Mellon, 1970—.

YAMENG LIU, Assistant Professor of English and Rhetoric — Ph.D., University of Southern California, Carnegie Mellon, 1993—

HILARY MASTERS, Professor of English and Creative Writing — A.B., Brown University; Carnegie Mellon, 1983—.

CHRISTINE NEUWIRTH, Associate Professor of English and Rhetoric and Director of the Center for Educational Computing in English — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1983—.

BEV SAUER, Assistant Professor of English and Rhetoric — Ph.D. Brandeis University; Carnegie Mellon, 1994—.

DAVID R. SHUMWAY, Associate Professor of English and Literary and Cultural Studies — Ph.D., Indiana University; Carnegie Mellon, 1985—.

ROBERT C. SLACK, Professor of English (Emeritus) — Ph.D., University of Pittsburgh; Carnegie Mellon, 1946—.

PAUL H. SMITH, Associate Professor of English and Literary and Cultural Studies — Ph.D., University of Kent at Canterbury; Carnegie Mellon, 1986—.

ERWIN R. STEINBERG, Professor of English and Rhetoric — Ph.D., New York University; Carnegie Mellon, 1946—.

KRISTINA STRAUB, Associate Professor of English and Associate Head of the English Department — Ph.D., Emory University; Carnegie Mellon, 1987—.

GARY WILLINGHAM-MCLAIN, Assistant Professor of English and Literary and Cultural Studies — Ph.D. Indiana University; Carnegie Mellon, 1994—.

RICHARD E. YOUNG, Thomas S. Baker Professor of English, Chair in Rhetoric and Literature — Ph.D., University of Michigan; Carnegie Mellon, 1976—.

Adjunct Faculty

ROBERT GANGEWERE, Adjunct Assistant Professor of English — Ph.D., University of Connecticut; Carnegie Mellon, 1966—.

JOSEPH P. RUDMAN, Adjunct Assistant Professor of English — D.A., Carnegie Mellon University; Carnegie Mellon, 1959—.

Department of History

Steven Schlossman, Department Head
Department Office: Baker Hall 240

The several 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 and cultural change. The History 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 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 array 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 change. Carnegie Mellon's Department of History is nationally known for its strength in three broad areas: social history, history and policy (or applied history), and anthropology and history (emphasizing links between anthropology and history). Social 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 public policy. 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 Department of History offers B. A. and B. S. degrees in Social History, History and Policy, and Anthropology and History, and a double major program in European Studies. 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 promotes abilities in handling and interpreting data that have a variety of uses. The Carnegie Mellon History program is 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 History majors go on to do just that. Most History majors, 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, librarianship, 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 gains 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 trends, journalism and editorial work are also natural careers for History majors.

The History major's horizons include business careers as well. Most History majors, 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, History majors 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 which continue to 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 can be an important professional addition to a major in History. Some students combine History with work in another specialty such as Industrial Management, Economics, Professional Writing, Political Science, or Modern Languages, which may provide a very attractive career preparation.

The Social History major provides a core sequence in social history, with related research training. It also encourages exploration of other types of history, and it encourages work in diverse geographical fields. As a liberal arts major it promotes exposure to history as a source of new knowledge, while also providing essential research training.

The History and Policy major focuses on policy-relevant history, along with solid training in other types of history. History and Policy majors can do specialized work in one or more policy areas including technology and environment, industrial development, criminal justice, international relations, education policy, and health policy.

The Anthropology and History major focuses on cultural patterns and social changes. Research experience is combined with work in interdisciplinary social science theory.

The European Studies major focuses on the historical foundations of European society and culture; the current state of European society, economy and culture; and the development of students' ability to think comparatively about the world in which they live. The major also has a language requirement in a foreign language of the student's choice. The European Studies major is available only as part of a double-major program; i.e., it may be either the primary or second major in a two-major program, but canot stand alone as a student's sole major.

The Department also offers a minor in History and one in European Studies. 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 Studies; International Affairs; Sociology; Political Science; Religious Studies; Psychology; and Minority Studies. Additional examples include minors offered in the arts, engineering, science, mathematics, industrial management, and computer science.

The Major in Social History

The Department has a national reputation in social history. Social 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 History major involves courses in labor, immigration, race, gender, political culture and leisure, as well as in the history of culture and mentalities. The Social 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, in other facets of history or of social history.

The Social 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 History majors will also find employment 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

The Social History major is offered as either a B. A. or B. S. degree. In addition to meeting the H&SS General Education requirements for the B. A. and B. S. degrees, Social History majors must satisfy requirements in the following areas:

Mathematics and Statistics Prerequisites* (B.S. only) 19-20 units

21-111 Calculus I*

PLUS one of the following:

21-112 Calculus II
36-202 Introduction to Statistical Methods (recommended by the Department over 21-112; prerequisite: 36-201**)

* If at all possible, to be taken in the first and/or second year.

* Also fulfills the Mathematical Reasoning requirement in the H&SS General Education program.

** 36-201 is the General Education Statistics requirement for all H&SS students.

Research Skills 12 units

79-300 History Workshop

Civilization 9 units

This requirement must be fulfilled by one course that deals with an area outside the United States and Europe, (e.g. Latin America, Africa, China, Russia).

Social History 30 units

79-251 Introduction to Social History
79-304 New Topics in Social History
79-444 Seminar in Social History (12 units)

History Electives 27 units

Three History electives, at or above 200-level.]

Social History, B. A. and B. S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Elective	History Workshop 79-300	Elective	Elective
Intro. to Social History 79-251	New Topics in Social History 79-304	Seminar in Social History 79-444	Elective
History Civilization Course 79-xxx	History Elective 79-xxx	History Elective 79-xxx	History Elective 79-xxx
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" schedule 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.

Degree Requirements

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Mathematics & Statistics prereq. (B.S. only)	(min.)	19 units
Social History Major requirements		78 units
Free Electives (B.S.)	(max.)	137 units
Free Electives (B.A.)	(max.)	156 units
Degree Requirements (minimum)		**360 units**

Double Majors in Social History

Social History may be scheduled as a double major in consultation with the departments concerned.

The Major in History and Policy

(formerly "Applied History")

History and Policy is a major with both a more professional and a more contemporary focus than the basic Social History major. 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. The History and Policy major may involve courses in the social and decision sciences, statistics, computer science, and the application of quantitative techniques to history, as well as a thorough grounding in historical studies. The major will strengthen a student's qualifications for a variety of management-oriented and research positions.

Majors in History and Policy use historical reasoning in conjunction with social science research tools in order to evaluate policy problems. Students investigate the ways in which decisions have been made in societies in the past, with the goal of bringing historical understanding to bear on the making of decisions in the present and on projects for the future.

Historical perspective enriches policy analysis in several ways. The History and Policy major develops skills in data management and communication that are vital to any policy research area, whether in the public or private sector. 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 also develops an ability to assess social trends, in order to establish both continuities and discontinuities as the context for determining appropriate policy.

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 and management, law, 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. The M. S. and Ph.D. degrees in History and Policy are also offered in H&SS. When qualified, undergraduate majors can move into graduate courses in their senior year.

Curriculum

The History and Policy major is available as either a B. S. or B. A. degree. In addition to satisfying all H&SS General Education requirements and requirements for the B. A. or B. S. degrees, History and Policy majors must fulfill requirements in the following areas:

Mathematics and Statistics Prerequisites* (B.S. only) 19-20 units

21-111 Calculus I*

PLUS one of the following:

21-112 Calculus II
36-202 Introduction to Statistical Methods (recommended by the Department over 21-112; prerequisite: 36-201**)

* If at all possible, to be taken in the first and/or second year.

* Also fulfills the Mathematical Reasoning requirement in the H&SS General Education program.

** 36-201 is the General Education Statistics requirement for all H&SS students.

Research Skills 12 units

79-300 History Workshop

Introductory and Project Course Sequence 21 units

79-250 Introduction to History and Policy
79-448 Project Course (12 units)

Issues on the Public Agenda (select three) 27 units

Especially relevant courses are:

79-309 Contemporary Latin American Politics
79-327 Industrial Policy: Historical Perspectives
79-328 Urban Policy: Historical Perspectives
79-329 Environmental Policy: Historical Perspectives
79-330 Health Policy: Historical Perspectives
79-331 Educational Policy: Historical Perspectives

79-332 Criminal Justice Policy: Historical Perspectives
79-360 The Rise of Industrial Research & Development

Electives — 18 units

Two History electives, at or above 200-level. Additional Public Agenda courses qualify as electives. The following courses are especially suited as History and Policy electives.

79-239 Child Welfare and Social Reform
79-254 Professions in Society
79-257 African-American I
79-258 African-American II
79-271 Medicine and Society
79-275 History of Modern Warfare
79-286 Kinship and Child Welfare Policy
79-290 Family Law and Social Policy
79-359 Technology and Organization

History and Policy, B. A. and B. S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Public Agenda Course 79-3xx	History Workshop 79-300	Project Course 79-448	History Elective 79-xxx
Intro. to History & Policy 79-250	Public Agenda Course 79-3xx	Public Agenda Course 79-3xx	Elective
Elective	History Elective 79-xxx	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" schedule 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.

Degree Requirements

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Mathematics & Statistics prerequisites (B.S. only)		29 units
History and Policy Major requirements		78 units
Free Electives (B.S.)	(max.)	137 units
Free Electives (B.A.)	(max.)	156 units
Degree Requirements (minimum)		**360 units**

Double Majors in History and Policy

History and Policy may be scheduled as a double major in consultation with the departments concerned.

The Major in Anthropology and History

(formerly "Interdisciplinary 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 may choose among 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. An advanced interdisciplinary course examines texts that best exemplify an exchange between the two disciplines.

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

The Anthropology and History major is offered as either a B. A. or B. S. degree. In addition to all H&SS General Education requirements and requirements for the B. A. or B. S. degree, Anthropology and History majors must satisfy requirements in the following areas:

Mathematics and Statistics Prerequisites* (B.S. only) — 19-20 units

21-111 Calculus I*

PLUS one of the following:

21-112 Calculus II
36-202 Introduction to Statistical Methods (recommended by the Department over 21-112; prerequisite: 36-201**)

* If at all possible, to be taken in the first and/or second year.

* Also fulfills the Mathematical Reasoning requirement in the H&SS General Education program.

** 36-201 is the General Education Statistics requirement for all H&SS students.

Introductory Courses — 21 units

79-202 Introduction to Anthropology
79-300 History Workshop (12 units)

Intermediate Courses — 36 units

Intermediate courses are divided into two clusters: Thematic and Regional. A major is required to take TWO courses from each cluster.

A. Thematic (2 required)

Courses in this cluster emphasize interdisciplinarity. The starred courses—at least one of which must be selected—integrate theories in anthropology or sociology with historical approaches in ethnography and human development. Others utilize concepts of culture in thinking historically about individual and society, mentality and performance, ideology and action.

79-211 Festivals and Ceremonies
79-213* Sociology as History
79-219* Picturing Others: A Course on Ethnographic Film
79-264 Gender Roles and Social Change
79-267* Culture, Power, and Social Action
79-295 Witchcraft and Dissent in the Middle Ages
79-271 Medicine and Society
79-273 Family and Population
79-303 Peasants in History
79-307* Ritual, Performance, and Time
79-308* History of the Concept of Culture
79-317* Social Structure and the Organization of Human Development
79-323* Visual Anthropology
76-437 Culture/Values/Text
82-455* The Latin American Fin de Siglo

B. Regional (2 required)

Regional courses offer a student the opportunity to explore a culture distant in time or place, understood in its own terms as well as ours. Each student is required to take at least ONE NON-EUROPEAN regional course, in order to expand the basis of comparison.

79-206 Chinese Culture and Society
79-207 History of Africa
79-208 History of South Africa
79-214 Modern Japan
79-223 Modern Latin America
79-231 Russian History: The First to the Last Tsar
79-276 Modern China
79-278 Gauchos and Indians in Latin America
79-279 Origins of Conflict in Central America
79-281 Irish History
79-294 Cultures of the Pacific
79-295 19th Century Europe
79-292 Modern Germany
79-343 Mediterranean Europe: History and Ethnography

*We strongly recommend that all Anthropology and History Majors learn a foreign language well enough to speak and read in that language. Familiarity with another language provides an insight into culture, as well as expanding one's understanding of the subjects and themes covered by an historical approach.

Advanced Courses: Both required **21 units**

79-402	Research Seminar in Anthropology and History (12 units)
79-403	Colloquium in Anthropology and History

Anthropology and History, B. A. and B. S.
(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Intro. to Anthro. 79-202	History Workshop 79-300	Intermediate Thematic Course 79-xxx	Intermediate Regional Course 79-xxx
Intermediate Thematic Course elective 79-xxx	Intermediate Regional Course 79-xxx	Seminar in Anthropology and History 79-402	Elective
Elective	Elective	Elective	Colloquium in Anthropology and History 79-403
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" schedule 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.

Degree Requirements

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Mathematics & Statistics prerequisites (B.S. only)		29 units
Anthropology and History Major requirements		78 units
Free Electives (B.S.)	(max.)	137 units
Free Electives (B.A.)	(max.)	156 units
Degree Requirements (minimum)		**360 units**

Double Majors in Anthropology and History
Anthropology and History may be scheduled as a double major in consultation with the departmental heads concerned.

European Studies Program

Donna Harsch, Program Director
Program Office: Baker Hall 240

America in the last half-century has grown more involved with all the major regions of the world. European ties with America have developed important new features, strengthened by common cultural roots, streams of immigration and intertwined economies. The greater openness of Eastern Europe and the challenge and opportunities created by a market of 325 million people in the twelve nations of the European Community have deepened American interest in contacts with the continent and in study of Europe's history, languages and culture. European Studies is a double-major and minor program for students who share these interests.

European Studies, located in the History Department of the College of Humanities and Social Sciences, is designed for students from all the Carnegie Mellon undergraduate colleges. Graduation requirements are 78 units (8-9 courses) for the double major and 60 units (6-7 courses) for the minor. For majors, there are three specific History course requirements. Two are at the intermediate level and the other is a capstone senior seminar (see below). For minors, there are two specific History course requirements, both at the intermediate level. With respect to language, there are two requirements for both majors and minors: first, completion of three courses (minimum 27 units) in a foreign language or demonstration of equivalent language proficiency; second, an additional six units of advanced foreign language study.

Advanced language options at Carnegie Mellon include subject-oriented language supplements to existing courses in a variety of fields.* Four approved program electives (totaling at least 42 units for the double major, and at least 36 units for the minor) on European themes are also required. A maximum of two courses (18-21 units) in the double major, and one course (9-12 units) in the minor, can be used to meet other requirements imposed by the University, a college or a department. The language and program elective requirements can be satisfied at Carnegie Mellon but also, at least in part, through a period of study at approved sites abroad.

The two required History courses for both majors and minors are 79-215 (Dynamics of European Society) and 79-204 (The Collapse and Renewal of Europe), generally taken in the sophomore or junior year. The first deals with European social patterns and political and economic systems as they developed in the late Eighteenth and Nineteenth Centuries. The second examines the problems of contemporary Europe, emphasizing how the upheavals of the Twentieth Century have transformed the lives and outlooks of Europeans. Both deal with relations between society and state and draw heavily on the comparative method of inquiry. Majors are also required to take 79-444 (Seminar in Comparative Social History) in their senior year.** This seminar encourages majors to use foreign language sources in a developed research project.

Both majors and minors are expected to undertake academic study in a European country for a summer, semester or academic year in sites recommended by the European Studies faculty. This study abroad would normally generate between 18 and 36 European Studies course units. A waiver may be requested if financial or other considerations make study abroad impossible. The planning and selection of program sites will be individually tailored from a list recommended by the European Studies faculty and the University's International Education advisor.

A European Studies double major or minor would be a wise choice for students in many different types of programs. For example, for Industrial Management majors and students interested in careers in business or law, it provides preparation for travel or work not only in Europe, but in Africa and Latin America. For Literary and Cultural Studies majors, it offers an opportunity to extend the study of European authors and their audiences. Students from the College of Fine Arts will find that a European Studies major or minor is an excellent way to give added definition to their major. For students more generally interested in Europe, past and present, it offers both structure and choice to allow students to deepen their understanding of one of the world's key regions.

*A list of available 3-unit supplementary offerings will be posted before registration each semester in the History office. See History course number 79-490 in the History course description section. This course is attached to a 200-, 300-, or 400-level History course, as indicated in course schedules issued each term by the Department. Language options include Spanish, French, Chinese, Russian and German.

**In some cases, students will be allowed to substitute a readings course, thesis, or some other research seminar that will draw on their knowledge of a foreign language.

Curriculum
The program in European Studies (to be taken only as part of a double major) consists of 78 units of course work. Its prerequisite is completion of three foreign language courses or their equivalent in terms of demonstrated language ability. European Studies is a B. A. program. It may be taken as either the primary or secondary part of a double major. If taken as the primary part of a double major, one's degree will be a B.A. Note: No more than two courses (18-21 units) may be taken in satisfaction of both the European Studies double major requirements and those of another major, minor, or college program.

Language Prerequisite **(min.) 27 units**
Three foreign language courses (minimum 27 units) or their equivalent in terms of demonstrated language ability.

Stem Courses **30 units**

79-204	The Collapse and Renewal of Europe
79-215	Dynamics of European Society
79-444	Seminar in Social History (12 units)

Language **6 units**
To be taken in further foreign language work (beyond the prerequisite level: see above), either in an additional language course, or, where ability warrants, in three-unit reading courses in a foreign language, attached to an existing course conducted in English.

Program Electives **42 units**

Courses to be selected from offerings in history, literature, art or architectural history, philosophy, languages or other fields of interest to the student. The criterion of acceptability is that each course focus on some aspect of European society. Examples of suitable courses are:

48-140	Introduction to Architectural History
48-241	Paris in the Jazz Age
48-141	Baroque Architecture
60-379	Cubism
60-385	Michelangelo
76-244	Shakespeare
76-332	Studies in European Literature: Medieval Literature
79-225	Riots, Revolts, and Revolutions
79-245	Survey of Soviet History

European Studies majors should consult the Program Advisor for assistance in identifying other appropriate courses for this requirement.

European Studies, B. A.

(Suggested Sequence)

Junior Year Fall	Spring	Senior Year Fall	Spring
Dynamics of European Society 79-215	The Collapse and Renewal of Europe 79-204	Seminar in Social History 79-444	Program Elective
Foreign Language 82-xxx **	Program Elective	Program Elective	Program Elective
Elective	Program Elective	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* **NOTE: This "suggested" schedule 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.**

** NOTE: It is assumed that the three-course language prerequisite (or alternative demonstration of language proficiency) will have been completyed before the junior year.

Degree Requirements

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Foreign Language prerequisite	(min.)	27 units
European Studies Major requirements		78 units
Free Electives	(max.)	129 units
Degree Requirements (minimum)		**360 units**

The Minor in European Studies

A prerequisite, as with the European Studies double major, is completion of three foreign language courses (minimum 27 units) or their equivalent in terms of demonstrated language ability. NOTE: No more than 12 units may be taken in satisfaction of both the European Studies minor requirements and those of another major, minor, or college program.

Language Prerequisite **(min.) 27 units**

Three foreign language courses (minimum 27 units) or their equivalent in terms of demonstrated language ability.

Stem Courses **18 units**

79-204	The Collapse and Renewal of Europe
79-215	Dynamics of European Society

Language **6 units**

To be taken in further language work beyond the prerequisite level (as described above in the curriculum description of the European Studies double major).

Program Electives **36 units**

Courses to be selected from offerings in history, literature, art or architectural history, philosophy, languages, or other fields of interest to the student (as described above in the curriculum description of the European Studies double major).

The Minor in History

The minor in History involves a mumimum of 54 units of course work (not including the 9-unit prerequisite), as described below.

Prerequisite 9 units

79-104	Introduction to World History (or the equivalent as approved by the Department)

Introductory Course in Social or Policy History **9 units**

One of the following:

79-250	Introduction to History and Policy
79-251	Introduction to Social History

Intermediate Courses **(min.) 27 units**

Three 200-level History courses

Advanced Courses **(min.) 18 units**

Two 300- or 400-level History courses

The Honors Program

The Honors Program provides recognition of outstanding performance by students in Social History, History and Policy, Anthropology and History or European Studies. By participation in the program, students have the opportunity to develop their skills in applying historical analysis through completion of an honors thesis. The honors thesis is completed during the senior year. By completing the 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 his or her department to become a participant.

Faculty

CAROLINE ACKER , Assistant Professor of History — Ph.D., University of California, San Francisco—Carnegie Mellon, 1993—.

SUSAN AMBROSE, Adjunct Professor of History; Director, University Teaching Center — D.A., Carnegie Mellon University; Carnegie Mellon, 1986—.

ANDREW BARNES, Associate Professor of History — Ph.D., Princeton University; Carnegie Mellon, 1981—.

EDWARD W. CONSTANT , Associate Professor of History — Ph.D., Northwestern University; Carnegie Mellon, 1976—.

EDWIN FENTON, Professor of History; Emeritus — Ph.D., Harvard University; Carnegie Mellon, 1954—.

DAVID H. FOWLER, Professor of History — Ph.D., Yale University; Carnegie Mellon, 1959—.

WENDY Z. GOLDMAN, Associate Professor of History — Ph.D., University of Pennsylvania; Carnegie Mellon, 1988—.

JOHANNA GRANVILLE, Lecturer in History and Social and Decision Sciences, — Ph.D., Fletcher School of Law and Diplomacy, Tufts University, Carnegie Mellon, 1994—.

DONNA HARSCH, Assistant Professor of History; Director, European Studies Program — Ph.D., Yale University; Carnegie Mellon, 1990—.

DAVID A. HOUNSHELL, Luce Professor of Technology and Social Change — Ph.D., University of Delaware, Carnegie Mellon, 1991—.

ROBERT W. KIGER, Adjunct Professor of History; Director, Hunt Institute for Botanical Documentation — Ph.D., University of Maryland; Carnegie Mellon, 1974—.

ERICK D. LANGER, Associate Professor of History; — Ph.D., Stanford University; Carnegie Mellon, 1984—.

BARBARA LAZARUS, Adjunct Professor of History; Associate Provost — Ed.D., University of Massachusetts; Carnegie Mellon, 1985—.

EUGENE D. LEVY, Associate Professor of History; Director, Undergraduate Studies in History — Ph.D., Yale University; Carnegie Mellon, 1965—.

MARY LINDEMANN, Associate Professor of History; — Ph.D. University of Cincinnati; Carnegie Mellon, 1987—.

CHARLES LOWRY, Adjunct Professor of History, University Librarian—Ph.D., University of Florida; Carnegie Mellon, 1992—

KATHERINE A. LYNCH, Associate Professor of History; — Ph.D., Harvard University; Carnegie Mellon, 1980—.

RICHARD MADDOX, Assistant 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—.

JOHN MODELL, Professor of History and Sociology; — Ph.D., Columbia University; Carnegie Mellon, 1982—.

JUDITH MODELL, Associate Professor of Anthropology and History — Ph.D., University of Minnesota; Carnegie Mellon, 1984—.

DANIEL P. RESNICK, Professor of History — Ph.D., Harvard University; Carnegie Mellon, 1966—.

LUDWIG F. SCHAEFER, Professor of History, Emeritus — Ph.D., Yale University; Carnegie Mellon, 1957—.

STEVEN SCHLOSSMAN, Professor of History; Head, Department of History — Ph.D. Columbia University; Carnegie Mellon 1988—.

RICHARD L. SCHOENWALD, Professor of History — Ph.D., Harvard University; Carnegie Mellon, 1964—.

PETER N. STEARNS, Heinz Professor of History; Dean, College of Humanities and Social Sciences — Ph.D., Harvard University; Carnegie Mellon, 1974—.

DONALD S. SUTTON, Professor of History and Anthropology — Ph.D., Cambridge University, England; Carnegie Mellon, 1969—.

JOEL A. TARR, Richard S. Caliguiri Professor of Urban Studies; — Ph.D., Northwestern University; Carnegie Mellon, 1967—.

JOE WILLIAM TROTTER, Professor of History — Ph.D., University of Minnesota; Carnegie Mellon, 1985—.

Department of Modern Languages

Barbara Freed, Head
Department Office: Baker Hall 160

It has become increasingly apparent that 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 Major in Modern Languages

Modern language majors are available in French, German and Spanish. Individuals may also propose student-defined major programs in Japanese or Russian through the H&SS Student-Defined Major Program (operated out of the Dean's Office, through the H&SS Academic Advisory Center). 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 Carnegie Mellon's Language Learning 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. Use of the Center is required in most lower-level Modern Language courses to help develop speaking and listening skills.

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. Semester or year-long programs are available in France, Germany, Spain, and Latin America. The Department also sponsors summer language courses in France, Germany and Spain (see course offerings). Foreign film series, informal conversation tables, and a conversation partners program 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. Advanced-level courses in stylistics, composition, and spoken language expose students to a wide range of discursive styles with the aim of developing a mastery of different forms of self-expression. 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. 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 encouraged 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, videodiscs 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 paths after graduation. Students will be prepared to pursue graduate studies in second language-related fields (e.g. linguistics, literature, second language acquisition) or they may use their undergraduate background as a complement to careers in fields such as the arts, government or public service, business and management, law and other areas in which proficiency in a second language is an asset.

Curriculum

Three specializations are available as Modern Languages majors: French, German, and Spanish. Language-specific faculty advisors for these specializations are:

Faculty name	Advisor for students in
Beryl Schlossman, Associate Professor of French	French
Stephen Brockmann, Assistant Professor of German	German
Kenya Carmen Dworkin y Mendez, Assistant Professor of Spanish	Spanish

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, CEEB or internal placement test scores.

1. Core Courses in Modern Languages — 39 units

A. Language-Specific Courses (27 units)

	French
82-303	Advanced Written French
82-304	Introduction to French and Francophone Culture
82-305	Contemporary Spoken French*

* A 400-level course may be substituted with an advisor's approval.

	German
82-323	Advanced German Grammar, Stylistics and Writing
82-324	Contemporary Spoken German
82-325	Introduction to German Studies

	Spanish
82-343	Language and Culture A
82-344	Language and Culture B
82-345	Introduction to Literature and Culture

B. General Courses — (12 units)

82-280	Learning About Language Learning
82-580	Senior Seminar- Senior project which integrates linguistic and content-oriented studies (3 units)

2. Core Course(s) in History — (minimum) 9 units

The student must take one of the following History courses after consultation with the Major Advisor and the relevant History professor (listed below):

French:	Professors Lynch or Barnes
German:	Professors Harsch or Lindemann
Spanish:	Professors Langer or Maddox

	History courses:
79-215	Dynamics of European Society
79-223	Modern Latin America
79-225	Riot, Revolts, and Revolutions
79-228	Religion and Society: The European Experience
79-292	Modern Germany
79-343	The Mediterranean World
79-348	European Cities

Majors are encouraged to take 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 Department of History.

3. Required 400-level courses — 27-36 units

Majors in French or Spanish are required to take three 400-level courses, with the option of taking either a fourth course or an appropriate elective with required work in the target language. Students in German will be required to take 82-582 in addition to three 400-level courses.

French

82-409	French Literature of the Nineteenth Century
82-412	Contemporary French Theatre
82-413	Contemporary French Novel
82-415/416	Studies in French Literary and Cultural Studies (e.g. Imperial and Occupied France; 18th Century: Texte et Société; Poetic Revolutions; Introduction to French Theater: Performance, Power, and the Art of Illusion; Expoculture: The Formation of French Cultural Identity and the Expositions Universelles, 1855-1937; France and America: Cross-Cultural Community)
82-465/466	Surrealism in France and Spain
82-501/509	Special Topics

Spanish

82-441	Survey of Spanish Literature and Culture
82-442	Analysis of Spoken Spanish
82-443	Introduction to Spanish Translation
82-451	Introduction to Latin American Literature and Culture: (e.g. "Voices from Within": The Crisis of Latin American Identity)
82-455/456	Spanish and Latin American Studies (e.g. Visions of Business in the Spanish Speaking World; Political Drama of the 20th Century in Spain and Latin America; Contemporary Novels of Spain and Latin America; Portrait of Family in Contemporary Spanish Drama; Gazing in the 'Buried Mirror': Reflections of Spain and Latin America)
82-457	Contemporary Latin American "Texts": "Back to the Future" - Revision, Rewriting, and Representation
82-465/466	Surrealism in France and Spain
82-541/549	Special Topics

German

82-427	The New Germany
82-430	German Literature of the 20th Century
82-435/436	Studies in German Literature (e.g. The German Literary Tradition)
82-437	Studies in German Culture: (e.g. (1933-1945): Nazi and Resistance Culture; Music and the German Soul)
82-438	History of German Film
82-521/529	Special Topics
82-582	Theory & Practice of Translation (w/emphasis on technical texts)
82-583	Special Topics in Modern Languages: German Scientific-Technical Translation

4. Electives (9-18 units)

An additional elective, chosen in consultation with the Major Advisor, will be required of all students. The student will be required to complete part of the course work in their target language.

History		Languages
79-215	Dynamics of European Society	(Fr., German)
79-223	Modern Latin America	(Sp.)
79-225	Riot, Revolts, and Revolutions	(Sp.)
79-228	Religion and Society: The European Experience	
79-292	Modern Germany	(German)
79-343	The Mediterranean World	(Sp.)
79-348	European Cities	

Philosophy

80-280	Introduction to Linguistic Analysis

Psychology

85-413	Psychology of Reading
85-421	Language and Thought

Modern Languages

82-480	Social and Cognitive aspects of Bilingualism

English

76-378	Rhetoric and the Writing Process
76-481/881	History of Rhetoric I
76-482/882	History of Rhetoric II

Architecture

48-462	Paris in the 1920's	(Fr.)

Art

60-377	Picasso and the 20th Century	(Fr.)
60-380	Modern Sculpture 1880-1960	
60-383	20th Century Painting	

Music

57-432	French Literature and Repertoire
57-435	German Literature and Repertoire
57-202	Opera History

New courses will be added as appropriate.

Suggested* Schedule

Junior Year Fall	Junior Year Spring	Senior Year Fall	Senior Year Spring
Advanced Language Course 82-3x3	Advanced Language Course 82-3x4	Advanced Language Course 82-3x5	Senior Seminar 82-580
Core History	Elective	Literature or Elective 82-4xx	Literature 82-4xx
Language Learning 82-280	Literature 82-4xx	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" schedule 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. Additionally (and relatedly), 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 a double major. In all cases, progress toward the major will be accelerated by study abroad which is strongly recommended for all majors.

* The normal prerequisite for 400-level courses is completion of language courses at the 300-level. Exceptions may be made with permission of the instructor.

Degree Requirements (summary)

(for H&SS students with a primary major in French, German or Spanish)

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Modern Language Core requirements		39 units
Core course(s) in History	(min.)	9 units
Modern Languages 400-level courses		36 units
Additional elective for the major		9 units
Free Electives*	(max.)	141 units
Degree Requirements (minimum)		**360 units**

* NOTE: Up to 42 of these "elective" units may be needed to fulfill 100- and 200-level Modern Language prerequisites. However, up to three of these courses may be used to fulfill College General Education and B.A. degree requirements. Students should consult their college and major advisors for additional information and guidance in this matter.

Additional Requirement: Proficiency Test and Interview

Satisfaction of a multi-skill proficiency test including an oral proficiency interview. This test should be taken by the end of the first semester of the senior year; students are encouraged to take it by the end of the junior year. Students will be permitted to retake the test.

Strongly Recommended: A semester or year of study abroad.

Double Majors

Students within and without H&SS may complete an additional (double) major in French, German or Spanish by completing the major requirements as outlined above in addition to the requirements for their primary major. Non-H&SS students interested in an additional major in a Modern Language need to fulfill only the requirements for the chosen Modern Language major, but not the H&SS General Education program requirements.

Minor in Modern Languages

In addition to the major in Modern Languages with specializations in French, Spanish or German, it is also possible to choose a minor in any of these three languages as well as in Japanese, Second Language Acquisition, or Teaching English to Speakers of Other Languages. Individuals may also propose a student-defined minor in Russian through the College's Student-Defined Major program.

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.

Curriculum

Four specializations are available as Modern Languages minors: French, German, Spanish, and Japanese. The minimum requirement for the Modern Language minor in French, German or Spanish is 54 units (not including any 100- or 200-level prerequisite work in the chosen language), as outlined below. The minimum requirement for the Modern Language minor in Japanese is 66 units, as outlined (separately) below.

The Minor in French, German or Spanish

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, CEEB or internal placement test scores.

1. Language-Specific Courses **27 units**

French

82-303	Advanced Written French
82-304	Introduction to French and Francophone Culture
82-305	Contemporary Spoken French*

German

82-323	Advanced German Grammar, Stylistics and Writing
82-324	Contemporary Spoken German
82-325	Introduction to Literature and Culture

Spanish

82-343	Language and Culture A
82-344	Language and Culture B
82-345	Introduction to Literature and Culture

*A 400-level course may be substituted with an advisor's approval.

2. Core Elective **9 units**

Choose one of the following:

82-280	Learning about Language Learning
or	
82-410/79-320	Issues in Contemporary European Civilization

Students should expect a language component in their language of specialization in these courses. This might include a selection of texts written in their target language and/or written assignments in that language.

To provide flexibility, Dynamics of European Civilization (79-215), Modern Latin America (79-223), The Mediterranean World (79-343), or Modern Germany (79-292) may be substituted with approval of the student's advisor.

3. Departmental Electives **18 units**

Two courses in the language of specialization, chosen from the following:

French

82-409	French Literature of the Nineteenth Century
82-412	Contemporary French Theatre
82-413	Contemporary French Novel
82-415/416	Studies in French Literary and Cultural Studies (e.g. Imperial and Occupied France; 18th Century: Texte et Société; Poetic Revolutions; Introduction to French Theater: Performance, Power, and the Art of Illusion; Conte, Fable et Nouvelle; France and America: Cross-Cultural Performance)
82-465/466	Surrealism in France and Spain
82-501/509	Special Topics: French

Spanish

82-441	Survey of Spanish Literature and Culture
82-442	Analysis of Spoken Spanish
82-443	Introduction to Spanish Translation
82-444	The Structure of Spanish
82-451	Introduction to Latin American Literature and Culture (e.g. "Voices from Within": The Crisis of Latin American Identity)
82-455/456	Spanish and Latin American Studies (e.g. Visions of Business in the Spanish Speaking World; Political Drama of the 20th Century in Spain and Latin America; Contemporary Novels of Spain and Latin America; Portrait of Family in Contemporary Spanish Drama; Gazing in the 'Buried Mirror': Reflections of Spain and Latin America)
82-457	Contemporary Latin American Texts: (e.g. "Back to the Future"- 'Revision, Rewriting and Representation')
82-465/466	Surrealism in France and Spain
82-541/549	Special Topics: Spanish

German

82-427	The New Germany
82-435/436	Studies in German Literature (e.g. The German Literary Tradition)
82-437	Studies in German Culture: (1933-1945): Nazi and Resistance Culture; Music and the German Soul
82-438	History of German Film
82-521/529	Special Topics German
82-582	Theory & Practice of Translation (w/emphasis on technical translations)
82-583	Scientific-Technical Translation

Additional Requirements

Students will be expected to pass an oral proficiency interview. They are encouraged to take this test no later than the middle of the junior year. Students will be permitted to retake the test if necessary.

The Minor in Japanese

Students must complete the following language-specific courses (min. 66 units):

82-171/172	Elementary Japanese I & II
82-271/272	Intermediate Japanese I & II*
82-371/372	Advanced Japanese I & II*

* Students who begin at the Intermediate level will be expected to take 4th year Japanese (82-471 & 82-472). In exceptional cases two electives may be substituted for the 4th-year courses. Students who begin at the Advanced level will be expected to take 4th-year Japanese (82-471 & 82-472) and two electives from the list below. In exceptional cases two additional electives may be substituted for the 4th-year courses.

Electives

82-571/572	Special Topics in Japanese
82-273	Introduction to Japanese Language and Culture
82-280	Learning about Language Learning
82-383	Second Language Acquisition
79-214	Modern Japan, 1868 to the present

Additional Requirements

Students will be expected to pass an oral proficiency interview. They are encouraged to take this test no later than the middle of the junior year. Students will be permitted to retake the test if necessary.

The Minor in Second Language Acquisition ("SLA")

The minor in SLA is of potential interest to students who are interested in language learning and who wish to understand the language learning process, including, but not limited to, students in Modern Languages, Psychology, English and Philosophy. The minor provides students with knowledge and skills that will serve subsequent careers in academia, business or government, and which will complement many other majors. Requirements for the minor total 54 units.

Curriculum

1. Required courses **45 units**

82-280	Learning about Language Learning
82-383	Introduction to Second Language Acquisition
82-480	Social and Cognitive Aspects of Bilingualism
82-481	Research Methods in Second Language Acquisition
85-421	Language and Thought (Prerequisites for this course include 80-180, 85-100, or 85-211)

2. Core Elective **9 units**

A choice may be made from among the following courses to complete the minor:

76-385	Introduction to Discourse Analysis

76-386	Sociolinguistics
80-183	Language, Culture and Thought
80-280	Introduction to Linguistic Analysis
82-182	Language and Culture: Language in Its Social Context
82-381	Issues and Trends in Second Language Learning and Teaching
85-211	Cognitive Psychology
85-218	Neuropsychology

Additional Requirements

Pre/co-requisite: Two semesters (or the equivalent) of college instruction (any level) in at least one foreign language or demonstrable proficiency in a second language acquired in another context.

The Minor in Teaching English to Speakers of Other Languages ("TESOL")

English is the most commonly spoken second language in the world today. A minor in the Teaching of English to Speakers of Other Languages ("TESOL") provides students with an introduction to the field through those courses that are generally accepted to be the core or foundation courses in the field. Students who elect to pursue the TESOL minor are required to complete the following courses, which total 57 units.

1. Required Modern Language courses — 39 units

82-182	Language and Culture: Language in Its Social Context
82-381	Issues and Trends in Second Language Learning and Teaching
82-382	Structure of English*
82-383	Introduction to Second Language Acquisition

2. Core Electives — 18 units

Students will choose two (2) from among the following courses to complete the minor.

82-280	Learning about Language Learning
82-480	Social and Cognitive Aspects of Bilingualism
76-385	Introduction to Discourse Analysis
79-331	Educational Policy
80-180	The Nature of Language
80-280	Introduction to Linguistic Analysis
85-211	Cognitive Psychology
85-390	Human Learning and Memory
85-421	Language and Thought

Additional Requirements

Pre/Co -requisite: Two semesters (or the equivalent) of college instruction (any level) in at least one foreign language or demonstrable proficiency in a second language acquired in another context.

* Indicates proposed new course

Secondary School (State of Pa.) Teacher Certification and Combined Bachelor's/ Master's Degree

The Master of Arts in Modern Languages, established as part of the Carnegie Mellon-Chatham partnership in teacher training, provides qualified undergraduate students with an opportunity to earn both their Bachelor's and Master's degree, as well as Teacher Certification in five years.

The goals of the program are:

- to provide prospective teachers with an opportunity to perfect their communicative language proficiency in all areas of language use;
- to expand and enhance teachers' insights into the history, culture, literature and the arts of the nations whose language they will teach and prepare teachers for sharing dimensions of multiculturalism with their students;
- to sensitize foreign language teachers to current theories of second language acquisition and pertinent aspects of the learning of second languages in and out of the classroom.

NOTE: This Master's option is available only in those languages in which Chatham currently offers secondary school teacher certification. At present, this does not include German.

General Program Requirements

Prior to entry:

- Carnegie Mellon or Chatham Bachelor's Degree in Modern Languages
- Satisfaction of a multi-skill proficiency test, including an oral proficiency interview. This test must be taken by the end of the first semester of the senior year; students are encouraged to take it by the end of the junior year or earlier.
- Teaching Certification in French or Spanish (6 courses in education, including supervised student teaching)

After entry:

- Master's Degree in Language of Specialization (8 courses, to be selected in consultation with the appropriate language advisor)

In addition, to the extent possible, all students in this program are strongly urged to spend a semester or year abroad as part of an approved study abroad program. This may be done for one or more semesters prior to receipt of the undergraduate degree, or for a maximum of one semester as part of the Master's year.

Faculty

TAMARA AL-KASEY, Assistant Professor of Second Language Acquisition and Spanish — Ph.D., University of Massachusetts; Carnegie Mellon, 1992—.

STEPHEN BROCKMANN, Assistant Professor of German with courtesy appointments in English and History— Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 1993—.

CHARLENE CASTELLANO, Visiting Assistant Professor of Russian — Ph.D., Cornell University; Carnegie Mellon, 1990—.

KENYA CARMEN DWORKIN Y MENDEZ, Assistant Professor of Spanish with a courtesy appointment in English — M.A., University of Hawaii; Carnegie Mellon, 1993—.

MICHEL FOUGERES, Associate Professor Emeritus of French — Ph.D., New York University; Carnegie Mellon, 1969—.

BARBARA FREED, Professor of French and Second Language Acquisition; Head of Modern Languages — Ph.D., University of Pennsylvania; Carnegie Mellon, 1990—.

ANNE M. GREEN, Lecturer in German — Ph.D., University of Illinois at Urbana-Champaign; Carnegie Mellon, 1993—.

CHRISTIAN HALLSTEIN, Senior Lecturer in German — Ph.D., Pennsylvania State University; Carnegie Mellon, 1979—.

MICHAEL W. HARRINGTON, Assistant Professor of Second Language Acquisition and Japanese with a courtesy appointment in Psychology — Ph.D., University of California, Santa Cruz; Carnegie Mellon, 1992—.

CHRISTOPHER M. JONES, Director of the Language Learning Resource Center and Senior Lecturer in French — Ph.D., University of Massachusetts, Amherst; Carnegie Mellon, 1993—.

ILSEDORE BARKOW JONAS, Professor Emeritus of German — Ph.D., University of Pittsburgh; Carnegie Mellon, 1958—.

BRIAN MACWHINNEY, Professor of Psychology with a courtesy appointment in the Department of Modern Languages — Ph.D., University of California, Berkeley; Carnegie Mellon, 1981—.

SUSAN G. POLANSKY, Senior Lecturer in Spanish — Ph.D., Boston College; Carnegie Mellon, 1986—.

GIOVANNI PUPPO, Instructor of Italian — Ph.D., University of Rome; Carnegie Mellon, 1975—.

BERYL SCHLOSSMAN, Associate Professor of French with a courtesy appointment in English — Ph.D., Université de Paris; Ph.D., Johns Hopkins University; Carnegie Mellon, 1993—.

JURIS SILENIEKS, Professor Emeritus of French — Ph.D., University of Nebraska; Carnegie Mellon, 1960—.

HERBERT A. SIMON, Richard King Mellon Professor of Computer Science and Psychology with a courtesy appointment in Modern Languages — Ph.D., University of Chicago; Carnegie Mellon, 1949—.

ETSUKO TAKAHASHI, Lecturer in Japanese — M.A., University of Iowa; Carnegie Mellon University, 1993—.

SONO TAKANO-HAYES, Senior Lecturer in Japanese — M.A., University of Pittsburgh; Carnegie Mellon, 1987—.

G. RICHARD TUCKER, Professor of Applied Linguistics — Ph.D., McGill University; Carnegie Mellon University, 1992—.

DIETER WAELTERMANN, Research Scientist — German, Translation Studies and Second Language Acquisition — Ph.D., University of Texas; Carnegie Mellon University 1991—.

MICHAEL WEST, Senior Lecturer in French with a courtesy appointment in English — Ph.D., University of California, Santa Barbara; Carnegie Mellon, 1989—.

BONNIE L. YOUNGS, Lecturer in French — M.A., University of Pennsylvania; Carnegie Mellon, 1993—.

Department of Philosophy

Wilfried Sieg, Department Head
Department Office: 135 Baker Hall

The Department of Philosophy was founded only in 1985. In its teaching and research, the department reflects the tradition of philosophy as a central discipline in the humanities, with emphases in the areas of logic and scientific methods, applied ethics, and computational linguistics. Today, it is still a new and exciting place with a distinctive view of what philosophy can be. The department has achieved an international reputation through the acclaimed research of its members and its innovative educational programs.

Philosophy comes alive most vigorously in interaction with other disciplines; interdisciplinary work - a traditional strength of the Carnegie Mellon community - is thus vital to the department. Issues addressed include classical philosophical ones, e.g., the nature of mind, the analysis of causality, the basis of moral action. But they are most often addressed in novel ways and explored in connection with research in appropriate disciplines. Consequently, many members of the department are engaged in interdisciplinary research projects, and courses and seminars with members of other departments are a regular feature of Philosophy's offerings.

The department offers three different undergraduate major degree programs: a (BA) major in Philosophy with a specialty in ethics; a (BS) major in Logic and Computation; and a (BS) major in Computational Linguistics. In addition, the Department sponsors minors in Philosophy, Ethics, Logic & Computation, and Computational Linguistics. The department also offers M.S. and Ph. D. degrees in Logic & Computation and Computational Linguistics. Both M.S. programs build on the undergraduate programs, so that majors can complete the requirements for the M.S. degree in one additional year.

The Major in Philosophy

Preston Covey, Director
Office: Hamburg Hall 241

The Major in Philosophy is intended to be flexible and to allow double majoring in other fields (also in majors with a strong professional focus). We encourage students to create a thematic concentration through their electives. For example, studies in political and moral issues can be a focus through "Game Theory," "Philosophy, Politics, and Economics," and "Environmental Ethics." 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&SS students) only one of them may be counted also as satisfying the College's General Education requirements (distributional categories 1-4).

Area 1 - Values & Normative Theory **9 units**
One of the following:

Ethics/Ethical Theory (80-x00, or 80-x30 through 80-x34)
Social/Political Philosophy (80-x35 through 80-x39)
Applied/Professional Ethics ((80-x40 through 80-x49)
Aesthetics (80-x60)

Area 2 - Philosophy of Mind / Language / Metaphysics **9 units**
One of the following:
Philosophy of Mind/Metaphysics (80-x70 through 80-x79)
Philosophy of Language (80-x80 through 80-x89)

Area 3 - Logic / Philosophy of Mathematics **9 units**
One course (80-x10 through 80-x19)

Area 4 - Epistemology / Methodology **9 units**
One of the following:
Epistemology/Methodology (80-x00 through 80-x09)
Philosophy of Science (80-x20 through 80-x29)

Area 5 - History of Philosophy **18 units**
Two courses (80-250 through 80-259)

Area 6 - Electives **27 units**
Three courses (80-xxx)

Philosophy, B.A.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Area 1 course	Area 3 course	Area 5 course	Area 6 course
Area 2 course	Area 4 course	Area 6 course	Area 6 course
Area 5 course	Elective	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" schedule 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.

Sample Curricula

Here are two sample curricula, reflecting different emphases:

1. For an emphasis on Ethics and Social Philosophy, a student might take:

Area 1 — Ethical Theory
Area 2 — Philosophy of Mind
Area 3 — Logic of Mathematics
Area 4 — Philosophy of Social Science
Area 5 — Presocratics; Ancient Philosophy
Area 6 — Metaphysics; Philosophy, Politics & Economics
Philosophy of Law

2. For an emphasis on Epistemology, a student might take:

Area 1 — Modern Political Philosophy
Area 2 — Philosophical Issues in Cognitive Psychology
Area 3 — Arguments and Inquiry
Area 4 — Minds, Machines and Knowledge
Area 5 — Ancient Philosophy, Modern Philosophy
Area 6 — Philosophy of Science, Philosophy of Mathematics, Logic and Computability I

Degree Requirements (summary)

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Philosophy major requirements		81 units
Free Electives	(max.)	153 units
Degree Requirements (minimum)		**360 units**

The Double Major in Philosophy

Students who wish to double major in Philosophy must fulfill the same departmental requirements as primary majors in Philosophy. However, non-H&SS students interested in a double major in Philosophy need to take only those courses in H&SS General Education program that are explicit prerequisites for courses in the major; all other H&SS General Education requirements are waived for these students.

The Major in Logic and Computation

Teddy Seidenfeld, Director; Kevin Kelly and Peter Spirtes, Advisors
Offices: Baker Hall 135

The Major in Logic and Computation offers students a firm background in computer science together with a grounding in logic, philosophy, and formal theories of language. All are necessary for the major task of making computers serve human needs. The 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:

- the structure and principles of artificial intelligence programs;
- computational linguistics;
- logic and the theory of computation;
- computer models in cognitive psychology.

Students in the program take a common core of courses in logic, methodology, and computer science, together with a two-semester 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.

The resulting education in logic, analytic philosophy, mathematics, statistics, and computer science enables students to pursue professional careers or graduate study. It also allows them, because of the broad theoretical grounding, to adapt readily to changes in computational studies and applications. Careers that make use of this background include research programming and artificial intelligence program development; fields of graduate study for which students are well prepared are, for example, computer science, cognitive science, philosophy, and logic.

Curriculum

Logic and Computation is a B.S. degree. In the freshman and sophomore years, students are expected to take four courses that provide *preparation in mathematics and statistics*. For students in H&SS they should be viewed in the context of the categories of the General Education Program. More specifically: (1) Introduction to Modern Mathematics (21-127); (2) Discrete Mathematics (21-228) or any other Mathematics course in the Quantitative Methods option of the College's two-course B.S. degree requirement; (3) - (4) Statistical Reasoning (36-201) and (36-202) or, and that is preferred, Introduction to Probability and Statistics (36-225) and (36-226). In addition, students are asked to complete — with a grade of B or better — two prerequisites, (15-127) and (80-213), by the end of their sophomore year.

The *requirements* include a minimum of 12 courses of which six are core courses taken by all majors. These core courses provide comprehensive background in logic, computability, and analytic philosophy. Four advanced courses are chosen in the area of focus. Each student attends the "senior seminar" (80-510 and 80-511) where some topics are addressed at an advanced level and where original research is presented by students and faculty alike: In the Fall (510), the seminar meets weekly; in the Spring (511), the meetings are biweekly and students pursue concurrently a research project for the senior thesis under the direction of a faculty member.

Mathematics and Statistics Prerequisites — 27 units

21-127	Introduction to Modern Mathematics*
21-228	Discrete Mathematics (recommended), or any other Mathematics course in the Quantitative Methods option of the College's two-course B.S. degree requirement
36-202	Introduction to Statistical Methods (prerequisite: 36-201**)
or	
36-226	Probability and Statistics II (preferred, if possible; prerequisite: 36-225**)

* Can also be used to fulfill the Mathematical Reasoning requirement in the H&SS General Education program.

** 36-201 (prerequisite for 36-202) fulfills the Statistical Reasoning requirement in the H&SS General Education program. If 36-225 is taken as prerequisite to 36-226 (taken instead of 36-202), 36-225 can replace 36-201 as the General Education statistics requirement.

Other Prerequisites — 19 units

15-127	Introduction to Programming and Computer Science
80-213	Arguments and Inquiry (or 80-210)

Logic and Computation Core — 78 units

15-211	Fundamental Structures of Computer Science I †
15-212	Fundamental Structures of Computer Science II †
80-203	Minds, Machines, and Knowledge.
80-312	Probability and Artificial Intelligence
80-310	Logic and Computability I
80-410	Logic and Computability II
80-510	Logic and Computation Seminar I
80-511	Logic and Computation Seminar II

† It is recommended that students complete 15-211 and 15-212 in the sophomore year (prerequisites: 15-127 and 21-127); H&SS students can use these courses to satisfy their General Education requirement in the category Science and Technology.

Logic and Computation Electives — 36 units

Bearing in mind prerequisites, Logic and Computation majors must complete four *advanced* courses in a areas that use logical and computational tools: Computational Linguistics, Computer Science, Mathematical Logic, Mathematics, Philosophy, Psychology, Statistics. The sequence of courses at the 300+ level should be selected in consultation with the Director of the Logic and Computation Program or the Program Advisors.

Sample Curricula

Here are four samples of Logic and Computation curricula (beyond the required core courses), each reflecting a different emphasis:

1. A student interested in computational linguistics might take the following courses:

80-381	Philosophy of Language
80-384	Pragmatics
80-480	Computational Linguistics
80-581	Syntax I

2. A student interested in computer science might take the following courses:

80-411	Recursion Theory
15-411	Compiler Design
15-412	Operating Systems
15-462	Computer Graphics

3. A student interested in artificial intelligence and cognitive science might take the following courses:

80-308	Philosophical Issues in Game Theory
15-381	Artificial Intelligence: Representation and Problem Solving
85-411	Cognitive Processes and Problem Solving
36-415	Introduction to Bayesian Statistics

4. A student interested in mathematical logic might consider the following courses:

80-411	Recursion Theory
80-415	Topics in Mathematical Logic
80-416	Proof Theory (or: 80-417 Intuitionism)
21-602	Introduction to Set Theory

Logic and Computation, B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Logic and Computability I 80-310	Logic and Computability II 80-410	Logic and Computation Seminar 80-510	Logic and Computation Seminar 80-511
Minds, Machines, and Knowledge 80-203	Probability & Artificial Intelligence 80-312	Specialization course	Specialization course
Specialization course	Specialization course	Elective	Elective
Fundamental Structures of Computer Science I 15-211**	Fundamental Structures of Computer Science II 15-212**	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" schedule 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. The Logic and Computation major in particular stresses the importance, if possible, of beginning major course sequences no later than the sophomore year. Students should consult their advisor when planning their program.

**If not taken in the sophomore year (which is recommended).

Degree Requirements (summary)

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Mathematics & Statistics prerequisites		27 units
Logic & Computation major requirements		133 units
Free Electives	(max.)	74 units
Degree Requirements (minimum)		**360 units**

The Double Major in Logic and Computation

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 a double 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 seven additional courses. However, the department limits the courses that may be 'double counted': the prerequisite and core courses in the Philosophy department may not be double counted.

The B.S./M.S. Program in Logic & Computation

The M.S. degree in Logic and Computation is designed to serve the needs of graduates in other fields who desire an advanced presentation of the subjects covered in the undergraduate Logic and Computation major. It is a two-year program; however, students with suitable preparation (e.g. through the Logic and Computation major) can complete the additional requirements in one year (one academic year plus, possibly, one summer to complete the Master's essay).

Prerequisites: A bachelor's degree in any related subject, knowledge of elementary statistics, programming competence (e.g., in LISP or C), and familiarity with formal logic, including a system of quantification theory. The last three requirements can be fulfilled while in residence, but that requires a restructuring of the curriculum described below; for detailed information see the department's graduate brochure.

Requirements for *students in the two-year program*: These requirements include ten core courses and writing of a master's essay under the supervision of a faculty member.

First Year Fall	Spring	**Second Year** Fall	Spring
Logic and Computability I 80-310	Logic and Computability II 80-410	Logic and Computation Seminar 80-510	Logic and Computation Seminar 80-610
Minds, Machines, and Knowledge 80-203	Probability & Artificial Intelligence 80-312	Recursion Theory 80-411	Thesis research (Directed)
Mathematics or CS Elective	Logic Elective	Specialization	Logic Elective
Fundamental Structures of Computer Science I 15-211	Fundamental Structures of Computer Science II 15-212*	Specialization	Specialization
Elective	Elective	Elective	Elective

(1) Specialization: Any three related courses at the 400+ from offerings in Computer Science, Mathematics, Philosophy, Psychology, or Statistics, subject to advisor approval.

(2) Logic Electives: Two courses chosen from Set Theory, Proof Theory, Intuitionism, Game Theory, Decision Theory, or more general methodology courses.

(3) Master's Essay: A publishable essay on a topic relevant to the subject of Logic and Computation. The essay may be considerably shorter than a full thesis.

For *students in the five year B.S./M.S. program*, the fifth year includes at least 8 master's level courses: one of these should be in Philosophy of Language, Philosophy of Science, Philosophy of Mathematics, or Topics in Mathematical Logic; two of these should be in Recursion Theory, Set Theory, Proof Theory, Intuitionism, Game Theory, or more general methodology courses. Three courses at the 400+ level should be chosen with the advisor and focused around the topic of the Master's Essay. The remaining two courses of the minimum requirement of eight are electives at the 300+ level. Completion of a Master's Essay is the final requirement.

The Major in Computational Linguistics

David Evans, Director; Brad Pritchett, Advisor
Offices: Baker Hall 135

The Department offers a Major in Computational Linguistics. Historically, linguistics was the first of the cognitive sciences to employ complex models (informed by concepts and techniques from mathematical logic), and it continues to play a central role in the computational and cognitive sciences. Its sub-discipline concerned with natural language processing constitutes one of the most important fields within artificial intelligence. The Computational Linguistics major stresses these connections with applications and provides also a thorough grounding in theoretical studies.

The major involves course work distributed across a range of topics in computation, linguistics, and natural language processing. These include syntax, semantics, fundamental structures of computer science, logic, and computability theory.

Curriculum

The major in Computational Linguistics is a B.S. degree. As in the Logic and Computation major, students are expected to take, during their freshman and sophomore years, four courses that provide preparation in mathematics and statistics. For students in H&SS these courses should be viewed in the context of the categories of the General Education Program. More specifically: (1) Introduction to Modern Mathematics (21-127); (2) Discrete Mathematics (21-228) or any other mathematics course Mathematics course in the Quantitative Methods option of the College's two-course B.S. degree requirement; (3) - (4) Statistical Reasoning (36-201) and (36-202) or, and that is preferred, Introduction to Probability and Statistics (36-225) and (36-226). In addition, students are asked to complete — with a grade of B or better — three *prerequisites*, (15-127), (80-180), and (80-213), by the end of their sophomore year.

The *requirements* include a minimum of 12 courses of which eight are core courses taken by all majors. These core courses provide comprehensive background in logic, computability, and linguistic methods. Four advanced courses are chosen in an area of focus. It is strongly recommended that students attend the Proseminar in Computational Linguistics (80-886 and 887) in their senior year.

Mathematics and Statistics Prerequisites — 27 units

21-127	Introduction to Modern Mathematics*
21-228	Discrete Mathematics (recommended), or any other Mathematics course in the Quantitative Methods option of the College's two-course B.S. degree requirement
36-202	Introduction to Statistical Methods (prerequisite: 36-201**)
or	
36-226	Probability and Statistics II (preferred, if possible; prerequisite: 36-225**)

* Can also be used to fulfill the Mathematical Reasoning requirement in the H&SS General Education program.

** 36-201 (prerequisite for 36-201) fulfills the Statistical Reasoning requirement in the H&SS General Education program. If 36-225 is taken as prerequisite to 36-226 (taken instead of 36-202), 36-225 can replace 36-201 as the General Education statistics requirement.

Other Prerequisites — 28 units

15-127	Introduction to Programming and Computer Science
80-180	Nature of Language
80-213	Arguments and Inquiry

Computational Linguistics Core — 78 units

15-211	Fundamental Structures of Computer Science I †
15-212	Fundamental Structures of Computer Science II †
80-280	Introduction to Linguistic Analysis
80-581	Syntax I
80-582	Syntax II

80-583	Semantics
80-680	Introduction to Computational Linguistics
80-681	Natural-Language Processing I

† It is recommended that students complete 15-211 and 15-212 in the sophomore year (prerequisites: 15-127 and 21-127); H&SS students can use these courses to satisfy their General Education requirement in the category Science and Technology.

Computational Linguistics Electives — 36 units

Bearing in mind prerequisites, Computational Linguistics majors must complete four *advanced* courses in Computer Science, English, Linguistics, Logic or Mathematics, Modern Languages, Philosophy, or Psychology. The sequence of courses at the 300+ level should be selected in consultation with the Director of the Program or the Program Advisor. Note that students are encouraged to take a foreign language. Higher-level language courses (not literature) will count as electives.

Sample Curricula

Here are four samples of Computational Linguistics curricula (beyond the required core courses), each reflecting a different emphasis:

1. A student interested in methodology might take the following courses:

80-381	Philosophy of Language
80-620	Philosophy of Science
80-703	Minds, Machines, & Knowledge
80-713	Philosophy of Mathematics

2. A student interested in computer science might take the following courses:

80-411	Recursion Theory
15-411	Compiler Design
15-412	Operating Systems
15-462	Computer Graphics

3. A student interested in artificial intelligence might take the following courses:

80-308	Philosophical Issues in Game Theory
15-381	Artificial Intelligence: Representation and Problem Solving
85-411	Cognitive Processes and Problem Solving
36-415	Introduction to Bayesian Statistics

4. A student interested in mathematical logic might consider the following courses:

80-310	Logic & Computability I
80-410	Logic & Computability II
80-411	Recursion Theory (or: 80-415)
80-416	Proof Theory (or: 80-417)

Computational Linguistics, B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Logic and Computability I 80-310	Introduction to Linguistic Analysis 80-280	Syntax I 80-581	Syntax II 80-582
Introduction to Computational Linguistics 80-680	Logic and Computability II 80-410	BS Elective I	Semantics 80-583
Fundamental Structures of of CS I 15-211	Fundamental Structures of of CS II 15-212	CL Proseminar I 80-886	CL Proseminar II 80-886
Elective	Elective	BS Elective II	Natural Language Processing I 80-681

* NOTE: This "suggested" schedule 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. The Computational Linguistics major in particular stresses the importance, if possible, of beginning major course sequences no later than the sophomore year. Students should consult their advisor when planning their program.

Degree Requirements (summary)

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Mathematics & Statistics prerequisites		27 units
Logic & Computation major requirements		142 units
Free Electives	(max.)	65 units
Degree Requirements (minimum)		**360 units**

Double Major in Computational Linguistics

The Computational Linguistics major is also suitable as a second major for students in H&SS or for students in other colleges within the University, in particular for students in computer science. Non-H&SS students interested in a double major in Computational Linguistics 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 Computational Linguistics can be fulfilled with as few as eight additional courses. However, the department limits the courses that may be 'double counted': the prerequisite and core courses in the Philosophy department may not be double counted.

The B.S./M.S. Program in Computational Linguistics

Students who are completing the requirements for the B.S. degree in Computational Linguistics may apply to take an extra year and receive an M.S. degree. This application (obtained from the department) should be submitted by the end of the Fall semester in the Senior year. Since the work for a B.S. degree includes all the courses that would normally be required of first-year master's students, completing the M.S. degree entails taking the required and elective courses currently offered to second-year master's students, as indicated in the following two sections.

Required Courses, Beyond the B.S., for an M.S., Degree (36 units)

Students must complete four electives (36 units) at the 400+ level, concentrated in an area chosen in consultation with the graduate student advisor. These would usually include topical courses in CL, offered, roughly, twice each year. Note: students who have not had 15-381 Artificial Intelligence: Representation and Problem Solving will be required to take this course as one of the four electives.

Additional Requirements, Beyond the B.S., for an M.S. Degree

In addition to course work, students are expected to satisfy the "Master's Examination" requirement-either a Master's Paper, or a Master's Project, or the Master's-Level Comprehensive Examination.

Sample B.S./M.S. Program

The following illustrates one possible fifth year plan for an M.S. degree, building on the curriculum suggested above. Note that after the fourth year, the student would receive the B.S. degree.

Fifth Year

Fall	Spring
Natural Language Processing II	Natural Language Processing III
Directed Research in CL I	Directed Research in CL II
MS Elective I	MS Elective III
MS Elective II	MS Elective IV

Philosophy Minors

Each of the majors in the Department allows for minors; in addition, there is a minor in ethics. 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 Philosophy

In addition to the general education requirements of the student's college and those requirements of the student's major, Philosophy minors must satisfy the following requirements:

Area 1 - Logic / Methodology — 9 units

One of the following:
(80-x10 through 80-x19) or (80-x20 through 80-x29)

Area 2 - History of Philosophy — 18 units

Two courses (80-250 through 80-259)

Area 3 - Electives **18 units**
Two courses (80-xxx) at the 200-level or higher.

The Minor in Ethics

With the explosive growth of science and technology have come not only new possibilities, but new problems as well. Developments in medicine, in biology, in chemistry, in nuclear engineering or in computer science all have their costs as well as their benefits, and they present us with many hard choices. Most of these new problems are at least in part 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.

In addition to the general education requirements of the student's college and those requirements of the student's major, Ethics minors must satisfy the following requirements:

Area 1 - Values & Normative Theory **27 units**
Three courses from any of the following areas, two at the 200-level or higher:
Ethics / Ethical Theory (80-x30 through 80-x34)
Social /Political Philosophy (80-x35 through 80-x39)
Applied / Professional Ethics (80-x40 through 80-x49)

Area 2 - Electives **18 units**
Two courses (80-xxx) at the 200-level or higher.

The Minor in Logic and Computation

The Philosophy Department's minor in Logic and Computation provides students with extended general course work in computation theory, logic, and philosophy. Students must complete seven courses.

80-213	Arguments and Inquiry (or: 80-210)
80-310	Logic and Computability I
80-410	Logic and Computability II
80-312	Probability and Artificial Intelligence
80-203	Minds, Machines, and Knowledge.

In addition to these core courses, students must choose - in consultation with the program director - two courses in one of the following areas: Computer Science, Linguistics, Mathematics, Psychology, Philosophy, or Statistics

The Minor in Computational Linguistics

Students who wish to receive a minor in Computational Linguistics must complete the following seven courses:

80-180	Nature of Language (or: 80-182, 80-183)
80-213	Arguments and Inquiry
80-280	Introduction to Linguistic Analysis
80-581	Syntax I
80-583	Semantics
80-680	Introduction to Computational Linguistics
80-681	Natural Language Processing I

The Honors Program

The H&SS Senior Honors Program provides recognition of outstanding performance by students in Philosophy, Logic and Computation, and Computational Linguistics. Students have the opportunity to develop their skills and 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." In Computational Linguistics, the "honors" project is completed through two additional courses, Natural-Language Processing II and Natural-Language Processing III, with a grade of "B" or better in each. 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 department to become a participant.

Faculty

CRISTINA BICCHIERI, Associate Professor of Philosophy and Social and Decision Sciences— Ph.D., Cambridge University; Carnegie Mellon, 1989 —.

ROBERT CARPENTER, Assistant Professor of Computational Linguistics — Ph.D., Edinburgh University; Carnegie Mellon, 1990 —.

DAVID CARRIER, Professor of Philosophy — Ph.D., Columbia University; Carnegie Mellon, 1973 —.

PRESTON K. COVEY JR., Associate Professor of Philosophy; Director of the Center for the Advancement of Applied Ethics — Ph.D., Stanford University; Carnegie Mellon, 1974 —.

BARBARA DI EUGENIO, Lecturer — Ph.D., University of Pennsylvania; Carnegie Mellon, 1993 —.

DAVID A. EVANS, Professor of Computational Linguistics and Computer Science; Director of the Computational Linguistics Program; Director of the Laboratory for Computational Linguistics — Ph.D., Stanford University; Carnegie Mellon, 1983 —.

CLARK GLYMOUR, Alumni Professor of Philosophy — Ph.D., Indiana University; Carnegie Mellon, 1984 —.

MARTHA HARTY, Lecturer — Ph.D., University of Pittsburgh; Carnegie Mellon, 1992 —.

ALEKSANDAR IGNJATOVIC, Assistant Professor of Philosophy, — Ph.D., University of California at Berkeley; Carnegie Mellon, 1990 —.

KEVIN T. KELLY, Associate Professor of Philosophy — Ph.D., University of Pittsburgh; Carnegie Mellon, 1985 —.

PETER MADSEN, Senior Lecturer — Ph.D., Duquesne University; Carnegie Mellon, 1992 —.

CHRISTOPHER D. MANNING, Assistant Professor of Computational Linguistics — Ph.D., Stanford University; Carnegie Mellon, 1994 —.

BRADLEY PRITCHETT, Assistant Professor of Computational Linguistics — Ph.D., Harvard University; Carnegie Mellon, 1990 —.

RICHARD SCHEINES, Research Scientist — Ph.D., University of Pittsburgh; Carnegie Mellon, 1987 —.

DANA S. SCOTT, University Professor of Mathematical Logic, Computer Science and Philosophy — Ph.D., Princeton University; Carnegie Mellon, 1981 —.

TEDDY I. SEIDENFELD, Professor of Philosophy and Statistics; Director of the Logic and Computation Program— Ph.D., Columbia University; Carnegie Mellon, 1985 —.

WILFRIED SIEG, Professor of Philosophy; Head, Philosophy Department — Ph.D., Stanford University; Carnegie Mellon, 1985 —.

HERBERT SIMON, Richard King Mellon University Professor — Ph.D., University of Chicago; Carnegie Mellon, 1949 —.

PETER L. SPIRTES, Associate Professor of Philosophy — Ph.D., University of Pittsburgh; Carnegie Mellon, 1987 —.

DEIRDRE W. WHEELER, Senior Research Scientist — Ph.D., University of Massachusetts, Amherst; Carnegie Mellon, 1990—.

Department of Psychology

Roberta Klatzky, Department Head
Department Office: Baker Hall 346-C

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 do disturbances of brain chemistry in schizophrenia affect thinking?

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.

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. Some of the sub-fields within psychology are cognitive, social, personality, developmental, educational, clinical, physiological, health, and industrial. In all of these areas knowledge is established through the scientific study of human behavior.

The orientation of the Carnegie Mellon Psychology curriculum is toward developing highly skilled and knowledgeable graduates. About half of our graduates go on to graduate 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.

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 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 some university funding available to help support student-initiated research projects. In the Readings course, the student reads extensively on a particular topic, guided by a reading list jointly prepared by a faculty member and the student. The faculty member and student meet to discuss the readings, and the student writes a paper on the topic selected. The Psychology 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 project. The clinical internship takes place at the 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. In an additional semester of clinical internship the student may either pursue the clinical experience in more depth or work in a different clinical or community setting. 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

Both the B.A. and the B.S. degrees are available in Psychology. Candidates for both degrees must complete the two-semester sequences in calculus (21-111/-112, or 21-121/-122), and the two-semester statistics sequence of 36-201 (Statistical Reasoning [required as part of the H&SS General Education program]) and 36-202 (Introduction to Statistical Methods). Both sequences should be completed before the junior year. (NOTE: 21-111 or 21-121 may be applied toward the General Education program's Mathematical Reasoning requirement.) A one-semester computer science course is also required for all Psychology majors. Finally, B.S. candidates must take two additional semesters of a single science outside the department (see below), and a third statistics course.

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); it is recommended that this be done as early as possible in the student's program. (NOTE: 85-102 may also be applied to the "Cognition, Choice and Behavior" requirement in the H&SS General Education program.) Alternatively, the breadth requirement can be met by taking an additional Survey course beyond the required set of three survey courses.

There are four suggested major tracks starting with the 200-level survey courses. These are cognitive, developmental, cognitive neuroscience, and social-personality. The tracks are designed to provide increasing depth of knowledge in a particular area of psychology, although the student may elect to combine advanced courses from more than one area into a meaningful program.

The breadth requirement, three survey courses at the 200-level, two research methods courses and three more advanced courses 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 four areas in which research methods are taught. The 18-unit advanced course requirement must be fulfilled by taking content seminars or courses rather than through Independent Research, Independent Reading, or Clinical Internship courses. In addition to the small number of psychology course requirements, 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. In particular, completion of 21-111 and 21-112, (or 21-121 and 21-122) and 36-201, 36-202, the breadth requirement and one or more Psychology Survey courses would enable students to take corresponding research methods courses early in the junior year, and thus prepare interested students to take advantage of research opportunities in the department.

Mathematics and Statistics Prerequisites — 29 units

21-111* or 21-121*	Calculus I or Calculus 1
21-112 or 21-122	Calculus II or Calculus 2
36-202**	Introduction to Statistical Methods

* Can be applied to the H&SS General Education requirement in Mathematical Reasoning.

** Prerequisite: 36-201, Statistical Reasoning (the H&SS General Education statistics requirement)

Breadth Requirement — 9 units

85-102 Introduction to Psychology or a fourth survey course (see list below)

Survey Courses — 27 units

Choose three of the following five courses.

85-211 Cognitive Psychology
85-219 Biological Foundations of Behavior
85-221 Principles of Child Development
85-241 Social Psychology
85-251 Introduction to Personality

Research Methods (choose two) — 18 units

85-310 Research Methods in Cognitive Psychology
85-320 Research Methods in Child Development
85-340 Research Methods in Social Psychology
85-350 Research Methods in Cognitive Neuroscience

Advanced Courses (choose three) — 27 units

Any advanced content course or seminar in psychology (i.e., courses with 85-360 numbers and above)

Statistics Requirement (beyond 36-201/202) (B.S. only) — 9 units

36-309 Experimental Design for Behavioral and Social Sciences

Additional Course Requirement (B.A. only) — 9 units

36-309 Experimental Design for Behavioral and Social Sciences
or
85-3xx Any advanced course or seminar in psychology (i.e., with 85-360 numbers and above)

Computer Science Requirement — 10 units

15-124 or higher, or 85-120 (BA)
15-125 or higher (BS)

Science Requirement (B.S. only) — (minimum) 18 units

The Psychology major requires (for B.S. candidates) two additional science courses (in the same science) beyond the College's two-course Science and Technology General Education requirement. Both courses should come from one of the following areas: chemistry, biology, or physics*. Although the College's requirement can be met by a year of statistics, courses in statistics do not count toward this Science Requirement.

* Those interested in a cognitive neuroscience focus are recommended to take biology courses, including if possible, 03-360, The Biology of Brains.

Psychology, B.A. and B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Psychology Survey Course 85-2xx	Psychology Survey Course 85-2xx	Advanced Psychology 85-3xx and above	Advanced Psychology 85-3xx and above
Research Methods Course 85-3xx	Psychology Survey Course 85-2xx	Elective	Elective
Elective (B.A.) or Science Requirement (B.S.)	Elective (B.A.) or Science Requirement (B.S.)	Elective	Elective
Exper. Design for Behav. & Soc. Sciences 36-309 (B.S.)/ 36-309 or Advanced Psychology Course (B.A.)	Research Methods Course 85-3xx *	Elective	Elective
Computer Science Requirement (or elective if satisfied previously)	Elective	Elective	Elective

* NOTE: This "suggested" schedule is presented as a two-year (junior-senior) plan for completing major requirements, and assumes that the mathematics and statistics prerequisites, and the one-course departmental breadth requirement, have been fulfilled previously. Its purpose is to show that this program (not including the 9-unit breadth requirement) 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. More specifically (and as noted earlier), prospective Psychology majors are encouraged to complete calculus and statistics requirements, the departmental breadth requirement and one or more Psychology Survey courses before the junior year. This would enable students to take corresponding research methods courses early in the junior year, and thus prepare interested students to take advantage of research opportunities in the department. Students should consult their advisor when planning their program.

Degree Requirements (summary)

Both the B.A. and B.S. degrees are offered in Psychology. Requirements vary concerning courses taken outside the Psychology Department; however, the requirements for courses taken within the department are the same for both degrees.

H&SS General Education requirements	(min.) 108 units
H&SS College Degree requirement	(min.) 18 units
Mathematics & Statistics prerequisites	29 units
Computer Science requirement	10 units
Psychology major departmental requirements	81 units
Statistics requirement (36-309; B.S. only)	9 units
Science requirement (B.S. only)	(min.) 18 units
Additional course requirement (B.A. only)	9 units
Free Electives (B.S.)	(max.) 87 units
Free Electives (B.A.)	(max.)105 units
Degree Requirements (minimum)	**360 units**

The Major in Cognitive Science

The Psychology Department also 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 five disciplines.

Curriculum

The Cognitive Science major is only offered as a B.S. degree. Candidates must complete before the junior year the two-semester engineering and science calculus sequence (21-121/-122) rather than 21-111/112, and the two-semester General Education statistics sequence (36-201/-202). In addition, candidates complete 15-127, Introduction to Programming and Computer Science, as their departmental computing course requirement (rather than 15-124 or 15-125, taken [respectively] by B.A. and B.S. Psychology major candidates).

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 21-121, 21-122, 36-201, 36-202, and 85-211 before the junior year will enable students to complete 85-310 in the Fall semester of the junior year and, if interested, to then take advantage of research opportunities in the department.

Computing Prerequisite — 10 units

15-127 Introduction to Programming and Computer Science*

* prerequisite for 15-211

Mathematics and Statistics Prerequisites — 38 units

21-121 Calculus 1*
21-122 Calculus 2
21-127 Introduction to Modern Mathematics*
36-202 Introduction to Statistical Methods+

* Can be applied to the H&SS General Education requirement in Mathematical Reasoning

** prerequisite for 15-211

+ Prerequisite: 36-201, Statistical Reasoning (the H&SS General Education statistics requirement)

Artificial Intelligence Core — 33 units

15-211 Fundamental Structures of Computer Science I **
15-212 Fundamental Structures of Computer Science II **
15-381 Artificial Intelligence: Representation and Problem Solving
or
85-412 Production System Models of Thought
or
85-419 Introduction to Parallel Distributed Processing

** The 15-211/-212 sequence can also be used to fulfill the College's Science and Technology General Education requirement.

Cognitive Psychology Core — 36 units

85-211 Cognitive Psychology
85-310 Research Methods in Cognitive Psychology (or another Psychology Research Methods course)
36-309 Experimental Design for the Behavioral and Social Sciences

Plus one of the following:

85-411 Cognitive Processes and Problem Solving
85-412 Production System Models of Thought
85-419 Introduction to Parallel Distributed Processing
85-423 Cognitive Development

Cognitive Science Breadth Requirement — 36 units

Select four courses from the following course listing. These four courses should be combined into "tracks," developed in cooperation with the student's major advisor. Some possible tracks include: human-computer interaction, machine learning, psycholinguistics, cognitive neuroscience and natural language processing.

a) Computer Science:

15-800 Topics in Computer Science
15-385 Artificial Intelligence: Computer Vision
15-384 Robotic Manipulation
15-453 Formal Languages and Automata

b) Psychology:

85-219 Biological Foundations of Behavior
85-320 Research Methods in Child Development
85-340 Research Methods in Social Psychology
85-350 Research Methods in Cognitive Neuroscience
85-390 Human Learning and Memory
85-408 Visual Cognition
85-411 Cognitive Processes and Problem Solving
85-412 Production System Models of Thought
85-413 Psychology of Reading
85-414 Cognitive Neuropsychology
85-417 Intelligent Computer-Assisted Instruction
85-418 Development of Mathematical Thinking
85-419 Introduction to Parallel Distributed Processing
85-420 Perception and Perceptual Development
85-421 Language and Thought
85-423 Cognitive Development
85-428 Brain Development and Cognition
85-611 Honors Thesis

c) Philosophy:

80-203 Minds, Machines and Knowledge
80-210 Introduction to Logic
80-211 Introduction to Formal Languages and Automata
80-215 Logic and Inductive Inference
80-220 Philosophy of Science
80-270 Foundations of Psychological Theory
80-310 Logic and Computability I
80-312 Probability and Artificial Intelligence
80-410 Logic and Computability II
80-370 Philosophical Issues in Cognitive Psychology
80-510 Seminar in Logic and Computation

d) Linguistics:

76-382 Introduction to Linguistic Analysis
76-380 Prescriptive Linguistics
76-385 Discourse Analysis
80-280 Introduction to Linguistic Analysis
80-281 Philosophy of Language
80-581 Syntax I
80-583 Semantics
80-384 Pragmatics
80-585 Topics in the Philosophy of Language
80-480 Computational Linguistics
80-681 Natural Language Processing I
80-682 Natural Language Processing II
80-485 Language and Learning Theory

e) Decision Sciences:

88-301 Psychology of Incoherent Decision Making
88-302 Behavioral Decision Theory
88-306 Artificial Intelligence and Decision Making
88-366 Social Issues in Computing
88-367 Computers in Organizations

f) Neurosciences:

03-360 The Biology of the Brain
42-500 Physiology
42-695 Sensory Processes: Perception and Psychophysics
42-820 Experimental Electrophysiology

Appropriate courses offered by the Department of Behavioral 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 Behavioral Neurosciences):

1003 Introduction to Neuroscience
1013 Functional Neuroanatomy
1014 Neurophysiology
1021 Sensory Physiology
1030 Psychiatric Disorders and Brain Function
1040 Biological Basis of Learning and Memory

g) Further courses selected in consultation with one's Psychology faculty advisor.

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: chemistry, biology, or physics.

Cognitive Science, B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Fundamental Structures of Computer Science I 15-211	Fundamental Structures of Computer Science II 15-212	Third AI Core course	Elective
Elective	Elective	Cognitive Science Breadth course	Cognitive Science Breadth course
Cognitive Psychology 85-211	Research Methods in Cognitive Psychology 85-310	Third Cognitive Psychology Core course	Elective
Exper. Design for Behav. & Soc. Sciences 36-309	Elective	Cognitive Science Breadth course	Cognitive Science Breadth course
Supplementary Science requirement	Supplementary Science requirement	Elective	Elective

* NOTE: This "suggested" schedule is presented as a two-year (junior-senior) plan for completing major requirements, and assumes that the computing, mathematics and statistics prerequisites have been fulfilled previously. Its purpose is to show that this program (not including prerequisites) 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. More specifically (and as noted earlier), prospective Cognitive Science majors are encouraged (because of the number and sequential nature of required courses) to complete the following before the junior year: computing, mathematics and statistics prerequisites, plus 85-211 (Cognitive Psychology survey course). This enables students to complete 15-211 and 15-212 in the junior year, and 85-310 in the Fall semester of the junior year. Then, if interested, majors are able to take advantage of research opportunities in the department. Students should consult their advisor when planning their program.

Degree Requirements (summary)

The Cognitive Science major is offered only as a B.S. degree.

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Computer Science prerequisite		10 units
Mathematics & Statistics prerequisites		38 units
Cognitive Science major requirements		
(A.I. Core + Cog. Psy. Core + Cog. Sci. Breadth)		105 units
Supplementary Science requirement	(min.)	18 units
Free Electives	(max.)	63 units
Degree Requirements (minimum)		**360 units**

Double Majors in Psychology

In order to complete a double 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 36-201/202 statistics sequence (or its approved equivalent). In addition, B.S. candidates must take the two-course science requirement and 36-309, Experimental Design for the Behavioral and Social Sciences. B.A. candidates may substitute a third advanced psychology course for 36-209. Note: For double majors who have taken 85-101, General Psychology, prior to declaring the second major in Psychology, 85-101 may be substituted for 85-102 to satisfy the breadth requirement.

The Minor in Psychology

This minor in Psychology is available to all students across the university.

There are currently four curricular "tracks" in the Psychology Department. These are: cognitive psychology, developmental psychology, social-personality psychology, and cognitive-neuroscience. A number of sets of courses can form meaningful survey/research methods/advanced course groupings within the four tracks.

Requirements (total 63 units)

Three courses from categories I and II, with no more than one from category I.

I. Introductory courses

(Choose a maximum of one course)

85-100	Cognitive Processes: Theory & Practice
85-101	General Psychology(self paced)
85-102	Introduction to Psychology

II. Area Survey courses

(Choose a minimum of two courses)

85-211	Cognitive Psychology
85-219	Biological Foundations of Behavior
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Personality

III. Statistics

At least one course in Statistics equivalent to 36-202.

Plus three courses from categories IV and V, with at least one course from each.

IV. Research Methods courses

85-310	Research Methods in Cognitive Psychology
85-320	Research Methods in Developmental Psychology
85-340	Research Methods in Social Psychology
85-350	Research Methods in Cognitive Neuroscience

V. Advanced courses

These courses exist within each of the above four tracks, and carry course numbers from 85-360 to 85-599. No more than one of these an be a reading, independent research, or clinical internship course.

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. Additional information can be obtained from Ms. Joan Meyers,(412) 268-5690.

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 his or her department to become a participant.

Faculty

KAREN ADOLPH, Assistant Professor of Psychology — Ph.D., Emory University; Carnegie Mellon, 1994—.

MARTHA WAGNER ALIBALI, Assistant Professor of Psychology — Ph.D., University of Chicago; Carnegie Mellon;1994—.

JOHN R. ANDERSON, Walter Van Dyke Bingham Professor of Psychology — 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, Adjunct Associate Professor of Psychology, — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993—.

MARGARET S. CLARK, Professor of Psychology — Ph.D., University of Maryland; Carnegie Mellon, 1977—.

JONATHAN D. COHEN, Assistant Professor— Ph.D., Carnegie Mellon University, Carnegie Mellon, 1990—.

SHELDON COHEN, Professor of Psychology — Ph.D., New York University; Carnegie Mellon, 1982—.

JOHN R. HAYES, Professor of Psychology — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1965—.

VICKI S. HELGESON, Assistant Professor — Ph.D., University of Denver; Carnegie Mellon, 1990—.

MARK H. JOHNSON, Associate Professor — Ph.D., University of Cambridge, UK; Carnegie Mellon, 1991—.

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, Head, Psychology Department — Ph.D., Stanford University; Carnegie Mellon, 1993—.

KENNETH KOTOVSKY, Associate Professor of Psychology, Director, Undergraduate Studies in Psychology — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1988— .

JILL H. LARKIN, Associate Professor of Psychology — Ph.D., University of California, Berkeley; Carnegie Mellon, 1978—.

STEPHEN J. LEPORE, Assistant Professor — Ph.D., University of California, Irvine; Carnegie Mellon, 1991—.

BRIAN MACWHINNEY, Professor of Psychology — Ph.D., University of California, Berkeley; Carnegie Mellon, 1981—.

JAMES MCCLELLAND, Professor of Psychology — Ph.D., University of Pennsylvania; Carnegie Mellon, 1984—.

LYNNE M. REDER, Associate Professor of Psychology — Ph.D., University of Michigan; Carnegie Mellon, 1978— .

MICHAEL SCHEIER, Professor of Psychology — Ph.D., University of Texas; Carnegie Mellon, 1975—.

ROBERT S. SIEGLER, Professor of Psychology — Ph.D., State University of New York, Stony Brook; Carnegie Mellon, 1974—.

HERBERT A. SIMON, Richard King Mellon Professor of Computer Science and Psychology — Ph.D., University of Chicago; Carnegie Mellon, 1949—.

EDWARD ZUCKERMAN, Adjunct Associate Professor of Psychology — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1988—.

Department of Social and Decision Sciences

Steven Klepper, Department Head
Department Office: Porter Hall 208

The Department of Social and Decision Sciences is an interdisciplinary undergraduate and graduate department in the College of Humanities and Social Sciences. Four undergraduate majors are offered (all B.S. degrees): Information and Decision Systems, Policy and Management, Political Science and Social and Decision Sciences. Departmental minors are offered in Information and Decision Systems, Political Science, and Public Management; interdisciplinary/interdepartmental minors in which the department participates include Sociology and International Affairs. The department's faculty represent a wide array of disciplines, including political science, sociology, organizational theory, economics, psychology, information systems, decision sciences, and public policy. Despite the diversity of the department's faculty, the department's teaching and research programs grow out of several intertwined intellectual themes that cut across the social sciences: decision theory, organization theory, and the impact of technology on society.

The multidisciplinary character of the department provides a unique opportunity for innovative research. Research areas of particular strength within the department include: behavioral decision theory, experimental political science and economics; social network theory; evolutionary and biological theories applied to economics and political science; organization ecology; political psychology; and bureaucratic politics. As this list indicates, members of the department stress the development of theories of social phenomena that do not always fit neatly into traditional disciplinary boundaries. There is a complementary emphasis on empirical testing of theory, leading to a common concern with methodology. Much of the research in the department has important and direct public policy implications in areas such as technology policy, health policy, federal budget policy, and the social and organizational impacts of computing.

The interdisciplinary style of the department is reflected in its unique teaching programs. All of the department's core offerings for its majors are innovative, interdisciplinary courses. They provide the basis for an exciting, integrated and distinctive curriculum in each of the department's majors.

In its undergraduate teaching, graduate education, and research activities, the department interacts closely with several other departments and colleges. The department currently has joint class offerings or programs of instruction with the H.J. Heinz III School of Public Policy and Management, the Department of Engineering and Public Policy, the Statistics Department, and the History Department. This adds additional flexibility and opportunities for students in the department.

The Major in Information and Decision Systems

Douglas Wholey, Director
Office: Porter Hall 208F

Governments, non-profit organizations and private sector firms, ranging from multinational corporations to small businesses, use computer-based management information systems. These systems gather, process, and analyze information for planning, operational, and decision making purposes. Examples of such systems range from airline reservation systems to accounts receivable software on a personal computer for the small business manager. Such systems aid in the day-to-day business of running the organization. -Increasingly, modern organizations are using computer-based systems - such as, data base systems, decision support systems, and expert systems - to make strategic decisions. For example, decision support systems help city planners determine how best to allocate city funds to mitigate the devastating effects of future earthquakes. Expert systems are being used to design computers and to do medical diagnoses. The managers of organizations who wish to maintain or develop such systems require personnel who understand how to design and maintain large scale data management systems, keep up with the rapid advances in computer and networking technology, and have the person skills to manage large projects. Yet, there is a shortage of people with both technical and managerial skills. This major gives students the tools needed to develop and use computer-based systems, the empirical skills needed to analyze such systems, and the organization and management background needed to manage the personnel needed to develop such programs.

The Information and Decision Systems major prepares students for a career in the rapidly changing area of computer-based management information systems and decision support systems. Students learn both the technical skills needed to design, analyze, implement, and maintain information systems; the analytical skills needed to analyze system usage, user interfaces, and reports; and the social and managerial skills needed to manage the process of system development and work with groups of users. These skills are developed both through hands-on training in a series of increasingly detailed project courses and through courses focusing on the analytical tools and organizational theory and policy. Students use state-of-the-art computer-aided design tools, modern data base management tools, and decision tools. In the information and decision systems area, changes are occurring almost daily in computer and computer-networking hardware and software. The goal of the program is to give students the knowledge and skills necessary to keep abreast of such changes, and not to simply acquaint them with the current "state of the art".

To keep pace with the rapidly changing technological developments in computer science and software engineering, as well as the cost/performance capabilities of computer hardware, Information and Decision Systems majors must master the fundamentals of programming, software design and analysis, and data base structures. To implement and to manage effectively large information systems, decision support systems, and expert systems, students must master the fundamentals of knowledge engineering and decision support techniques such as statistics, economic analysis, and decision analysis. They also must understand how individuals and organizations make decisions. The diverse background provided by the Information and Decision Systems major helps students attain the broad-based understanding needed for a career in this area.

The employment opportunities for graduates of the Information and Decision Systems program are diverse and extensive. The salaries compare favorably with those for graduates of other technically and managerially-oriented programs. Students are prepared for possible professional careers in consulting, management of technology, management information systems, system programming, system design, system analysis, decision support systems, information system sales, and data base design. Students are prepared for graduate education in business, information systems, law and technology, organizations, and with appropriate electives, sociology, political science, and decision theory. By taking the appropriate course electives or concentrations, additional career opportunities are made available in law and technology, software engineering, expert systems, knowledge engineering, or application of computer-based information systems in politics, government relations, or the arts. In addition to these career opportunities for the student earning the B.S. degree, students in good standing can apply to the Heinz School 3/1/1 program or the GSIA 3/2 program where in 5 years students get both a B.S. in Information and Decision Systems and an M.S. in Public Management and Policy or an M.S. in Industrial Administration.

Curriculum

All Information and Decision Systems majors must satisfy the H&SS General Education requirements for the B.S. degree. In addition to College General Education Program requirements, Information and Decision Systems majors must complete computing, mathematics and statistics prerequisites (see below) by the end of the sophomore year.

Computer Science Prerequisites — 19 units

15-125	Introduction to Programming & Computation (Prerequisite for 15-200)
plus	
15-200	Data Structures**
OR	
15-127	Introduction to Programming & Computer Science (Prerequisite for 15-211; also suffices as prerequisite for 15-200)
plus	
15-211	Fundamental Structures of Computer Science I** (Prerequisites: 15-127 [as noted above] plus 21-127, Introduction to Modern Mathematics)

** See note below under course category "Information and Decision Systems: Theory and Practice."

Mathematics and Statistics Prerequisites — 29 units

21-111	Calculus I (or 21-121, Calculus 1)*
21-112	Calculus II (or 21-122, Calculus 2)*
36-202	Introduction to Statistical Methods (prerequisite: 36-201, Statistical Reasoning [the H&SS General Education Statistics requirement])

* NOTE: Information and Decision Systems majors interested in the major's optional Computer Science Concentration should take 21-121 and 21-122 instead of 21-111 and 21-112.

Information and Decision Systems: Theory and Practice — 51 units

88-200	Structured Analysis and Design ** (taken concurrently with 88-204)
88-201	Data Base Management Systems**
88-202	Information Systems Applications
88-204	Structured Analysis and Design Lab**
88-223	Decision Analysis and Decision Support Systems

PLUS

At least 6 units of a computer language other than Pascal (e.g., Cobol, C++, Lisp, Prolog) or 15-312, 85-110 or 90-875/90-876. *

** NOTE: Prospective Information and Decision Systems majors should take 15-200, Data Structures, or 15-211, Fundamental Structures of Computer Science I, prior to their junior year. IDS majors are required to achieve a grade of at least a C in 15-200 or 15-211 before being allowed to continue on to 88-202. IDS majors must successfully complete 88-200, 88-201, and 88-204 to continue on to 88-202. Students who fail to meet this requirement, who believe there are extenuating circumstances and who still want to major in IDS, may request a review of their case from the IDS program director and will be appropriately advised.

* NOTE: The course 15-212 cannot be substituted for this computer language requirement.

Research Methods — 18 units

88-240	Empirical Research Methods I
88-241	Empirical Research Methods II

Theoretical Perspectives — 18 units

88-220	Policy Analysis I
88-260	Organizations

Management, Decision Making and Technology — 18 units

Select two courses from the following lists of courses. You may select two (2) courses from List A or one (1) course from List A and one (1) course from List B.

List A

88-222	Policy Analysis III
88-312	Political Psychology and Sociology
88-313	Introduction to Models of Political Science
88-316	Social Theory and Analysis
88-317	Social Structures and Human Development
88-323	Legislative Processes
88-338	Health Care Policy
88-342	Market Organization and Business Behavior
88-343	Economics of Technological Change
88-344	Strategic Games and Decisions
88-345	The Rise of Industrial Research and Development
88-361	Technology and Social Change
88-366	Social Issues in Computing
88-367	Computers in Organizations
88-368	User Interface Design
88-470	Advanced Projects in Information and Decision Systems

List B

15-312	Programming Languages: Design and Processing
15-381	Artificial Intelligence: Representation & Problem Solving
15-412	Operating Systems
15-413	Software Engineering
15-414	Structured Programming and Program Proving
15-462	Computer Graphics
19-402/	Telecommunications Policy
19-714	Telecommunications Policy (mini)
19-448	Science, Technology and Ethics
51-170/1	Graphic Design Fundamentals
51-180	Industrial Design Fundamentals
70-455	Business Applications of Artificial Intelligence
70-457	Technology, Innovation and Implementation in Organizations
70-510	Management Research Experience I
70-511	Management Research Experience II
76-392	Integrating Visual and Verbal Text
76-470	Professional and Technical Writing
76-475	Writing in Software Engineering
79-224	Technology and Values
79-226	Technology in Western Civilization
79-254	Professions in Society
79-359	Technology and Organization
79-405	Science, Technology and Business in U.S. History
80-203	Minds, Machines, and Knowledge
80-241	Ethical Judgments in Professional Life
80-242	Conflict and Dispute Resolution
80-243	Business and Ethics
80-244	Management, Environment and Ethics
80-312	Probability and Artificial Intelligence
80-411	Recursion Theory
80-480	Introduction to Computational Linguistics
85-393	Human Factors
85-417	Intelligent Computer-Assisted Instruction
90-745	Decision Support Systems for the Public Sector
90-754	Object Oriented Software Analysis & Design
90-768	Telecommunications Policy
90-784	Geographic Information Systems
90-802	Computer Applications for Public Managers

Optional Concentrations

The Information and Decision Systems program offers six optional concentrations for its majors: one each in computer science, artificial intelligence and expert systems, business management, public management, political and social analysis, and user interface design. Courses in these options would be taken in addition to all other major requirements with the one following exception. Students can count one course in an option toward the requirements in the Management, Decision Making and Technology portion of the major. Optional concentrations are simply a course of study in a particular area that students might choose to follow in order to build up special areas of expertise. These concentrations are not minors and are not reflected on the student's transcript. Information and Decision Systems majors are not required to choose a concentration.

1. Information and Decision Systems Major (Computer Science Concentration)

Mathematics Prerequisites:

21-121	Calculus 1 (instead of 21-111)
21-122	Calculus 2 (instead of 21-112)

Information and Decision Systems requirements:

21-127	Introduction to Modern Mathematics (addition)
15-211	Fundamental Structures of Computer Science I (instead of 15-200)
15-212	Fundamental Structures of Computer Science II

PLUS at least two of the following courses:

15-312	Comparative Languages
15-381	Artificial Intelligence: Representation and Problem Solving
15-384	Robotic Manipulation
15-385	Computer Vision
15-411	Compiler Design
15-412	Operating Systems
15-413	Software Engineering
15-462	Computer Graphics 1
15-681	Machine Learning

2. Information and Decision Systems Major (Artificial Intelligence and Expert Systems Concentration)

Lisp course (as the 6-unit programming course required for the major)

PLUS at least four of the following courses:

80-312	Probability and Artificial Intelligence
85-411	Cognitive Processes and Problem Solving
85-417	Intelligent Computer-Assisted Instruction
85-419	Introduction to Parallel Distributed Processing
15-381	Artificial Intelligence: Representation and Problem Solving
15-681	Machine Learning
70-455	Business Applications of Artificial Intelligence

3. Information and Decision Systems Major (Business Management Concentration)

70-122	Introduction to Accounting

PLUS at least three of the following courses:

21-257	Optimization for the Social Sciences
70-371	Production I
70-381	Marketing
70-391	Finance I
70-422	Cost Accounting
70-471	Production II
70-481	Marketing Research I
70-491	Finance II
88-342	Market Organization and Business Behavior
88-367	Computers in Organizations

4. Information and Decision Systems Major (Public Management Concentration)

88-221	Policy Analysis II
88-222	Policy Analysis III

PLUS at least two of the following courses:

88-321	Campaigns and Elections
88-322	Elections, Interest Groups, and Public Policy
88-323	Legislative Processes
88-338	Health Care Policy
88-344	Strategic Games and Decisions
88-361	Technology and Social Change
88-366	Social Issues in Computing
88-425	Regulatory Processes
79-252	The American Presidency

5. Information and Decision Systems Major (Political and Social Analysis Concentration)

Choose four of the following courses:

88-312	Political Psychology and Sociology
88-316	Social Theory and Analysis
88-320	U.S. - Soviet Relations: From Confrontation to Cooperation
88-321	Campaigns and Elections
88-322	Elections, Interest Groups, and Public Policy
88-323	Legislative Processes
88-331	Europe in Transition: The Cold War and Alternative Systems for Conflict Management
88-333	The Cold War in Historical Perspective
88-338	Health Care Policy
88-361	Technology and Social Change
88-366	Social Issues in Computing
88-367	Computers and Organizations
79-202	Introduction to Anthropology
79-221	A History of American Urban Life
79-226	Technology in Western Civilization
79-230	Population and History
79-234	The Development of the Modern Mind
79-264	Gender Roles and Social Change
79-303	Peasants in History
79-359	Technology and Organization
79-402	Research Seminar in Anthropology and History

6. Information and Decision Systems Major (User Interface Concentration)

88-367	Computers in Organizations

PLUS one of the following courses:

85-393	Human Factors
88-368	User Interface Design

PLUS two of the following courses:

15-462	Computer Graphics 1
51-170/1	Graphic Design Fundamentals
51-180	Industrial Design Fundamentals
51-302	Contemporary Design
76-392	Integrating Visual and Verbal Text
76-470	Professional and Technical Writing
76-475	Writing in Software Engineering
85-393	Human Factors
85-417	Intelligent Computer Assisted Instruction
88-368	User Interface Design
90-768	Telecommunications Policy
90-802	Computer Applications for Public Managers

Information and Decision Systems, B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Organizations 88-260	Decision Analysis & Decision Support Systems 88-223	Policy Analysis I 88-220	88-470 or Elective
Additional computer programming course	Management, Decision Making & Technology course	Management, Decision Making & Technology course	88-471 or Elective
Structured Analysis & Design 88-200 & Lab 88-204	Data Base Management Systems 88-201	Information Systems Applications 88-202	Elective
Empirical Research Methods I 88-240	Empirical Research Methods II 88-241	Elective	Elective
Elective	15-200** Data Structures or 15-211** Fundamental Structures of Computer Science I	88-501 Honors Thesis or Elective	88-502 Honors Thesis or Elective

* NOTE: This "suggested" schedule is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program (not including prerequisites) 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.

** NOTE: As previously noted, prospective Information and Decision Systems majors should take 15-200, Data Structures, or 15-211, Fundamental Structures of Computer Science I, prior to their junior year. IDS majors are required to achieve a grade of at least a C in 15-200 or 15-211 before being allowed to take 88-202. IDS majors must also successfully complete 88-200, 88-204, and 88-201 to continue on to 88-202. Students who fail to meet this requirement, who believe there are extenuating circumstances and who still want to major in IDS, may request a review of their case by the IDS Program Director and will be appropriately advised.

Degree Requirements (summary)

The Information and Decision Systems major is offered only as a B.S. degree.

H&SS General Education requirements	(min.)108 units
H&SS College Degree requirement	(min.) 18 units
Computer Science prerequisites	(min.) 19 units
Mathematics and Statistics Prerequisites	29 units
Major Requirements	105 units
Electives	(max.) 80 units
Degree Requirements	**(minimum) 360 units**

Double Majors

Students who elect Information and Decision Systems as part of an additional, or double major must fulfill all Information and Decision Systems major requirements. Because of the rigorous technical requirements for the Information and Decision Systems major, it may prove difficult to combine Information and Decision Systems with some other degree programs and still complete the program in four years. It is possible, however, to combine the Information and Decision Systems program with a number of majors, and still graduate after the normal eight-semester undergraduate time frame.

Students pursuing a double major in Information and Decision Systems/ Social and Decision Sciences may only count 88-240, 88-241, and 88-260 toward the completion of both majors. Students

pursuing a double major in Information and Decision Systems/Policy and Management may only count 88-220, 88-223, 88-240, 88-241 and 88-260 toward the completion of both majors. Students pursuing a double major in Information and Decision Systems/Political Science may only count 88-220, 88-240, and 88-241 toward the completion of both majors.

Students contemplating a double major in Information and Decision Systems are advised to begin planning it (with appropriate advisors) as soon as possible. This is particularly true of students whose other major has a complex set of requirements and prerequisites.

The Major in Policy and Management

Wesley Cohen, Director
Office: Porter Hall 319B

The Policy and Management major prepares students for decision making and management roles in government, the non-profit sector, and business. The major emphasizes basic skills and concepts that enhance an individual's ability to understand why individuals and organizations behave the way they do as well as to choose rationally among competing courses of action and to organize the actions of those who will carry out those decisions.

The Policy and Management major is comprised of four clusters of courses. The Analytical Methods cluster consists of four courses that provide theoretical training and practical experience in using analytical methods for problem solving and decision making. These courses provide systematic methods for dealing with the complexities that make decisions difficult. One complication is risk or uncertainty about the possible consequences of different courses of action. For instance, when businesses decide to market a new product or a government agency decides to initiate a new program, the potential consequences are typically very uncertain. The Policy and Management major prepares students to use systematic procedures for analyzing decisions involving uncertainty and to make them in a way that reflects the decision maker's willingness to accept risk. Another complication in decision making is that a decision maker may be pursuing mutually conflicting objectives. For instance, the goal of reducing air pollution necessarily conflicts with the objective of producing manufactured goods at the lowest possible cost. The Policy and Management major grounds students in a variety of methods for dealing with such goal conflicts. Finally, the major gives students a thorough grounding in the economic analysis of decisions. A central issue addressed here concerns the proper roles of government and private markets. What kinds of decisions are better made by government and which can better be made by private markets?

The Research Methods cluster is a two-course sequence that introduces students to a variety of methods for collecting and analyzing data that can be used to make informed decisions. Students learn to perform simple surveys (e.g., regarding consumer preferences or political preferences), to conduct simple experiments to evaluate theories or to test the effectiveness of different policy alternatives (e.g., evaluating a new way of organizing workers who perform a manufacturing task), and to use systematic observational and interview methods to discover how people think about important issues and perform important tasks (e.g., using a new computer system).

The Organizational Context cluster consists of single course entitled Organizations. The emphasis of this course is on how people organize and coordinate their behavior to perform complex tasks that far outstrip the capacities of any individual in the organization. The course also analyzes potential shortcomings of large organizations, such as inertia, coordination failures, and bureaucratic infighting. Knowing how organizations work is a critical component in learning how to translate decisions into action.

Finally, the Management, Decision Making, and Technology cluster consists of five courses chosen by the student to emphasize his or her primary interests. These courses are chosen from six areas of concentration that emphasize different aspects of decision making and management. These six areas are: (1) individual decision making, (2) organizational and political decision making, (3) technology and society, (4) information and decision technology, (5) financial systems and analysis, and (6) international affairs and comparative politics. A student may take all five courses in one of these concentration areas, or take courses from several of these areas. Advisors will assist students in selecting a set of courses that fit the student's interests and needs.

In short, the Policy and Management major emphasizes analytical approaches to decision making, management, and organization. It provides an excellent combination of theoretical and practical skills for students who intend to seek managerial positions immediately following graduation from Carnegie Mellon. Because of its strong analytical orientation, it is also an excellent major for those who intend to go on to professional school programs in law, business, or public policy, or to pursue graduate degrees in economics, political science, or decision science. One such option is the Heinz School 3/1/1 program where in 5 years students get both a B.S. in Policy and Management and an M.S. in Public Management and Policy.

Curriculum

Primary responsibility for the Policy and Management major resides in the Department of Social and Decision Sciences, and a large share of the required courses are taught by its faculty members. In addition, the program draws on courses offered by the departments of Industrial Management, Mathematics and Statistics, and the College of Computer Science. Many students also take courses or work on projects associated with the University's Department of Engineering and Public Policy and the H. J. Heinz III School of Public Policy and Management.

All Policy and Management majors must satisfy the H&SS General Education Program requirements for the B.S. degree. In addition to College General Education Program requirements, Policy and Management majors must complete mathematics and statistics prerequisites (see below), by the end of the sophomore year.

Mathematics and Statistics Prerequisites **29 units**

21-111	Calculus I
21-112	Calculus II
36-202	Introduction to Statistical Methods (prerequisite: 36-201, Statistical Reasoning [the H&SS General Education Statistics requirement])

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

Research Methods **18 units**

88-240	Empirical Research Methods I
88-241	Empirical Research Methods II

Organizational Context **9 units**

88-260	Organizations

Management, Decision Making and Technology **45 units**

Select five courses from the following clusters 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 in this category, and should plan to take one or more additional courses as appropriate. The selected courses may be from one cluster or from any combination of clusters. At least three of these courses (27 units) must be Social and Decision Sciences courses.

1. Individual and Social Decision Making

88-302	Behavioral Decision Making
88-309	Altruism and Selfishness
88-312	Political Psychology and Sociology
88-316	Social Theory and Analysis
88-317	Social Structures and the Organization of Human Lives
88-347	Marriage, Divorce and the Family

2. Organizational and Political Decision Making

88-311	Applied Social and Political Theory: Aids
88-313	Introduction to Models of Political Science
88-321	Campaigns and Elections
88-322	Elections, Interest Groups, and Public Policy
88-323	Legislative Processes
88-336	Educational Policy: A Historical Perspective
88-337	Health Policy Reform: A Historical Perspective
88-338	Health Care Policy
88-340	Law and Public Policy
88-342	Market Organization and Business Behavior
88-344	Strategic Games and Decisions
88-348	Family Law and Social Policy
88-425	Regulatory Processes
73-356	Political Economy of Public Institutions
73-359	Benefit Cost Analysis
73-476	American Economic History
79-252	The American Presidency

80-221	Philosophy of Social Science
80-235	Modern Political Philosophy
80-242	Conflict and Dispute Resolution

3. Technology and Society

88-343	Economics of Technological Change
88-345	The Rise of Industrial Research and Development
88-361	Technology and Social Change
88-366	Social Issues in Computing
88-367	Computers in Organizations
19-448	Science, Technology and Ethics
80-241	Ethical Judgments in Professional Life
80-244	Management, Environment and Ethics
79-226	Technology in Western Civilization
79-275	History of Modern Warfare
79-359	Technology and Organization

4. Information and Decision Technology

88-470	Advanced Projects in Information and Decision Systems
19-402/	Telecommunications Policy
19-714	Telecommunications Policy (mini)
70-455	Business Applications of Artificial Intelligence
70-457	Technology, Innovation and Implementation in Organizations
80-312	Probability and Artificial Intelligence
85-417	Intelligent Computer Assisted Instruction
88-368	User Interface Design
90-745	Decision Support Systems for the Public Sector
90-768	Telecommunications Policy
90-784	Geographic Information Systems

5. Financial Systems

70-122	Introduction to Accounting
70-391	Finance I
70-491	Finance II
70-422	Cost Accounting

6. International Affairs and Comparative Politics

88-318	Contemporary Latin American Politics
88-320	U.S. - Soviet Relations: From Confrontation to Cooperation
88-324	Comparative Politics
88-326	Issues in International Affairs
88-328	Stalin and Stalinism
88-329	Recent American Foreign Policy
88-331	Europe in Transition: The Cold War & Alternative Systems for Conflict Management
88-332	Global Security and Science
88-334	Foreign Policy Issues of the Middle East
88-341	Comparative Perspectives on Public Policy in the U.S. and Europe
70-365	International Trade and International Law
70-430	International Management
79-214	Modern Japan, 1868 to the Present
79-292	Modern Germany
79-380	Problems in National Security Since 1945

Policy and Management, B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Policy Analysis I 88-220	Policy Analysis II 88-221	Policy Analysis III 88-222	Management, Decision Making, & Technology course
Empirical Research Methods I 88-240	Empirical Research Methods II 88-241	Management Decision Making, & Technology course	Management Decision Making, & Technology course
Organizations 88-260	Decision Analysis & Decision Support Systems 88-223	Management, Decision Making, & Technology course	Management, Decision Making, & Technology course
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" schedule is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program (not including prerequisites) 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.

Degree Requirements (Summary)

The Policy and Management major is offered only as a B.S. degree.

H&SS General Education requirements	(min.) 108 units
H&SS College Degree requirement	(min.) 18 units
Mathematics & Statistics prerequisites	29 units
Major requirements	111 units
Free Electives	(max.) 94 units
Degree Requirements	**(minimum) 360 units**

Double Majors

Students who elect Policy and Management as part of a double major must fulfill all of the requirements of the Policy and Management major. Students pursuing a double major in Policy and Management/Social and Decision Sciences may only count 88-240, 88-241 and 88-260 toward the completion of both majors. Students pursuing a double major in Policy and Management/Information and Decision Systems may only count 88-220, 88-223, 88-240, 88-241 and 88-260 toward the completion of both majors. Students pursuing a double majors in Policy and Management/Political Science may only count 88-220, 88-240, and 88-241 toward the completion of both majors. Students who are interested in a double major in Policy and Management should see the Director of the Policy and Management program.

The Major in Political Science

Patrick K. Stroh, Director
Office: Porter Hall 223A

The Political Science major prepares the student for a wide variety of careers. Political Science provides a valuable background for those pursuing careers in law and journalism, as well as for those seeking professional masters degrees in business, public policy, and public administration. The major is also appropriate for a wide variety of careers in government, trade associations, lobbying groups, international organizations, business, and teaching. A recent study of teaching and research careers at universities and colleges points to a strong demand for qualified professors in political science, with only seven eligible candidates for every ten available positions in the field by the end of the 1990's.

Prior to entering the Political Science major, students complete many of the H&SS General Education requirement courses. The Political Science major builds on these courses through four 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: 88-104, Decision Processes in American Political Institutions; 88-220, Policy Analysis I; 88-240, Empirical Research Methods I; and 88-241, Empirical Research Methods II. Together these requirements provide an outstanding background in social science methods and theory, as well as solid grounding in the study of politics. Note that one of these courses, 88-104, Decision Processes in American Political Institutions, is an option in one of the H&SS General Education distributional categories ("Social, Political and Economic Institutions"), and should therefore be taken as part of the General Education Program by H&SS students interested in the Political Science major.

Having established this base, students in the Political Science major must take five upper division menu electives in the following three clusters: American Politics, International Affairs and Comparative Politics, and Political Theory and Methodology. There are a wide range of offerings within each cluster. 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. This typically involves three elective courses in one concentration and one elective course in each of the other two.

Students may also complement their formal course work with internship experiences, such as the Washington Semester Program, through which they are able to experience directly the inner workings of the U.S. Congress, executive agencies or a variety of government-related organizations. 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 Heinz School 3/1/1 program where a student can get a B.S. in Political Science after four years and an M.S. in Public Management and Policy after five years.

Curriculum

All Political Science majors must satisfy the H&SS General Education Program requirements for the B.S. degree. The mathematics and statistics prerequisites (see below) must be completed by the end of the sophomore year. In addition to College General Education Program requirements, Political Science majors must satisfy requirements in the following areas (some of these prerequisites - Decision Processes in American Political Institutions, for example - may fulfill H&SS General Education Program requirements):

Mathematics and Statistics Prerequisites — 29 units

21-111	Calculus I
21-112	Calculus II
36-202	Introduction to Statistical Methods(prerequisite: 36-201, Statistical Reasoning [the H&SS General Education Statistics requirement])

Theoretical Perspectives — 18 units

88-104	Decision Processes in American Political Institutions
88-220	Policy Analysis I

Research Methods — 18 units

88-240	Empirical Research Methods I
88-241	Empirical Research Methods II

Theories and Applications — 45 units

Select five courses from the following clusters of courses. 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. This typically involves three elective courses in one cluster and one elective course in each of the other two. At least three of these courses (27 units) must be Social and Decision Sciences courses (i.e. 88-xxx).

1. American Politics

88-321	Campaigns and Elections
88-322	Elections, Interest Groups, and Public Policy
88-323	Legislative Processes
88-336	Education Policy: A Historical Perspective
88-337	Health Policy Reform: A Historical Perspective
88-338	Health Care Policy
88-340	Law and Public Policy
88-348	Family Law and Social Policy
88-425	Regulatory Processes
70-332	Business and Society
70-361	Foundations of Law
70-363	Law in Modern American Society
73-357	Regulation: Theory and Practice
79-218	Twentieth Century America
79-241	Crime and Punishment in American Society
79-249	Power and Rights: The American Constitution
79-252	The American Presidency
79-284	American Environmental History: Critical Issues

2. International Affairs and Comparative Politics

88-318	Contemporary Latin American Politics
88-320	U.S. - Soviet Relations: From Confrontation to Cooperation
88-324	Comparative Politics
88-326	Issues in International Affairs
88-328	Stalin and Stalinism
88-329	Recent American Foreign Policy
88-331	Europe in Transition: The Cold War & Alternative Systems for Conflict Management
88-332	Global Security and Science
88-333	The Cold War in Historical Perspective
88-334	Foreign Policy Issues in the Middle East
88-341	Comparative Perspectives on Public Policy in the U.S. and Europe
70-365	International Trade and International Law
70-430	International Management
79-204	Collapse and Renewal of Europe
79-214	Modern Japan, 1868 to the Present
79-292	Modern Germany
79-380	Problems in National Security Since 1945

3. Political Theory and Methodology

88-221	Policy Analysis II
88-311	Applied Social & Political Theory: The Case of AIDS
88-312	Political Psychology and Sociology
88-313	Introduction to Models of Political Science
88-344	Strategic Games and Decisions
73-356	Political Economy of Public Institutions
73-360	Strategy in Economics and Politics
80-221	Philosophy of Social Science
80-235	Modern Political Philosophy
80-242	Conflict and Dispute Resolution

Political Science, B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Policy Analysis I 88-220	Theories & Applications 88-xxx	Theories & Applications 88-xxx	Elective
Empirical Research Methods I 88-240	Empirical Research Methods II 88-241	Theories & Applications 88-xxx	Elective
Theories & Applications 88-xxx	Theories & Applications 88-xxx	Elective	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" schedule is presented as a two-year (junior-senior) plan for completing major requirements. Its purpose is to show that this program (not including prerequisites) 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.

Degree Requirements (Summary)

The Political Science major is offered as a B.S. degree.

H&SS General Education requirements	(min.) 108 units
H&SS College Degree requirement	(min.) 18 units
Mathematics & Statistics prerequisites	29 units
Political Science Major requirements	81 units
Free Electives	(max.) 124 units
Degree Requirements (minimum)	**360 units**

Double Majors

Students may pursue the Political Science major as the second half of a double major. Students must complete all of the major's requirements as described above. Students pursuing double majors in Political Science and Information and Decision Systems, Policy and Management, or Social and Decision Sciences may only count 88-220, 88-240, and 88-241 toward the completion of both majors. These double majors cannot double count menu electives toward simultaneously fulfilling more than one major or minor.

The Major in Social and Decision Sciences

Otto A. Davis, Director
Office: Porter Hall 223F

The Social and Decision Sciences major reflects the three intellectual themes of the department. The major builds on a basic set of concepts and theories concerning decision making, information flow, and change in organizations and society. Students are first introduced to many of these concepts and theories in the H&SS General Education Program courses taken in the freshman and sophomore years. Particularly relevant are the General Education course requirements and options in such areas as cognitive psychology, social decision making, political science, economics, and statistics. After this introduction, students majoring in Social and Decision Sciences are required to take Empirical Research Methods I and II (88-240, 241). The Empirical Research Methods course sequence develops the skills required to conduct social science research. The objective of the sequence is to teach students about logically rigorous explanations of social and decision phenomena that are supported with the necessary evidence. In addition, students are required to take three theoretical courses: Policy Analysis I (88-220), Decision Analysis and Decision Support Systems (88-223), and Organizations (88-260). These courses draw on economics, political science, psychology, and economics. They provide students with a solid background in theories of individual, organizational, and societal decision making. They also analyze the impact of social, economic, and political institutions on these decisions and the social outcomes they produce.

Although all students majoring in Social and Decision Sciences begin with this common set of courses, there are many opportunities to develop individualized programs. Students are free to select at least three courses from a large set of Theories and Applications courses. They may select in a way that allows for the continued exploration of

the broad range of the department's offerings, or they may concentrate in an area in which the department is especially strong, such as behavioral decision theory, politics, organizations, or the role of technology in society. Students may also complement their formal course work with internship experiences, such as the Washington Semester Program, through which they are able to experience directly the inner workings of the U.S. Congress, executive agencies or a variety of government-related organizations. Students can also spend a semester or year of study abroad at a wide range of overseas study programs with which Carnegie Mellon is affiliated.

Because the Social and Decision Sciences major offers a rich blend of academic and practical experiences, students planning careers in law, government or business management should find it of particular interest and value. The major also provides an excellent foundation for further graduate-level work in a variety of the social, management and decision sciences. One option is the Heinz School 3/1/1 program where in 5 years the students get a B.S. in Social and Decision Sciences and an M.S. in Public Management and Policy.

Curriculum

All Social and Decision Sciences majors must satisfy the H&SS General Education Program curriculum requirements for the B.S. degree. In addition to College General Education Program requirements, Social and Decision Sciences majors must complete mathematics and statistics prerequisites (see below), by the end of the sophomore year.

Mathematics and Statistics Prerequisites — 29 units

21-111	Calculus I
21-112	Calculus II
36-202	Introduction to Statistical Methods (prerequisite: 36-201, Statistical Reasoning [the H&SS General Education Statistics requirement])

Research Methods — 18 units

88-240	Empirical Research Methods I
88-241	Empirical Research Methods II

Theoretical Perspectives — 27 units

88-220	Policy Analysis I
88-223	Decision Analysis and Decision Support Systems
88-260	Organizations

Theories and Applications — 27 units

Select three courses from the following clusters of courses. The selected courses may be from one cluster or from any combination of clusters. At least two of these courses (18 units) must be Social and Decision Sciences courses.

1. Individual and Social Decision Making

88-302	Behavioral Decision Making
88-309	Altruism and Selfishness
88-312	Political Psychology and Sociology
88-316	Social Theory and Analysis
88-317	Social Structures and Human Development
88-347	Marriage, Divorce and Family

2. Organizational and Political Decision Making

88-311	Applied Social & Political Theory: The Case of Aids
88-313	Introduction to Models of Political Science
88-321	Campaigns and Elections
88-322	Elections, Interest Groups, and Public Policy
88-323	Legislative Processes
88-336	Educational Policy: A Historical Perspective
88-337	Health Care Policy Reform: A Historical Perspective
88-338	Health Care Policy
88-340	Law and Public Policy
88-342	Market Organization and Business Behavior
88-344	Strategic Games and Decisions
88-348	Family Law and Social Policy
88-425	Regulatory Processes
70-510	Management, Research Experience I
70-511	Management, Research Experience II
73-356	Political Economy of Public Institutions
73-359	Benefit Cost Analysis
73-476	American Economic History
79-252	The American Presidency
79-384	Classics of the Social Sciences
80-221	Philosophy of Social Science
80-235	Modern Political Philosophy
80-242	Conflict and Dispute Resolution

3. Technology and Society

88-343	Economics of Technological Change
88-345	The Rise of Industrial Research and Development
88-361	Technology and Social Change
88-366	Social Issues in Computing
88-367	Computers in Organizations
19-448	Science, Technology and Ethics
80-241	Ethical Judgments in Professional Life
80-244	Management, Environment and Ethics
79-226	Technology in Western Civilization
79-275	History of Modern Warfare
79-359	Technology and Organization

4. Information and Decision Technology

88-470	Advanced Projects in Information and Decision Systems
19-402/	Telecommunications Policy
19-714	Telecommunications Policy (mini)
70-455	Business Applications of Artificial Intelligence
70-457	Technology, Innovation and Implementation in Organizations
80-312	Probability and Artificial Intelligence
85-417	Intelligent Computer Assisted Instruction
88-368	User Interface Design
90-745	Decision Support Systems for the Public Sector
90-768	Telecommunications Policy
90-784	Geographic Information Systems

5. International Affairs and Comparative Politics

88-318	Contemporary Latin American Politics
88-320	U.S. - Soviet Relations: From Confrontation to Cooperation
88-324	Comparative Politics
88-326	Issues in International Affairs
88-328	Stalin and Stalinism
88-329	Recent American Foreign Policy
88-331	Europe in Transition: The Cold War & Alternative Systems for Conflict Management
88-332	Global Security and Science
88-334	Foreign Policy Issues of the Middle East
88-341	Comparative Perspectives on Public Policy in the U.S. and Europe
70-365	International Trade and International Law
70-430	International Management
79-214	Modern Japan, 1868 to the Present
79-255	American Attitudes to European Integration
79-292	Modern Germany
79-380	Problems in National Security Since 1945

Social and Decision Sciences, B.S.

(Suggested* Schedule)

Junior Year Fall	Spring	Senior Year Fall	Spring
Policy Analysis I 88-220	Decision Analysis & Decision Support Systems/ 88-223	Elective	Elective
Empirical Research Methods I 88-240	Empirical Research Methods II 88-241	Theories & Applications 88-xxx	Elective
Organizations 88-260	Theories & Applications 88-xxx	Theories & Applications 88-xxx	Elective
Elective	Elective	Elective	Elective
Elective	Elective	Elective	Elective

* NOTE: This "suggested" schedule 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.

Degree Requirements (Summary)

The Social and Decision Sciences major is offered only as a B.S. degree.

H&SS General Education requirements	(min.) 106 units
H&SS College Degree requirement	(min.) 18 units
Mathematics & Statistics prerequisites	29 units
Major requirements	72 units
Free Electives	(max.) 133 units
Degree Requirements	**(minimum) 360 units**

Double Majors

Students may pursue the Social and Decision Sciences major as the second half of a double major. Students must complete all of the major's requirements as described above. Students pursuing double majors in Social and Decision Sciences and either Information and Decision Systems or Policy and Management may only count 88-240, 88-241 and 88-260 toward the completion of both majors. Students pursuing a double majors in Social and Decision Sciences/Political Science may only count 88-220, 88-240, and 88-241 toward the completion of both majors. Students who are interested in a double major in Social and Decision Sciences should see the Director of the Social and Decision Sciences major.

The Minor in Information and Decision Systems

Douglas Wholey, Program Director
Office: Porter Hall 208F

The minor in Information and Decision Systems is designed to provide the student with a solid introduction to the central concepts and tools needed to understand the design and management of information systems and decision support systems in organizations. This background should help students understand and appreciate the difficulties involved in developing and using computer-based systems and in managing the personnel needed to develop such systems. The broadened background in organizational theory and information system methodology will enable students to adapt to the rapid changes in technology. Students will be able to enter professional careers in consulting, management of technology, law and technology, and graduate studies.

Curriculum

In addition to the core or general education curriculum requirements of the student's college and those requirements of the student's major, Information and Decision Systems minors must satisfy the following requirements:

Required Courses **39 units**

15-200 or 15-211	Data Structures or Fundamental Structures of Computing I
88-200	Structured Analysis and Design
88-201	Data Base Management Systems
88-260	Organizations

Elective Courses **18 units**

88-202	Information Systems Applications (prerequisite: 15-200 or 15-211, 88-200, 88-204, 88-201)
88-204	Structured Analysis and Design Lab (prerequisite: 88-200 taken concurrently or prior to 88-204)
88-220	Policy Analysis I
88-223	Decision Analysis and Decision Support Systems
88-344	Strategic Games and Decisions
88-361	Technology and Social Change
88-366	Social Issues in Computing
88-367	Computers and Organizations
88-471	Industrial Applications in Information and Decision Systems

PLUS: any 6 or 9 unit computer language course.

Courses other than those listed above will be considered for inclusion as part of the minor when appropriate. Course substitution forms are available in PH 208. All substitutions must be approved by the Information and Decision Systems Program Director and the Department Head.

Only 9 units of courses in the minor can double count with requirements for any other minor or major. Exceptions in rare cases must be approved by the Information and Decision Systems Program Director and the Department Head.

The Minor in Public Management

Douglas Wholey, Program Director
Office: Porter Hall 208F

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 Public Management minor is intended for students who expect to need these management concepts and skills in the public sector.

Curriculum

Required Courses **36 units**

88-220	Policy Analysis I
88-221	Policy Analysis II
88-223	Decision Analysis and Decision Support Systems
88-260	Organizations

Elective Courses **18 units**

Choose two courses, in any combination, from the following areas*:

1. Individual and Social Decision Making

88-302	Behavioral Decision Making
88-312	Political Psychology and Sociology
88-316	Social Theory and Analysis
88-317	Social Structures and Human Development

2. Organizational and Political Decision Making

88-313	Introduction to Models of Political Science
88-321	Campaigns and Elections
88-322	Elections, Interest Groups, and Public Policy
88-323	Legislative Processes
88-324	Comparative Politics
88-338	Health Care Policy
88-342	Market Organization and Business Behavior
88-344	Strategic Games and Decisions
88-425	Regulatory Processes
70-510	Management, Research Experience I
70-511	Management Research Experience II
79-252	The American Presidency
80-221	Philosophy of Social Science
80-235	Modern Political Philosophy

3. Technology and Society

88-343	Economics of Technological Change
88-345	The Rise of Industrial Research and Development
88-367	Computers in Organizations
19-448	Science, Technology and Ethics
79-226	Technology in Western Civilization
79-275	History of Modern Warfare
79-359	Technology and Organization
80-241	Ethical Judgments in Professional Life
80-244	Management, Environment and Ethics

4. Information and Decision Technology

88-470	Advanced Projects in Information & Decision Systems
19-402/19-714	Telecommunications Policy Analysis
70-455	Business Applications of Artificial Intelligence
70-457	Technology, Innovation and Implementation in Organizations
80-312	Probability and Artificial Intelligence
85-417	Intelligent Computer Assisted Instruction
90-745	Decision Support Systems for the Public Sector

5. Financial Systems

70-122	Introduction to Accounting
70-391	Finance I
70-422	Cost Accounting
70-491	Finance II

6. International Affairs and Comparative Policy

88-318	Contemporary Latin American Politics
88-320	U.S.-Soviet Relations: From Confrontation to Cooperation
88-329	Recent American Foreign Policy
88-331	Europe in Transition: The Cold War & Alternative Systems for Conflict Management
88-333	The Cold War in Historical Perspective
88-341	Comparative Perspectives on Public Policy in the U.S. and Europe
70-365	International Trade and International Law
70-430	International Management
79-214	Modern Japan, 1868 to the Present
79-292	Modern Germany
79-380	Problems in National Security Since 1945

7. Policy Analysis

88-222	Policy Analysis III

8. Research Methods

88-240	Empirical Research Methods I
88-241	Empirical Research Methods II

*Total must be a minimum of 18 units

**must be taken together

NOTE: Certain "Elective Courses" listed here have additional prerequisites.

NOTE: Students majoring in Social and Decision Sciences, Policy and Management or Information and Decision Systems (with a Public Management concentration) are not eligible for this minor. Other Information and Decision Systems majors are eligible for this minor, but must complete five (rather than two) "Elective" courses, none of which can be courses that double-count for major requirements.

The Minor in Political Science

Patrick K. Stroh, Director
Office: Porter Hall 223A

The minor in Political Science consists of 54 units of course work. The prerequisites are 88-104, Decision Processes in American Political Institutions; and (as prerequisites for 88-240, Empirical Research Methods I) 21-112, Calculus II, and 36-202, Introduction to Statistical Methods. There is no prerequisite for 88-220, Policy Analysis I. Note that one of these courses, 88-104, Decision Processes in American Political Institutions, is an option in one of the H&SS General Education distributional categories ("Social, Political and Economic Institutions"), and should therefore be taken as part of the General Education Program by H&SS students interested in the Political Science minor.

Curriculum

Required Courses **18 units**

88-104 Decision Processes in American Political Institutions

Plus one of the following:

88-220 Policy Analysis I
88-240 Empirical Research Methods I

Elective Courses **36 units**

Select four courses from the following clusters of courses. 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 cluster or from any combination of clusters. At least two of these courses (18 units) must be Social and Decision Sciences courses (i.e., 88-xxx).

1. American Politics

88-321 Campaigns and Elections
88-322 Elections, Interest Groups, and Public Policy
88-323 Legislative Processes
88-336 Education Policy: A Historical Perspective
88-337 Health Policy Reform: A Historical Perspective
88-338 Health Care Policy
88-340 Law and Public Policy
88-348 Family Law and Social Policy
88-425 Regulatory Processes
70-332 Business and Society
70-361 Foundations of Law
70-363 Law in Modern American Society
73-357 Regulation: Theory and Practice
79-218 Twentieth Century America
79-241 Crime and Punishment in American Society
79-249 Power and Rights: The American Constitution
79-252 The American Presidency
79-284 American Environmental History: Critical Issues

2. International Affairs and Comparative Politics

88-318 Contemporary Latin American Politics
88-320 U.S. - Soviet Relations: From Confrontation to Cooperation
88-324 Comparative Politics
88-326 Issues in International Affairs
88-328 Stalin and Stalinism
88-329 Recent American Foreign Policy
88-331 Europe in Transition: The Cold War & Alternative Systems for Conflict Management
88-332 Global Security and Science
88-333 The Cold War in Historical Perspective
88-334 Foreign Policy Issues in the Middle East
88-341 Comparative Perspectives on Public Policy in the U.S. and Europe
70-365 International Trade and International Law
70-430 International Management
79-204 Collapse and Renewal of Europe
79-214 Modern Japan, 1868 to the Present
79-292 Modern Germany
79-380 Problems in National Security Since 1945

3. Political Theory and Methodology

88-221 Policy Analysis II
88-311 Applied Social & Political Theory: The Case of AIDS
88-312 Political Psychology and Sociology
88-313 Introduction to Models of Political Science
88-344 Strategic Games and Decisions
73-356 Political Economy of Public Institutions
73-380 Strategy in Economics and Politics
80-221 Philosophy of Social Science
80-235 Modern Political Philosophy
80-242 Conflict and Dispute Resolution

The Honors Program

The College's Senior Honors Program provides recognition of outstanding performance by students in any of the College's majors, including those offered by the Department of Social and Decision Sciences. By participating in the program, students have the opportunity to both demonstrate and develop their skills and knowledge through completion of an honors thesis. The honors thesis is completed during the senior year. By completing the 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 his or her department to become a participant.

Faculty

CRISTINA BICCHIERI, Associate Professor of Philosophy — Ph.D., Cambridge University; Carnegie Mellon, 1989—.

KATHLEEN CARLEY, Associate Professor of Sociology and Graduate Program Director — Ph.D., Harvard University; Carnegie Mellon, 1984—.

WESLEY M. COHEN, Associate Professor of Economics and Social Science and Director, Policy and Management Program — Ph.D., Yale University; Carnegie Mellon, 1980—.

OTTO A. DAVIS, William B. Cooper Professor of Economics and Public Policy and Director, Social and Decision Sciences Program — Ph.D., The University of Virginia; Carnegie Mellon, 1960—.

ROBYN M. DAWES, University Professor of Psychology — Ph.D., The University of Michigan; Carnegie Mellon, 1985—.

PAUL FISCHBECK, Assistant Professor of Social and Decision Sciences and Engineering and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1990— .

BARUCH FISCHHOFF, Professor of Social and Decision Sciences and Engineering and Public Policy — Ph.D., The Hebrew University of Jerusalem; Carnegie Mellon, 1987—.

JAMES E. GOODBY, Distinguished Service Professor of International Peace and Security — Carnegie Mellon, 1988—.

JOANNA GRANVILLE, Lecturer — Ph.D., Tufts University; Carnegie Mellon, 1994—.

TIMOTHY J. GROSECLOSE, Assistant Professor of Political Science and Political Economy — Ph.D., Stanford University; Carnegie Mellon, 1992— .

DONNA HARSCH, Assistant Professor of History — Ph.D., Yale University; Carnegie Mellon, 1990—.

DAVID A. HOUNSHELL, Luce Professor of Technology and Social Change — Ph.D., University of Delaware; Carnegie Mellon, 1991—.

JOSEPH B. KADANE, Leonard J. Savage Professor of Statistics and Social Science — Ph.D., Stanford University; Carnegie Mellon, 1969—.

MARK KAMLET, Dean, H.J. Heinz III School of Public Policy and Management and Professor of Economics and Public Policy — Ph.D., University of California, Berkeley; Carnegie Mellon, 1978—.

SARA B. KIESLER, Professor of Social Sciences and Social Psychology — Ph.D., Ohio State University; Carnegie Mellon, 1979—.

STEVEN KLEPPER, Head, Department of Social and Decision Sciences and Professor of Economics and Social Science — Ph.D., Cornell University; Carnegie Mellon, 1980—.

ROBERT E. KRAUT, Professor of Social Psychology and Human Computer Interaction — Ph.D., Yale University; Carnegie Mellon, 1993—.

PATRICK D. LARKEY, Professor of Public Policy and Decision Sciences — Ph.D., The University of Michigan; Carnegie Mellon, 1977—.

GEORGE LOEWENSTEIN, Professor of Economics — Ph.D., Yale University; Carnegie Mellon, 1990—.

JOHN H. MILLER, Assistant Professor of Economics and Social Sciences — Ph.D., The University of Michigan; Carnegie Mellon, 1989—.

JOHN MODELL, Professor of History and Sociology — Ph.D., Columbia University; Carnegie Mellon, 1982—.

RICHARD A. SMITH, Associate Dean, College of Humanities and Social Sciences and Associate Professor of Political Science — Ph.D., The University of Rochester; Carnegie Mellon, 1978—.

MARCO R. STEENBERGEN, Assistant Professor of Political Science — Ph.D., State University of New York; Carnegie Mellon, 1993—.

PATRICK K. STROH, Assistant Professor of Political Science and Director, Political Science Program — Ph.D., State University of New York; Carnegie Mellon, 1990—.

SERGE TAYLOR, Associate Professor of Social and Decision Sciences — Ph.D., The University of California at Berkeley; Carnegie Mellon, 1986—.

DOUGLAS R. WHOLEY, Associate Professor of Organizations and Information Systems and Director, Information and Decision Systems Program — Ph.D., The University of California at Berkeley; Carnegie Mellon, 1990—.

Department of Statistics

Robert E. Kass, Department Head
Department Office: Baker Hall 232

The Department of Statistics at Carnegie Mellon University is world-renowned for its contributions to the advancement of statistical theory, methods and practice. Furthermore, the Department is noted for its commitment to undergraduate education. The undergraduate program in Statistics is small, personalized, and emphasizes the application of statistical methods to real problems. A central feature of the program is that majors in Statistics have the opportunity to work with individual faculty members on research projects and independent studies. In addition, majors are encouraged to diversify their knowledge of other fields by pursuing interdisciplinary study. The Department's undergraduate major in Statistics is offered as a B.S. degree.

The Major in Statistics

The science of statistics is concerned with the development of a body of theory and techniques appropriate for making inferences under conditions of uncertainty and partial ignorance. One of the most exciting aspects of this field, and the reason for current strong demand for well-trained statisticians, is the diversity of application areas and scientific disciplines to which statisticians can effectively contribute. At Carnegie Mellon the interdisciplinary nature of the Statistics program brings together faculty and students interested in statistical applications in many fields. Examples of the wide range of problems with which faculty and students are involved include the design and analysis of data in the social and physical sciences, clinical trials in medical research, econometric modeling and forecasting, sample survey and opinion polling, industrial research and development, quality and process control, biometry and epidemiology, historical demography, and rhetoric.

The practice of statistics requires a broad knowledge of the world. The modern statistical scientist not only needs to understand when and how to use appropriate statistical methods but also needs to understand the nuances of the relevant application area. The curriculum in statistics reflects both of these requirements. The required courses in statistics provide skills in applied mathematics, probability, statistics, computing, and data analysis. The H&SS General Education program introduces students to ideas in the humanities, arts, and sciences. Further, Statistics majors are required to diversify their knowledge by taking a sequence of courses outside of the Statistics Department in another discipline of their choice. Completion of a major in Statistics will provide students with skills that are essential for the appropriate application of statistical methods to real problems.

Students with a Bachelor of Science degree in Statistics may be employed in either industry or government or pursue a graduate degree in statistics. The major also provides a solid foundation for graduate work in other disciplines such as biostatistics, business, or quantitative social science.

Curriculum

The emphasis in the Statistics major is on the practice of statistics. In addition to satisfying all of the H&SS General Education requirements, the Statistics major is required to take courses that help the student develop skills in the application of statistical methods to real problems as well as courses that help the student understand the role that the theory of probability and statistics plays in making sound inferences. Furthermore, since the successful application of statistics in practice requires collaborations with investigators from other disciplines, students in the major are required to take a sequence of four courses outside of the Statistics Department in another discipline. These courses will make up a "Concentration Area" and may be selected from any discipline of the student's choice in consultation with the student's advisor. Finally, students will have the opportunity throughout their program to be involved in research projects or independent study under the supervision of a faculty member.

All students wishing to major in Statistics are advised to complete their introductory calculus sequence, either 21-121/122 or 21-111/112, and the introductory sequence in probability and statistics, 36-201, Statistical Reasoning, and 36-202, Introduction to Statistical Methods, in their freshman year. Statistics majors are encouraged to take, if they are able, 21-121/122 in place of 21-111/112 as their calculus sequence. Following the completion of the 36-201/202 sequence, students will take 36-295, a research course in which the student will be required to design, implement, analyze and report on a research study of their choice. This project will usually be completed by the end of the sophomore year. Early in their major, and in consultation with their advisor, students will decide on the four courses that will satisfy the requirements for their "Concentration Area." For example, students planning on graduate study in statistics will be advised to take further course work in mathematics beyond the introductory calculus sequence. Students interested in applications in the health or biomedical sciences, might satisfy their "Concentration Area" requirement by taking further course work in biology or chemistry. Students are encouraged to choose a "Concentration Area" in a discipline that is of interest to them.

During their senior year, qualified students are encouraged to participate in an advanced research project or independent study under the supervision of a faculty advisor. Students earn credit for this work by enrolling in 36-495. Exceptionally talented students may apply to participate in the H&SS Senior Honors Program. Honors students will further develop their skills by completing a project under the close supervision of a faculty advisor. The honors thesis project is completed during the senior year, through which students earn 18 units of credit and qualify for graduation with "College Honors." To qualify for the honors program, the student must maintain a quality point average of 3.25 overall, and be invited by the department to become a participant. Interested students should consult with their advisor.

Mathematics — 20 units

21-121*	Calculus 1 (counts towards the General Education Mathematical Reasoning requirement)
21-122*	Calculus 2

* 21-121/122 is recommended but 21-111/112 will be accepted.

Data Analysis — 36 units

36-202	Introduction to Statistical Methods
36-295	Independent Research Project
36-401	Advanced Data Analysis I
36-402	Advanced Data Analysis II

Probability and Statistics — 27 units

36-225	Introduction to Probability and Statistics I*
36-226	Introduction to Probability and Statistics II*
36-461	Statistical Modeling

* Or 36-325/326, Probability and Mathematical Statistics I-II. Students considering graduate school in Statistics or Operations Research might consider taking the 36-325/326 sequence, after consulting with their advisor.

Statistics Elective — 18 units

Choose two from the following:

21-241	Linear Algebra
36-203	Surveys, Sampling and Society
36-309	Experimental Design for Behavioral and Social Sciences
36-410	Elementary Applied Probability
36-462	Applied Multivariate Analysis

Concentration Area* — 36 units

*To be selected in consultation with the student's advisor.

Statistics, B.S.

(Sample Curriculum)

Year	Fall	Spring
Freshman	36-201	36-202
	21-121	21-122
Sophomore	36-309	36-295
	21-241	
Junior	36-225	36-226
Senior	36-401	36-402
	36-461	

Degree Requirements (summary)

The Statistics major is offered only as a B.S. degree.

H&SS General Education requirements	(min.)	108 units
H&SS College Degree requirement	(min.)	18 units
Mathematics & Statistics requirements		20 units
Statistics major requirements		81 units
Concentration Area		36 units
Free Electives	(max.)	97 units
Degree Requirements (minimum)		**360 units**

Double Majors

Students who elect Statistics as part of a double major must fulfill all Statistics degree requirements. However, the "Concentration Area" requirement may be waived in consultation with the student's advisor. There are a number of other programs with which it would be natural to combine a major in Statistics. These programs include, for example, Industrial Management, Economics, Social and Decision Sciences, Policy and Management, History and Policy, and Psychology.

Students contemplating a double major in Statistics are advised to begin planning it (with appropriate advisors) as soon as possible. This is particularly true for students whose other major has a complex set of requirements and prerequisites.

The Minor in Statistics

The minor in Statistics is intended for students who wish to further their understanding of the statistical sciences, and both broaden and strengthen their research skills, while pursuing a major in another discipline. Statistics minors study the mathematical theory of probability and statistics and, in addition, will develop skills in the application of statistical methods for data analysis.

Students should consult with an advisor in the Statistics Department about their choice of courses for the minor. In addition to the core curriculum requirements of the student's college and those requirements of the student's major, a student minoring in statistics must satisfy the following requirements:

Mathematics — 20 units

21-121*	Calculus I
21-122*	Calculus with Linear Algebra

* Fulfills H&SS General Education Mathematical Reasoning requirement. 21-121/122 is recommended but 21-111/112 will be accepted.

Statistics Core Requirements — 45 Units

36-201*	Statistical Reasoning
36-202	Introduction to Statistical Methods
36-225	Introduction to Probability & Statistics I
36-226	Introduction to Probability & Statistics II
36-401	Advanced Data Analysis I

* Fulfills H&SS General Education Statistical Reasoning requirement.

One of the following: — 9 units

36-203	Surveys, Sampling and Society
36-309	Experimental Design for Behavioral and Social Sciences

Quantitative Science Electives — 9 Units

Choose one (1) course from the following list. Course(s) selected here may not be applied toward any other program requirement(s) faced by the candidate.

NOTE: Additional prerequisites are required for some of these courses. Students should carefully check the course description of each course considered to determine if additional prerequisites are necessary.

15-200	Data Structures
21-127	Introduction to Modern Mathematics
21-241	Linear Algebra
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-292	Operations Research I
21-301	Combinatorial Analysis
36-402	Advanced Data Analysis II
36-410	Elementary Applied Probability
36-461	Undergraduate Statistics Seminar
73-360	Econometrics
70-371	Production I
70-381	Marketing I
70-391	Finance I
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
88-306	Artificial Intelligence and Decision Making

Statistics Minor (Sample Curriculum):

Year	Fall	Spring
Freshman	21-111 or 21-121	21-112 or 21-122
	36-201	36-202
Sophomore	36-309 or 36-203	
Junior	36-225	36-226
Senior	36-401	Quant. Sci. Elective

Faculty

DAVID BANKS, Associate Professor of Statistics — Ph.D., Virginia Polytechnic; Carnegie Mellon, 1987—.

GEORGE T. DUNCAN, Professor of Statistics and Public Policy — Ph.D., University of Minnesota; Carnegie Mellon, 1974—.

NGAI HANG CHAN, Associate Professor of Statistics — Ph.D., University of Maryland; Carnegie Mellon, 1990—.

WILLIAM F. EDDY, Professor of Statistics — Ph.D., Yale University; Carnegie Mellon, 1976—.

STEPHEN E. FIENBERG, Maurice Falk Professor of Statistics and Social Science — Ph.D., Harvard University; Carnegie Mellon, 1980-1991; 1993—.

CHRISTOPHER GENOVESE, Assistant Professor of Statistics — Ph.D., University of California, Berkeley; Carnegie Mellon, 1994—

JOEL B. GREENHOUSE, Associate Professor of Statistics — Ph.D., University of Michigan; Carnegie Mellon, 1982—.

BRIAN JUNKER, Assistant 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, Head, Department of Statistics, Professor of Statistics — Ph.D., University of Chicago; Carnegie Mellon, 1981—.

JOHN P. LEHOCZKY, Professor of Statistics — Ph.D., Stanford University; Carnegie Mellon, 1969—.

MICHAEL M. MEYER, Senior Research Scientist in Statistics — Ph.D., University of Minnesota; Carnegie Mellon, 1986—.

KATHRYN ROEDER, Associate Professor of Statistics — Ph.D., Pennsylvania State university; Carnegie Mellon, 1994—

MARK J. SCHERVISH, Professor of Statistics — Ph.D., University of Illinois; Carnegie Mellon, 1979—.

TEDDY SEIDENFELD, Professor of Philosophy and Statistics — Ph.D., Columbia University; Carnegie Mellon, 1985—.

NORMA TERRIN, Assistant Professor of Statistics — Ph.D., Boston University; Carnegie Mellon, 1989—.

ISABELLA VERDINELLI, Visiting Associate Professor of Statistics — M.Sc., University College, London; Carnegie Mellon, 1991— .

LARRY WASSERMAN, Associate Professor of Statistics — Ph.D., University of Toronto; Carnegie Mellon, 1988—.

Graduate School of Industrial Administration

Graduate School of Industrial Administration

Robert S. Sullivan, Dean
Office: Graduate School of Industrial Administration 101

The Graduate School of Industrial Administration (GSIA) at Carnegie Mellon University conducts educational programs not only at the undergraduate level (see p. 161 for the program in Economics and p. 207 for the program in Industrial Management) but also at the master's, 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, GSIA 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. GSIA's insistence on excellence among its faculty and students and on a rigorous academic program has consistently earned the school a ranking among the top business schools in the nation.

GSIA students in the undergraduate and master's programs gain a solid foundation in the fundamental scientific disciplines — 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. GSIA is not content with teaching traditional approaches but develops innovative courses and programs.

At GSIA, research and education are closely related. The outstanding GSIA faculty 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. GSIA 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 and political economics, finance, accounting, marketing, and operations management/ production.

GSIA 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, GSIA alumni provide a strong network for new graduates.

3-2 Program for Carnegie Mellon Students

All Carnegie Mellon undergraduates in good standing are eligible to apply to the Graduate School of Industrial Administration for GSIA's prestigious master's program. Students who are accepted bypass their senior year as undergraduates and earn both their bachelor's degree and their Master of Science in Industrial Administration 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. Admissions to the M.S.I.A. program is highly competitive, and 3-2 applicants are competing with the entire applicant pool for spaces in the program.

Students interested in the 3-2 program should read the Master's catalog, available from the GSIA Admissions Office (GSIA Room 149-C). They should also talk with their individual departments concerning completion of their undergraduate requirements.

Faculty

EGON BALAS, University Professor of Industrial Administration and Applied Mathematics; The GSIA Alumni Chair — D.Sc.Ec., University of Brussels; D.U. (Math), University of Paris; Carnegie Mellon, 1968—.

ILKER BAYBARS, Deputy Dean for Academic Programs, and Professor of Operations Management — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1979—.

DAVID A. BOURNE, Adjunct Professor of Industrial Administration — Ph.D., University of Pennsylvania; Carnegie Mellon, 1980—.

MARGARET BRINDLE, Visiting Assistant Professor of Organizational Behavior — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1993—.

LISA CAMERON, Assistant Professor of Economics — Ph.D., Stanford University (expected 1994); Carnegie Mellon, 1993—.

THOMAS N. CANFIELD, Adjunct Professor of Industrial Administration — M.B.A., Harvard University; Carnegie Mellon, 1983—.

ESTELLE F. COMAY, Adjunct Professor of Industrial Administration — J.D., University of Pittsburgh; Carnegie Mellon, 1978—.

GERARD P. CORNUEJOLS, Professor of Operations Research — Ph.D., Cornell University; Carnegie Mellon, 1978—.

RICHARD M. CYERT, Professor of Economics and Industrial Administration — Ph.D., Columbia University; Carnegie Mellon, 1948—.

W. ROBERT DALTON, Senior Lecturer of Economics — Ph.D., University of Missouri; Carnegie Mellon, 1985—.

ROBERT M. DAMMON, Associate Professor of Financial Economics — Ph.D., University of Wisconsin, Madison; Carnegie Mellon, 1984—.

L. FRANK DEMMLER, Adjunct Professor of Industrial Administration — MBA, University of California at Los Angeles; Carnegie Mellon, 1987—.

STUART W. ELLIOTT, Visiting Assistant Professor of Economics — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1991—.

EDWARD W. EVANS, Adjunct Professor of Industrial Administration, Head of Graphic Communications Management — B.S., Carnegie Institute of Technology; Carnegie Mellon, 1977—.

PETER S. FAYNZILBERG, Assistant Professor of Industrial Administration — Ph.D., University of Illinois at Urbana - Champagne; Carnegie Mellon, 1991 —.

MARK FICHMAN, Associate Professor of Organizational Behavior and Theory — Ph.D., University of Michigan; Carnegie Mellon, 1980—.

NICK F. FLOR, Assistant Professor of Industrial Administration — Ph.D., University of California at San Diego; Carnegie Mellon, 1994—.

P.S. GIRIDHARAN, Assistant Professor of Industrial Administration — Ph.D., The University of Rochester; Carnegie Mellon, 1990 —.

JONATHAN C. GLOVER, Assistant Professor of Industrial Administration — Ph.D., The Ohio State University; Carnegie Mellon, 1992—.

FUSUN F. GONUL, Assistant Professor of Marketing — Ph.D., The Ohio State University; Carnegie Mellon, 1988—.

PAUL S. GOODMAN, Professor of Industrial Administration and Psychology — Ph.D., Cornell University; Carnegie Mellon, 1972—.

RICHARD C. GREEN, Professor of Financial Economics — Ph.D., University of Wisconsin; Carnegie Mellon, 1982—. (on leave 1994-95)

THOMAS J. HAJDUK, Lecturer in Communications — Ph.D., Carnegie Mellon (expected 1994); Carnegie Mellon, 1992—.

DON HALE, Adjunct Professor of Industrial Administration — B.S., Temple University; Carnegie Mellon, 1982—.

DALE HERSHEY, Adjunct Professor of Industrial Administration — LL.B., Harvard Law School; Carnegie Mellon, 1987—.

BURTON HOLLIFIELD, Visiting Assistant Professor of Finance — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1994—.

JOHN N. HOOKER, JR., Professor of Industrial Administration — Ph.D., Vanderbilt University; Ph.D., University of Tennessee; Carnegie Mellon, 1984—.

JOSEPH S. HORNACK, Adjunct Professor of Industrial Administration — J.D., Rutgers, The State University of New Jersey; Carnegie Mellon, 1990—.

PAUL INGRAM, Assistant Professor of Industrial Administration — Ph.D., Cornell University; Carnegie Mellon, 1994—.

YUJI IJIRI, Robert M. Trueblood University Professor of Accounting and Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1967—.

RONEN ISRAEL, Associate Professor of Finance — Ph.D., Northwestern University; Carnegie Mellon, 1993—.

SURYA N. JANAKIRAMAN, Assistant Professor of Industrial Administration — Ph.D., University of Pennsylvania; Carnegie Mellon, 1992—.

DONALD H. JONES, Adjunct Professor of Industrial Administration — B.S., Electrical Engineering, University of Pittsburgh; Carnegie Mellon, 1989 —.

JOSEPH B. KADANE, Leonard J. Savage Professor of Statistics and Social Sciences (Statistics) — Ph.D., Stanford University; Carnegie Mellon, 1969—.

AJAY KALRA, Assistant Professor of Marketing — Ph.D., Duke University; Carnegie Mellon, 1992—.

SOK-HYON KANG, Associate Professor of Industrial Administration — Ph.D., Massachusetts Institute of Technology ; Carnegie Mellon, 1988—.

SUNDER KEKRE, Associate Professor of Industrial Administration — Ph.D., University of Rochester; Carnegie Mellon, 1984—.

ROBERT E. KELLEY, Adjunct Professor of Industrial Administration — Ph.D., Colorado State University; Carnegie Mellon, 1985—.

DAVID KELLY, Visiting Assistant Professor of Economics — Ph.D., Carnegie Mellon University (expected 1994); Carnegie Mellon, 1994—.

THOMAS M. KERR, Associate Professor of Law and Industrial Administration Emeritus — J.D., George Washington University; Carnegie Mellon, 1964—.

BYUNG-DO KIM, Assistant Professor of Marketing — Ph.D., University of Chicago; Carnegie Mellon 1993—.

CLAUDIA A. KIRKPATRICK, Adjunct Professor of Industrial Administration — D.A., Carnegie Mellon University; Carnegie Mellon, 1981—.

STEVEN KLEPPER, Professor of Economics and Social and Decision Sciences — Ph.D., Cornell University; Carnegie Mellon, 1980—.

ROBERT E. KRAUT, Professor of Social Psychology and Human/Computer Interactions — Ph.D., Yale University; Carnegie Mellon, 1993—.

CHARLES H. KRIEBEL, Professor of Industrial Administration — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1964—.

PRAVEEN KUMAR, Associate Professor of Economics and Finance — Ph.D., Stanford University; Carnegie Mellon, 1985—.

FINN KYDLAND, Professor of Economics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1977—.

DAVID L. LAMONT, Adjunct Professor of Industrial Administration — M.S.I.A., Carnegie Mellon University; Carnegie Mellon, 1984—.

LESTER B. LAVE, Harry B. and James H. Higgins University Professor of Economics — Ph.D., Harvard University; Carnegie Mellon, 1963—.

F. JAVIER LERCH, Associate Professor of Industrial Administration — Ph.D., University of Michigan; Carnegie Mellon, 1986—.

MICHAEL LOUIK, Adjunct Professor of Industrial Administration — J.D., Duquesne University School of Law; Carnegie Mellon, 1992 —.

JOHN H. MATHER, Senior Lecturer in Marketing — Ph.D., University of Arizona; Carnegie Mellon, 1992—.

BENNETT T. McCALLUM, H. J. Heinz Professor of Economics and Head, Department of Economics — Ph.D., Rice University; Carnegie Mellon, 1981—.

R. BRUCE McKERN, President, Carnegie Bosch Institute and Professor of Industrial Administration — Ph.D., Harvard University; Carnegie Mellon 1993—.

ALLAN H. MELTZER, John M. Olin University Professor of Political Economy and Public Policy — Ph.D., University of California, Los Angeles; Carnegie Mellon, 1957—.

GERALD C. MEYERS, Ford Distinguished Professor — M.S., Carnegie Institute of Technology; Carnegie Mellon, 1985—.

JEFFREY A. MILES, Visiting Assistant Professor of Organizational Behavior — Ph.D., The Ohio State University; Carnegie Mellon, 1993-95.

ROBERT A. MILLER, Associate Professor of Economics — Ph.D., University of Chicago; Carnegie Mellon, 1982—.

THOMAS E. MORTON, Professor of Industrial Administration — Ph.D., University of Chicago; Carnegie Mellon, 1969—.

TRIDAS MUKHOPADHYAY, Associate Professor of Industrial Administration — Ph.D., University of Michigan; Carnegie Mellon, 1986—.

MILDRED S. MYERS, Senior Lecturer — D.A., Carnegie Mellon University; Carnegie Mellon, 1984—.

JOHN R. O'BRIEN, Associate Professor of Industrial Administration — Ph.D., University of Minnesota; Carnegie Mellon, 1984—.

MAARTEN OOSTEN, Visiting Assistant Professor of Operations Research — Ph.D., University of Limburg, Netherlands (expected 1995); Carnegie Mellon, 1993-94.

EVELYN M. PIERCE, Adjunct Professor of Industrial Administration — M.F.A., University of Pittsburgh; Carnegie Mellon, 1993—.

KEITH T. POOLE, Professor of Political Economy — Ph.D., University of Rochester; Carnegie Mellon, 1982—.

GARY M. QUINLIVAN, Visiting Assistant Professor of Industrial Administration — Ph.D., State University of New York at Albany; Carnegie Mellon, 1989—.

UDAY RAO, Assistant Professor of Manufacturing Systems — Ph.D., Cornell University; Carnegie Mellon, 1994—.

NORMAN ROBERTSON, Adjunct Professor of Economics — B.Sc., University of London; Carnegie Mellon, 1985—.

JACK ROSEMAN, Adjunct Professor of Industrial Administration — M.A. (Mathematics), University of Massachusetts; Carnegie Mellon, 1988—.

FREDERICK H. RUETER, Adjunct Professor of Industrial Administration — Ph.D., Carnegie Mellon; Carnegie Mellon, 1988—.

KRISTIAN RYDQVIST, Visiting Associate Professor of Finance — Ph.D., Stockholm School of Economics; Carnegie Mellon, 1993-95.

TALIA RYMON, Assistant Professor of Marketing — Ph.D., University of Pennsylvania; Carnegie Mellon, 1993—.

GERALD R. SALANCIK, David M. and Barbara A. Kirr Professor of Organization — Ph.D., Yale University; Carnegie Mellon, 1985—.

DUANE J. SEPPI, Associate Professor of Financial Economics — Ph.D., University of Chicago; Carnegie Mellon, 1986—.

JEAN-JACQUES SERVAN-SCHREIBER, Distinguished Service Professor of Strategic Management; Chairman, International Committee (CMU) — Ecole Polytechnique; Carnegie Mellon, 1985—.

KATHRYN L. SHAW, Associate Professor of Economics — Ph.D., Harvard University; Carnegie Mellon, 1981—.

RUSSELL W. SHELDON, Adjunct Professor of Industrial Administration — Ph.D., Cornell University; Carnegie Mellon, 1988—.

MANJULA R. SHYAM, Adjunct Associate Professor of International Business Management — Ph.D., University of Pittsburgh; Carnegie Mellon, 1988—.

HERBERT A. SIMON, Richard K. Mellon University Professor of Computer Science and Psychology — Ph.D., University of Chicago; Carnegie Mellon, 1949—.

MARVIN A. SIRBU, Professor of Engineering and Public Policy, Industrial Administration, and Electrical and Computer Engineering — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1985—.

KONDURU SIVARAMAKRISHNAN, Assistant Professor of Industrial Administration — Ph.D., Northwestern University; Carnegie Mellon, 1988—.

HARVEY F. SLOAN, Adjunct Professor of Industrial Administration — J.D., University of Pittsburgh; Carnegie Mellon, 1953—.

ANTHONY ALAN SMITH, JR., Assistant Professor of Economics — Ph.D., Duke University; Carnegie Mellon, 1992—.

FALLAW B. SOWELL, Associate Professor of Economics — Ph.D., Duke University; Carnegie Mellon, 1988—.

CHESTER S. SPATT, Professor of Economics and Finance — Ph.D., University of Pennsylvania; Carnegie Mellon, 1979—.

STEPHEN E. SPEAR, Professor of Economics — Ph.D., University of Pennsylvania; Carnegie Mellon, 1982—.

KANNAN SRINIVASAN, Associate Professor of Industrial Administration — Ph.D., University of California, Los Angeles; Carnegie Mellon, 1986—.

SANJAY SRIVASTAVA, Professor of Economics and Finance — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1982—.

JAMES C. STALDER, Adjunct Professor of Industrial Administration — B.S., Pennsylvania State University; Carnegie Mellon, 1985—.

SUSAN G. STRAUS, Assistant Professor of Industrial Administration — Ph.D., University of Illinois at Urbana - Champagne; Carnegie Mellon, 1991 —.

ROBERT S. SULLIVAN, Dean and Professor of Industrial Administration — Ph.D., The Pennsylvania State University; Carnegie Mellon, 1991 —.

SHYAM SUNDER, Richard M. Cyert Professor of Management and Economics — Ph.D., Carnegie Mellon; Carnegie Mellon, 1988—.

GEORGE A. TAAFFE, JR., Adjunct Professor of Industrial Administration — J.D., University of Pittsburgh; Carnegie Mellon; 1988 —.

SRIDHUR R. TAYUR, Associate Professor of Industrial Administration — Ph.D., Cornell University; Carnegie Mellon, 1991—.

CHRIS I. TELMER, Assistant Professor of Financial Economics — Ph.D., Queen's University (Canada); Carnegie Mellon, 1992 —.

GERALD L. THOMPSON, IBM Professor of Systems and Operations Research — Ph.D., University of Michigan; Carnegie Mellon, 1959—.

JOHN R. THORNE, David T. and Lindsay J. Morgenthaler Professor of Entrepreneurship — M.S.I.A., Carnegie Institute of Technology; Carnegie Mellon, 1972—.

RICHARD W. THORNE, Adjunct Assistant Professor — M.S.I.A., Carnegie Mellon; Carnegie Mellon, 1993—.

MICHAEL A. TRICK, Associate Professor of Industrial Administration — Ph.D., Georgia Institute of Technology; Carnegie Mellon, 1988—.

DAVID E. TUNGATE, Adjunct Professor of Law — J.D., University of Illinois School of Law; Carnegie Mellon, 1991 —.

CHENG WANG, Assistant Professor of Economics — Ph.D., University of Western Ontario; Carnegie Mellon, 1994—.

LAURIE R. WEINGART, Assistant Professor of Industrial Administration — Ph.D., Northwestern University; Carnegie Mellon 1989—.

JEFFREY R. WILLIAMS, Professor of Industrial Administration — Ph.D., University of Michigan; Carnegie Mellon, 1977—.

AMIR YARON, Assistant Professor of Economics and Finance — Ph.D., University of Chicago; Carnegie Mellon, 1994—.

RICHARD O. YOUNG, Lecturer of Industrial Administration — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1985—.

HAROLD HUIBING ZHANG, Assistant Professor of Economics — Ph.D., Duke University; Carnegie Mellon, 1994—.

STANLEY E. ZIN, Associate Professor of Economics and Finance — Ph.D., University of Toronto; Carnegie Mellon, 1986—.

Undergraduate Industrial Management Program

Ilker Baybars, Deputy Dean for Academic Programs
Claudia A. Kirkpatrick, Director
Edward W. Evans, Assistant Head

The Industrial Management Program, a unit of the Graduate School of Industrial Administration, is intended for undergraduate students interested in a broadly-based business management program. The academic requirements are designed to be flexible enough to accommodate students pursuing a wide variety of goals. An eclectic field like Industrial Management calls for an eclectic curriculum.

The IM curriculum consists of six basic elements: core functional business courses, core economics courses, core mathematics and computer skills courses, breadth requirements, depth requirements, and unrestricted electives. Students meet the depth requirement by completing one of several IM "Tracks" which are designed to give a deeper understanding of various management-related areas. In the interest of facilitating the student's ability to combine IM with other interests, the depth requirement may also be satisfied by doing a double major (or an approved minor) with an outside department.

IM students are encouraged to spend a semester abroad to gain international experience. GSIA offers several exchange programs with business schools abroad, and Carnegie Mellon's Office of International Education maintains an extensive library of other programs. Students should seriously consider foreign language study during their first and second years to ensure that they will enjoy a wide selection of study-abroad programs.

Upon graduation, students are prepared to begin fields in all areas of management. Historically, about 40-50% of the IM program graduates eventually obtain an MBA. Additionally, many students go on to law school or any of several academic disciplines such as economics and mathematics.

The IM Program offers a second major and a minor program for students who are majors in other departments of the university. Students interested in studies in management are invited to discuss these possibilities with IM Program advisors. These opportunities are offered only to students who meet the academic standards of the IM Program and to the extent that space is available in the required major courses. Further information can be obtained from the IM office, located in the Graduate School of Industrial Administration, room 139.

IM Major Requirements

To receive a degree in Industrial Management, students must complete at least 364 units, consisting of three basic core sequences, as well as breadth, depth and general elective requirements.

Curriculum Overview

	Units
Functional Business Core	90
Economics Core	36
Mathematics/Computer Skills Core	40
Breadth Requirement	81
Depth Requirement	54
General Electives	63
Total	**364**

These requirements break down as follows:

Functional Business Core

		Units
70-101	Introduction to Business Management	9
70-122	Introduction to Accounting	9
70-311	Organizational Behavior I	9
70-332	Business and Society	9
70-340	Business Communications	9
70-371	Production I	9
70-381	Marketing	9
70-391	Finance I	9
70-401*	Management Game	9
70-451	Management Information Systems	9
	Total	**90**

*or Business Leadership and Strategy (70-440).

Economics Core

		Units
73-100*	Principles of Economics	9
70-251**	Managerial Economics	9
73-300	Intermediate Macroeconomics	9
70-350***	Regression and Forecasting	9
	Total	**36**

*or Laboratory Economics (73-110).

**or Intermediate Microeconomics (73-250). Students considering a Financial Economics emphasis or an Economics Double Major must take 73-250. See the IM office for details.

***or Econometrics II (73-360), for which 73-260 is a prerequisite. Students pursuing a Financial Economics emphasis or an Economics Double Major must take 73-360. See the IM office for details.

Mathematics/Computer Skills Core

		Units
21-121	Calculus	10
21-259	Calculus in Three Dimensions	9
21-257*	Optimization for Social Sciences	9
70-220	Probability and Statistics for Business	9
99-101	Computing Skills Workshop	3
	Total	**40**

*or Operations Research I (21-292). Students considering an emphasis in Manufacturing and Operations should take 21-292, a prerequisite for Operations Research II (21-393).

Breadth Requirements

The categories used to define the IM Program's breadth requirements are those given by the IM General Education Program. (See the end of this section.)

Required:

79-104 Introduction to World History

Choose 1 from each category:

Writing/Expression;
Science & Technology;
Cognition, Choice & Behavior;
Political & Social Institutions.

Choose 1 from each, plus a 3rd from either:

Creative Production & Reflection;
Cultural Analysis.

Choose 1 from:

any of the above categories (except Writing/Expression).

Depth Requirements

The depth requirement may be satisfied by completing any one of the following:

* an IM track (see below);
* a double major with another department;
* an IM approved minor with another department.

An IM track consists of a menu of courses (both required and elective) of which the student must complete six (54 units). Since the particular offerings may vary from year to year, students should contact the IM office for an up-to-date list of currently offered tracks and their associated courses. Students must consult with an IM advisor for approval of their track selection. Presently, IM offers the following tracks:

* Organizational Behavior
* Marketing
* Manufacturing and Operations
* Information Systems
* Graphic Communications Management
* Financial Economics
* General Management

General Electives

In addition to all of the above requirements, students must complete 63 units of general elective courses from any department. Students may use at most 9 units of Pass/Fail credit towards this requirement.

Suggested Curriculum

What follows is a *suggested* curriculum for IM students. In designing their own curriculum, students are strongly encouraged to meet with an IM advisor to ensure that all of the preceding requirements are met. Students must also 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. Students planning on studying abroad should make every effort to begin language studies as early as possible.

Freshman Year

	Fall	Units
21-121	Calculus	10
70-101	Introduction to Business Management	9
76-10x	Argument OR Interpretation	9
79-104	Introduction to World History	9
99-101	Computing Skills Workshop	3
xx-xxx	Breadth course	9
		49
	Spring	
21-259	Calculus in 3D	9
73-100	Principles of Economics	9
xx-xxx	Breadth course	9
xx-xxx	Breadth course	9
xx-xxx	Breadth course	9
		45

Sophomore Year

	Fall	Units
21-257*	Optimization for Social Sciences	9
70-122	Introduction to Accounting	9
70-220	Probability & Statistics for Business	9
xx-xxx	Breadth course	9
xx-xxx	Elective	9
		45
	Spring	
70-311	Organizational Behavior I	9
70-340	Business Communications	9
70-251**	Managerial Economics	9
70-350***	Regression & Forecasting	9
xx-xxx	Elective	9
		45

*or Operations Research I (21-292). Students considering an emphasis in Manufacturing and Operations should take 21-292, a prerequisite for Operations Research II (21-393).

**or Intermediate Microeconomics (73-250). Students considering a Financial Economics emphasis or an Economics Double Major must take 73-250. See the IM office for details.

***or Econometrics I (73-260) followed by Econometrics II (73-360) in the fall of the junior year. Students pursuing a Financial Economics emphasis or an Economics Double Major must take 73-260 and 73-360. See the IM office for details.

Junior Year

	Fall	Units
70-371	Production I	9
70-391	Finance I	9
70-451	Management Information Systems	9
xx-xxx	Breadth course	9
xx-xxx	Elective	9
		45
	Spring	
70-381	Marketing	9
73-300	Intermediate Macroeconomics	9
xx-xxx	Depth course	9
xx-xxx	Depth course	9
xx-xxx	Elective	9
		45

Senior Year

	Fall	Units
70-440	Business Leadership & Strategy*	9
xx-xxx	Depth course	9
xx-xxx	Depth course	9
xx-xxx	Breadth course	9
xx-xxx	Elective	9
		45
	Spring	
70-332	Business and Society	9
70-401	Management Game*	9
xx-xxx	Depth course	9
xx-xxx	Depth course	9
xx-xxx	Elective	9
		45

*Students must take either Business Leadership and Strategy (70-440, offered in the Fall) or Management Game (70-401, offered in the Spring); one (but not both) of these classes may be replaced by an elective..

Double Major/Minor Requirements

Students from other departments may complete a either a second major in Industrial Management or a minor in Industrial Management as follows:

Double Major Requirements

Students seeking a second major in IM are required to complete all of the courses in each of the three core sequences:

* Functional Business Core;
* Economics Core;
* Mathematics/Computer Skills Core.

See p. 209 for a complete description of the course requirements for each of these core sequences. There are no breadth, depth or elective requirements for students seeking a second major in Industrial Management.

Minor Requirements

Prerequisite Courses

Two semester courses in Calculus

Two semester courses in Statistics (or 70-220)

73-100 Principles of Economics

Required Course:

70-101 Introduction to Business Management

Choose 2:

70-122 Introduction to Accounting
70-311 Organizational Behavior
70-451 Management Information Systems

Choose 2:

70-371 Production I
70-381 Marketing
70-391 Finance I

Choose 1:

Any 70-xxx or 73-xxx course (200 level or above).*

*except 70-393, 70-394, 70-401, 70-440.

Minor in Management (CFA students only)

Prerequisite Courses

73-100 Principles of Economics

Required Courses

70-101 Introduction to Business Management
70-311 Organizational Behavior

Choose 2:

70-122 Introduction to Accounting
70-332 Business and Society
70-340 Business Communications
70-381* Marketing
70-520 Publicity & Public Relations

Choose 2:

Any 70-xxx or 73-xxx course (200 level or above).**

*prerequisites: 21-121, 70-220.

**except 70-393, 70-394, 70-401, 70-440.

IM General Education Program Course Categories

Writing/Expression:

76-100	Argument
76-101	Interpretation

Science and Technology:

Mellon College of Science Courses:

03-121	Modern Biology
03-122	Organismic Botany (prerequisite: 03-121)
03-130	Biology of Organisms (prerequisite: 03-121)
03-240	Cell Biology (prerequisite: 03-121)
09-103	Atoms, Molecules and Chemical Change
09-104	Fundamental Aspects of Organic Chemistry and Biochemistry (prerequisite: 09-103)
09-105	Modern Chemistry I
09-106	Modern Chemistry II (prerequisite: 09-105)
33-102	Concepts of Modern Physics
33-111	Physics for Science Students I
33-112	Physics for Science Students II (prerequisite: 33-111)
33-114	Physics of Musical Sound
33-115	Introductory Physics I
33-116	Introductory Physics II (prerequisite: 33-115)

Carnegie Institute of Technology Courses:

06-100	Introduction to Chemical Engineering
12-101	Innovation and Design in Civil Engineering
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

School of Computer Science Courses:

15-211	Fundamental Structures of Computer Science I (prerequisites: 15-127, 21-127)
15-212	Fundamental Structures of Computer Science II (prerequisite: 15-211)

Cognition, Choice and Behavior:

80-150	The Nature of Reason
80-180	The Nature of Language
80-182	Language and Thought
80-242	Conflict, Culture, and Dispute Resolution
85-100	Cognitive Processes: Theory and Practice
85-102	Introduction to Psychology
85-150	Introduction to Social Problems
85-211	Cognitive Psychology
85-221	Developmental Psychology
85-241	Social Psychology
85-251	Introduction to Personality

Political and Social Institutions:

36-203	Sampling, Surveys, and Society
79-114	Causal Models and Historical Explanation (statistics prerequisite)
79-115	Education and Inequality
80-136	Social Structure, Public Policy, and Ethical Dilemmas
88-104	Decision processes in American Political Institutions
88-109	Institutions and Individuals

Creative Production and Reflection

NOTE: Some of the courses on this list are offered for less than nine units. Students must take a minimum of nine units to fulfill the requirement for each course in this category.

48-095	Architecture for Non-Majors
51-170	Graphic Design Fundamentals
51-210	Beginning Photography
51-220	Darkroom I (4.5 units)
51-224	Darkroom II (4.5 units)
51-233	Typography for Non-Majors
57-417	Concert Choir (6 units)
57-418	Symphonic Wind Ensemble (6 units)
57-419	Repertory Chorus (6 units)
57-430	Philharmonic Orchestra (6 units)
60-101	Concept Studio I
60-110	Electronic Media Studio I (10 units)
60-130	Three Dimensional Media Studio I (10 units)
76-206	The Craft of Creative Writing
80-120	Reflections on Science
80-241	Ethical Judgments in Professional Life
80-260	Philosophy and Art
82-101	Elementary French I
82-102	Elementary French II
82-103	Self-Paced French
82-121	Elementary German I
82-122	Elementary German II
82-123	Self-Paced German
82-131	Elementary Chinese I
82-132	Elementary Chinese II
82-141	Elementary Spanish I
82-142	Elementary Spanish II
82-143	Self-Paced Spanish
82-161	Elementary Italian I
82-162	Elementary Italian II
82-163	Self-Paced Italian
82-171	Elementary Japanese I
82-172	Elementary Japanese II
82-191	Elementary Russian I
82-192	Elementary Russian II

Cultural Analysis:

76-201	Cultural Practices and Literary Production
76-240	What Is Cultural Studies?
79-110	Dynamics of Cultural Change
79-111	Cultural and Cross-Cultural Perspectives on the Environment
79-112	Race, Nationality, and the Development of American Cultures
79-113	Culture and Identity in American Social Life
79-200	Society and the Arts
80-100	What Philosophy Is
80-183	Language, Culture and Thought
82-107	Reflections of French Culture in Film
82-193	The Faust Legend from Europe to Russia
82-409	French Literature of the Nineteenth Century
82-412	Twentieth-Century French Theater
82-413	Twentieth-Century French Novel
82-415/416	Studies in French Literature
82-427	The New Germany
82-428	German Classical Literature
82-429	German Literature of the Nineteenth Century
82-430	German Literature of the Twentieth Century
82-431	Postwar German Literature
82-436	Studies in German Literature
82-441	Survey of Spanish Literature
82-451	Introduction to Latin American Literature and Culture
82-455/456	Studies in Spanish and Latin American Literature
82-465/466	Surrealism in France and Spain
82-491	Literature, Politics and Film in Russia and East Europe Today
82-492	The Historical Imagination in Nineteenth Century Russian Literature

Academic Standards and Actions

Grading
Grading regulations for undergraduate students are detailed on p. 46.

Withdrawing from Courses
The department of Industrial Management follows the Carnegie Mellon policies on withdrawing from courses:

1. A student carrying a full-time course load (defined as at least 36 units) as of the 10th regularly-scheduled day of classes may not drop down below 36 units after that day.

2. Students who wish to withdraw from a course must do so before the published university deadline. After that date, students are allowed to withdraw from a course only under the following conditions:

a. Students who are overloading may drop down to a regular full-time load (usually 45 units);

b. Students who have a real emergency, such as a severe illness or serious family crisis (properly documented) may withdraw from a course or courses (with permission of the Department).

Academic Actions
Academic actions are taken at the college and department levels.

College Academic Actions
Dean's List
Students who receive a QPA of 3.75 or higher (while taking 45 or more units and receiving no incompletes) will be placed on the Dean's List.

Honors
Students who achieve an overall QPA of 3.5 or higher will be graduated with University Honors.

The Honors Program
The Industrial Management Honors Program provides recognition of outstanding seniors. Students have the opportunity to develop their skills in research and analysis through completion of an honors thesis. In a 2-semester project, students earn 18 units of IM credit and graduate with "College Honors." To qualify, students must maintain a QPA of 3.50 in the major and 3.25 overall.

Other Actions
In the first year, quality point averages below 1.75 (carrying a normal load of 41 or more units) 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 freshman year) is below 2.00 (carrying a normal load).

Probation
The action of probation will be taken if:

One semester of the freshman year QPA is below 1.75 (carrying 41 or more units); carrying 36-40 factorable units, QPA is below 2.00;

The semester QPA of a student in good standing beyond the freshman year falls below 2.00 (carrying a normal load of 42 or more units); carrying 36-41 factorable units, QPA is below 2.25.

The term of probation is one semester as a full-time student. A freshman is removed from probation at the end of the second semester if the semester QPA is 1.75 or above (carrying a normal load). A student in the third or subsequent semester of study is removed from probation at the end of one semester if the semester QPA (carrying a normal load) and cumulative QPA (excluding the freshman year) are 2.00 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 will be suspended who does not meet minimum standards at the end of one semester of probation.

A first year student will be suspended if the QPA from both semesters is below 1.75 (carrying a normal load of 41 or more units);

A student in the third or subsequent semester of study will be suspended if either the semester factor or the cumulative factor (excluding the first year) is below 2.00 (carrying a normal load of 42 units) 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 final probation) by:

Receiving permission in writing from the person authorized by the Industrial Management Program to deal in such matters;

Completing a "returning student's form", obtained from and returned to the Registrar; and

Providing transcripts and clearance forms if the student has been in a degree program at another college or university.

Drop
This is a permanent severance. A student is dropped from the Industrial Management Program when it seems clear that he/she will never be able to meet minimum standards. A student who has been suspended and who fails to meet minimum standards after returning to school is dropped.

If a student has been suspended or dropped, that student is required to absent himself or herself from the campus (including dormitories and fraternity 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 exclusion from part-time or summer courses for the duration of the period of the action.

The relation indicated above between probation, suspension, and drop is normal, not binding. In unusual circumstances, a student may be suspended or dropped without prior probation.

Department Academic Actions
Academic action will be taken if, in any semester, the IM quality point average (IMQPA) falls below a 2.00 (carrying a normal load of 42 or more factorable units). This IMQPA is calculated for IM courses and those defined to be directly related to the IM sequence. IM courses are any courses offered by the IM Department (i.e., any course with a 70- prefix). Directly related courses are any courses from the Economics Core and the Mathematics/Computer Skills Core of the IM Program (as defined earlier). The specific forms of academic action which may be taken are defined below.

Departmental Probation
The act of departmental probation will be taken if the IMQPA of a student in good standing falls below a 2.00 (carrying a normal load of 42 or more factorable units).

The term of departmental probation is one semester as a full-time student. A student is removed from probation at the end of the next semester if:

The next semester IMQPA in the previously defined courses is above a 2.00 (carrying a normal load), and the cumulative IMQPA in the previously defined courses is above a 2.00.

A student is occasionally continued on departmental probation who has had one semester on departmental 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.

Removal from Department
A student will be asked to leave the IM Program if the semester factor or the cumulative factor in the IMQPA is below a 2.00 for two consecutive semesters.

The above requirements in no way supersede the requirements already in place (see College Academic Actions, above) of maintaining a 1.75 QPA (carrying a normal load) in either semester of the freshman year and a semester and cumulative 2.00 QPA in all subsequent years.

Other Regulations Affecting Student Status

The last date to add courses is the one stipulated for each semester on the University Calendar — about three weeks after the beginning of a term.

The last date to drop courses (scheduled as part of a normal load, i.e., above 36 units and normally 45 to 54 units) is two weeks after mid-semester grades are due in the Registrar's Office. However, a student carrying an overload may petition to drop the overload courses to bring the load down to normal up to and including the last day of classes, excluding the final examination period. In any case, a full-time student will be expected to maintain a load of at least 36 units.

A student may petition to withdraw from the college at any time until and including the last day of classes and excluding the final examination period, with the understanding that "W" grades will be recorded if the withdrawal takes place after the official drop deadline. At the time of withdrawal a written statement will be placed on record setting forth the time and conditions under which the student may be permitted to return, with copies to the student, the parents, the Dean's Office, and the Program Director. If a student is under 18 years of age, guardian or parents' signatures must appear on the withdrawal form.

Exceptions to the regulations above will be granted only upon approval of a petition to the Industrial Management Program.

Non-Carnegie Mellon Courses

With the written permission of the IM program, students may receive credit for courses taken at other institutions in which they receive a grade equivalent to a "C" or higher. Under no circumstances will IM students be permitted to earn elsewhere more than 180 of the 364 units required for graduation. In general, and commencing with their matriculation to Carnegie Mellon as degree candidates, IM students may take a maximum of five courses (or their unit equivalent) elsewhere and receive transfer credit for these courses. For students entering IM as internal transfers, these limits apply retroactively to their matriculation to Carnegie Mellon as degree candidates.

Academic Advising

Students are required to meet with their IM academic advisor at least once each semester to ensure that they are making normal progress toward their degree. Note that it is the individual student's responsibility to make sure that he or she fulfills the requirements for graduation.

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 freshman year.

Students must be recommended for a degree by the faculty of the appropriate college.

Students will be required to meet the Residence Requirement (see Residence Requirement, page 52) and to 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 IM Program.

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

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

Mark Kamlet, Dean
Office: 1104 Hamburg Hall

How should a governor develop a fiscally sound tax-reform proposal that will also stimulate economic growth? How can a regulator decide if a utility rate increase should be granted? How should a manufacturing firm assist workers displaced by new technology? How can a community theater continue to produce quality entertainment despite reductions in public funding?

Every day, government officials and public and non-profit managers must make decisions that have an impact on thousands, and frequently millions, of citizens.

Named for the late U.S. Sen. John Heinz, the H. John Heinz III School of Public Policy and Management was established to meet the need for skilled analysts and managers capable of applying modern management techniques to public sector problems.

A graduate school, the Heinz School has a way for exceptional undergraduate students to earn their Master of Science in Public Policy and Management or Master of Arts Management degree, along with their undergraduate degree, in just five years through the school's 3-1-1 program. In the program, students take their undergraduate course load during the first three years, a combination of Heinz School courses and undergraduate courses in the fourth year, and finish their master's degree in their fifth and final year.

Students admitted to the 3-1-1 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 to finish their B.A./B.S. degree and also take courses towards their Heinz School degree. They may elect to receive their B.A./B.S. degree at the end of the fourth year. During the fifth year,they register as Heinz School graduate students, pay graduate tuition, and receive graduate financial aid.

What is the Heinz School?

At the Heinz School, students learn how to develop innovative solutions to important problems and how to effectively put these solutions into action. Students at the Heinz School:

- learn to identify and analyze complex issues and problems using models and techniques from statistics, economics, finance, and operations research;
- learn to use computers to quickly analyze problems and to synthesize information from large amounts of data;
- gain insight into how policies are developed and implemented in a political environment, and learn how to manage change in both large and small organizations;
- develop strong communication skills and experience in working on projects as a member of a professional team.

During their first year at the Heinz School, students take the Common Core, which provides a strong foundation in the critical skills needed by managers and analysts in today's complex society. During the second year, they specialize in one of five concentration areas: Policy Analysis, Management, Urban Planning and Economic Development, Management Information Systems, or Financial Management and Analysis.

How is the Heinz School different?

Diversity

Heinz School students come from all types of backgrounds, and the school is nationally recognized for the diversity of its student body. During the 1993-94 academic year, 50 percent of the school's students were students of color or international students. Heinz School students have undergraduate degrees in architecture, biology, business administration, economics, education, engineering, English, government, history, music, 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 national and local problems and present their findings to the officials who have responsibility for addressing those problems. And students take a paid summer internship to practice the skills they've learned in school.

What kinds of careers do Heinz School graduates pursue?

An MS degree from the Heinz School opens doors to a wide range of management careers in government agencies, financial institutions, top consulting firms, private foundations, multinational corporations and a host of other organizations. Heinz School graduates have the expertise in finance, accounting, information systems, and decision-making that employers need, and they can get the kind of interesting, exciting jobs they want.

Last year the average starting salary of the Heinz School's graduates was $34,000, with some graduates receiving starting salaries in the mid $40's. Some of the jobs 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 Corporation
- 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

The Faculty

Members of the Heinz School faculty have been recognized nationally and internationally for their accomplishments in research and their contributions to public policy. They include economists, political scientists, communications and computer experts, transportation and environmental engineers, statisticians, accountants and labor relations specialists. Examples of their contributions include federal and state tax reform, changes in regulatory systems, redesign of urban and criminal justice policies, refashioning of social welfare programs, and rethinking of economic development policy.

Other Heinz School Programs

The Heinz School also offers a joint degree program in law (with the University of Pittsburgh School of Law) and operates a collaborative program in Private and Public Management and Policy with the Graduate School of Industrial Administration.

Master of Arts Management

With public funding for arts organizations becoming more and more scarce, arts organizations are looking for talented managers. The Heinz School and the College of Fine Arts at Carnegie Mellon jointly developed the Master of Arts Management program to provide skilled management for all forms of arts organizations: theatres, art galleries, orchestras, ballets, and operas, to name a few. The 3-1-1 Master of Arts Management program provides undergraduate students the opportunity to complete their Bachelor of Fine Arts and Master of Arts Management degree in just five years. Graduates of the MAM program hold positions such as:

- Director of Marketing, Bardavon 1869 Opera House, Poughkeepsie, NY
- Consultant, Hill Arts and Entertainment
- Special Projects Coordinator, Washington Very Special Projects

Ph.D. Program

The Heinz School Ph.D. program prepares qualified students from a variety of academic and professional backgrounds for careers in research, academia, governmental organizations and in the private sector where expertise in advanced research is desired. Graduates of the Heinz School work as professors, research scientists or directors of research, serve as consultants, and participate in diverse areas of public service and management.

For further information about the Heinz School, contact:

Paula Davis
Director of Admissions and Alumni Relations
H. John Heinz III School of Public Policy and Management
Carnegie Mellon University
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Faculty

DELORESE AMBROSE, Adjunct Professor of Management — Ph.D., Columbia University; Carnegie Mellon, 1980—.

STEPHEN J. APPOLD, Assistant Professor of Sociology and Public Policy — Ph.D., University of North Carolina; Carnegie Mellon, 1990—.

ASHISH ARORA, Assistant Professor of Economics and Public Policy — Ph.D., Stanford University; Carnegie Mellon, 1991—

LINDA BABCOCK, Associate Professor of Economics — Ph.D., University of Wisconsin; Carnegie Mellon, 1988—.

JOSEPH BALESTREIRE, Adjunct Instructor of Health Systems Management — Ph.D., University of Pittsburgh, Carnegie Mellon, 1994—.

MARY GAIL BIEBEL, Adjunct Assistant Professor of Management — Ph.D., University of Pittsburgh; Carnegie Mellon, 1988—.

MULUGETTA BIRRU, Adjunct Instructor of Urban Planning — Ph.D., Cornell University, Carnegie Mellon, 1993—.

ALFRED BLUMSTEIN, J. Erik Jonsson Professor of Urban Systems and Operations Research; Director, Urban Systems Institute — Ph.D., Cornell University; Carnegie Mellon, 1969—.

SUSAN BRANSCUM, Adjunct Instructor of Health Systems Planning — MBA, Kent State University, Carnegie Mellon, 1992—.

KATHLEEN CARLEY, Associate Professor of Sociology — Ph.D., Harvard University, Carnegie Mellon, 1984—.

JONATHAN CAULKINS, Assistant Professor of Operations Research and Public Policy — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1990—.

JACQUELINE COHEN, Principal Research Scientist and Associate Director, Urban Systems Institute — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1970—.

WESLEY COHEN, Associate Professor of Social and Decision Sciences (affiliated) — Ph.D., Yale University, Carnegie Mellon, 1982—.

OTTO A. DAVIS, W.W. Cooper University Professor of Economics and Public Policy — Ph.D., University of Virginia; Carnegie Mellon, 1960—.

ERIK DEVEREUX, Assistant Professor of Political Science and Public Policy — Ph.D., University of Texas, Austin; Carnegie Mellon, 1991—

GEORGE T. DUNCAN, Professor of Statistics and Director, Decision Systems Research Institute — Ph.D., University of Minnesota; Carnegie Mellon, 1974—.

WILLIAM F. ELLIOTT, Adjunct Associate Professor of Marketing — Ph.D., University of Pittsburgh; Carnegie Mellon, 1970—.

JOHN ENGBERG, Assistant Professor of Economics — Ph.D., University of Wisconsin; Carnegie Mellon, 1988—.

HARRY R. FAULK, Adjunct Professor of Education Policy; Associate Dean — D.Ed., University of Pittsburgh; Carnegie Mellon, 1978—.

BEN FISCHER, Distinguished Public Service Professor of Labor Relations and Public Policy — Carnegie Mellon, 1981—.

RICHARD FLORIDA, Professor of Public Policy and Management; Director, Center for Economic Development — Ph.D., Columbia University; Carnegie Mellon, 1986—.

DON FULLERTON, Professor of Economics and Public Policy — Ph.D., University of California, Berkeley; Carnegie Mellon, 1991 —.

WILPEN GORR, Professor of Public Policy and Management Information Systems — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1985—.

ROBERT W. HAHN, Adjunct Professor of Economics, Engineering and Public Policy — Ph.D., California Institute of Technology; Carnegie Mellon, 1982—.

BENNETT HARRISON, Professor of Political Economy — Ph.D., University of Pennsylvania; Carnegie Mellon, 1989—.

LAKS IYENGAR, Adjunct Assistant Professor of Management - - M.B.A., University of Pittsburgh; Carnegie Mellon, 1986—.

MARK KAMLET, Dean, The H. John Heinz III School of Public Policy and Management; Professor of Economics and Public Policy — Ph.D., University of California, Berkeley; Carnegie Mellon, 1978—.

MARYELLEN KELLEY, Associate Professor of Management and Public Policy — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.

JOAN KIEL, Adjunct Instructor of Management — Ph.D., New York Graduate School of Public Administration/Leonard N. Stern Graduate School of Business, Carnegie Mellon, 1992—.

EDWARD KIELY, Adjunct Instructor of Public Management — Ph.D., University of Pittsburgh, Carnegie Mellon, 1993—.

STEVEN KLEPPER, Professor of Economics and Social Science (affiliated) — Ph.D., Cornell University, Carnegie Mellon, 1980—.

CHRISTOPHER KOWALSKY, Adjunct Instructor of Management of Information Systems — MPM, Carnegie Mellon University, Carnegie Mellon, 1991—.

DAVID KRACKHARDT, Associate Professor of Organizations and Public Policy — Ph.D., University of California, Irvine; Carnegie Mellon, 1991—.

RAMAYYA KRISHNAN, Associate Professor of Management Science and Information Systems — Ph.D., University of Texas at Austin; Carnegie Mellon, 1987—.

FRANK LABARBERA, Adjunct Instructor of Accounting — MBA, University of Pittsburgh, Carnegie Mellon, 1992—.

PATRICK LARKEY, Professor of Public Policy and Decision Sciences — Ph.D., University of Michigan; Carnegie Mellon, 1977—.

LESTER B. LAVE, James Higgins Professor of Economics and Urban Affairs — Ph.D., Harvard University; Carnegie Mellon, 1963—.

BARBARA B. LAZARUS, Associate Provost and Adjunct Associate Professor of Educational Anthropology — Ed.D., University of Massachusetts; Carnegie Mellon, 1985—.

GORDON H. LEWIS, Associate Professor of Sociology — Ph.D., Stanford University; Carnegie Mellon, 1969—.

PAMELA LEWIS, Adjunct Assistant Professor of Communication — D.A., Carnegie Mellon University; Carnegie Mellon, 1980—.

PETER MADSEN, Adjunct Associate Professor of Ethics and Public Policy — Ph.D., Duquesne University; Carnegie Mellon, 1988—.

SHARON McCARTHY, Adjunct Instructor of Management, Ph.D., Bucknell University, Carnegie Mellon, 1993—.

SUSAN McELROY, Assistant Professor of Economics — ABD, Stanford University; Carnegie Mellon, 1993—.

M. GRANGER MORGAN, Professor of Electrical Engineering; Head, Department of Engineering and Public Policy — Ph.D., University of California, San Diego; Carnegie Mellon, 1974—.

DANIEL NAGIN, Professor of Management — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1986—.

KAREN OVERFIELD, Adjunct Instructor of Public Management — Ed.D., University of Pittsburgh, Carnegie Mellon, 1993—.

REMA PADMAN, Assistant Professor of Operations Research — Ph.D., University of Texas, Austin; Carnegie Mellon, 1989—.

JAMES M. PETERS, Assistant Professor of Accounting — Ph.D., University of Pittsburgh; Carnegie Mellon, 1990—.

DANA M. PHILLIPS, Adjunct Instructor of Management — M.S., Northwestern University; Carnegie Mellon, 1988—.

WALTER PLOSILA, Adjunct Instructor of Public Policy — Ph.D., University of Pittsburgh, Carnegie Mellon, 1991—.

RONALD DAVID PORTER, Adjunct Instructor of Multicultual Management — B.S., Millersville University, Carnegie Mellon, 1993—.

IAN RAWSON, Adjunct Professor of Health Policy — Ph.D., University of Pittsburgh; Carnegie Mellon, 1985—.

STEPHEN ROEHRIG, Assistant Professor of Information Systems — Ph.D., University of Pennsylvania; Carnegie Mellon, 1991—.

VELMA B. SAIRE, Adjunct Professor of Educational Management — Ph.D., University of Pittsburgh; Carnegie Mellon, 1990—.

SETH SANDERS, Assistant Professor of Economics and Public Policy — Ph.D., University of Chicago; Carnegie Mellon, 1991—.

ROSANNE SAUNDERS, Adjunct Assistant Professor of Health Management — J.D., Duquesne University; Carnegie Mellon, 1985—.

KAREN A. SHASTRI, Assistant Professor of Accounting and Public Policy — Ph.D., University of Pittsburgh; Carnegie Mellon, 1990—.

JOHN SHEPHERD, Adjunct Instructor of Management of Information Systems — Ph.D., University of Pittsburgh, Carnegie Mellon, 1991—.

KATHLEEN SMITH, Adjunct Instructor of Statistics — MBA, University of Pittsburgh, Carnegie Mellon, 1992—.

RICHARD STAFFORD, Adjunct Professor of Public Policy — M.S., Carnegie Mellon University; Carnegie Mellon, 1987—.

WILBUR STEGER, Adjunct Professor of Policy Analysis — Ph.D., Harvard University; Carnegie Mellon, 1985—.

SHELBY STEWMAN, Professor of Sociology and Demography — Ph.D., Michigan State University; Carnegie Mellon, 1973—.

ROBERT P. STRAUSS, Professor of Economics and Public Policy — Ph.D., University of Wisconsin; Carnegie Mellon, 1979—.

JOEL ARTHUR TARR, Richard S. Caliguiri Professor of History and Urban Affairs — Ph.D., Northwestern University; Carnegie Mellon, 1967—.

TIMOTHY TASSONE, Adjunct Professor of Strategic Marketing/Communications — Kent State University; Carnegie Mellon, 1985—.

LOWELL J. TAYLOR, Assistant Professor of Economics and Public Policy — Ph.D., University of Michigan; Carnegie Mellon, 1990—.

MARCIA TAYLOR, Adjunct Instructor of Accounting — BSBA, BUniversity of Pittsburgh, Carnegie Mellon, 1993—.

K. CRAIG TROUT, Adjunct Instructor for Financial Management of Health Systems — M.B.A., University of South Florida; Carnegie Mellon, 1988—.

MARK WESSEL, Associate Dean — M.S., University of Wisconsin, Carnegie Mellon, 1993—.

ALAN R. WHITMAN, Adjunct Professor of Health Systems Management — Ph.D., Clemson University; Carnegie Mellon, 1983—.

NANCY WYNSTRA, Adjunct Assistant Professor for Legal Issues in Health Systems — J.D., Columbia University; Carnegie Mellon, 1985—.

Mellon College of Science

Mellon College of Science

Susan A. Henry, Dean
Eric W. Grotzinger, Associate Dean for Undergraduate Affairs
Undergraduate Office: Scaife Hall 115

Undergraduate education in the Mellon College of Science (MCS) is the responsibility of faculty in the departments of Biological Sciences, Chemistry, Mathematics, and Physics. The MCS faculty is committed to teaching and to a wide range of scientific research that has brought national and international recognition to the university. The combined emphasis on education and research brings special benefits to students; among these are increased awareness of current scientific developments that can be incorporated into classroom instruction, and, most importantly, opportunities for undergraduates to participate with faculty, graduate students, and other research scientists in a variety of research projects. The goal of MCS is to provide science education based on a strong grounding in fundamental knowledge complemented by state-of-the-art expertise and exposure to the modern research environment.

Degree Programs

The degree programs and course offerings available in the Mellon College of Science are outlined in the following sections by the departments of Biological Sciences, Chemistry, Mathematics, and Physics. 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 enable a student to choose a major from any of the programs offered in MCS.

Students select their major in the spring of the freshman 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 for undergraduate research, interdisciplinary studies, study abroad, double majoring and minoring in another field, applied science study, and other specialty courses oriented either toward immediate job placement upon graduation or entry into graduate studies.

Each degree program includes a minimum of 72 units of study in the humanities, social sciences, or fine arts. The requirements governing the distribution of these courses are listed below under a separate heading. Electives which are designated as free electives rather than technical electives may be used for additional study in the humanities, social sciences, or fine arts. This makes it possible to concentrate significantly in one of these areas, to earn a minor, or to double major. Free electives are more numerous in B.A. programs than in B.S. programs.

Degree Program Options

Departments offer optional programs and tracks that allow students to explore particular fields within a science discipline. Among these are the Computer Science tracks in Biological Sciences, Chemistry and Physics. There are many other choices. The departmental sections should be consulted for further details.

Minors in MCS

The Mellon College of Science offers minors in Biological Sciences, Chemistry, Mathematics and Physics. These minors are available to all students in the university. Complete descriptions of these minors are found in the departmental descriptions.

Undergraduate Research Opportunities

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. A listing of research opportunities is available in the MCS dean's office and in the departments. Jobs which rely on one's science background are also available in administrative and service areas on campus. Because of the strong research base of MCS, undergraduate research positions offer an exciting opportunity to participate in the discovery of new knowledge.

Advisory Services

Several offices offer a variety of advisory services to MCS undergraduates. Science students are advised and monitored through the MCS Office of Undergraduate Affairs, Scaife Hall 115. Additionally, all upperclass students have advisers in their major department. Students who are interested in medical school or other graduate schools in the health professions are advised by the Carnegie Mellon Health Professions Program. The Carnegie Mellon Career Center is staffed by professional counselors to help students identify their career goals and to instruct them in searching for a job. The Career Center also offers students the opportunity to meet with employers through a job interview program. The Counseling Center gives students professional help with personal problems. There are many campus organizations, departmental clubs, and activities that bring faculty and students together to supplement the undergraduate experience.

Freshman 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

21-121	Calculus 1
21-122	Calculus 2
33-111	Physics for Science Students I
33-112	Physics for Science Students II
03-121	Modern Biology
09-105	Modern Chemistry I
15-125	Introduction to Programming and Computation
or	
15-127	Introduction to Programming and Computer Science

In the freshman year, students are required to take 21-121 Calculus 1, 21-122 Calculus 2 and 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 freshman year include one course from the intended major, humanities, social sciences or fine arts courses and Computing Skills Workshop, a course that introduces students to the computing environment 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 freshman year.

Fall Semester		50-52 units
21-121	Calculus	10
xx-xxx	Science Core Course	9-10
xx-xxx	Science Core Course	10
xx-xxx	Free Elective Course	9-10
76-xxx	Designated Writing Course	9
99-101	Computing Skills Workshop	3

Spring Semester		46-49 units
21-122	Calculus with Linear Algebra	10
xx-xxx	Science Core Course	9-10
xx-xxx	Technical Elective from Intended Major	9-10
xx-xxx	Free Elective Course	9-10
xx-xxx	Humanities, Social Sciences or Fine Arts Course	9

Notes

1. Technical electives for intended major are as follows:

Biological Sciences or Chemistry		
09-106	Modern Chemistry II	10
Mathematics		
21-127	Introduction to Modern Mathematics	9
Physics		
33-104	Experimental Physics	9
or		
33-102	Concepts of Modern Physics	9

2. A free elective is any Carnegie Mellon course. However, a maximum of nine units of physical education and/or military science may be taken as free electives in any MCS degree program. Credit earned for physical education and military science 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.

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)

Complete one of the following:

76-100	Introduction to English Studies: Argument
or	
76-101	Introduction to English Studies: Interpretation

B. Distributional Course Requirements (36 units)

Complete four courses including at least one course from Category 1, one course from Category 2, and at least one course from either Category 3 or Category 4.

Category 1: Cognition Choice and Behavior

80-150	Nature of Reason
80-180	Nature of Language
80-182	Language and Thought
80-242	Conflict, Culture and Dispute Resolution
85-100	Cognitive Processes: Theory and Practice
85-101	General Psychology (Self-Paced)
85-102	Introduction to Psychology
85-150	Introduction to Social Problems
85-211	Cognitive Psychology
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Introduction to Personality

Category 2: Economic, Political and Social Institutions

36-203	Sampling, Surveys and Society
73-100	Principles of Economics
79-114	Causal Models and Historical Explanation
79-115	Education and Inequality
80-136	Social Structure, Public Policy and Ethical Dilemmas
88-104	Decision Processes in American Foreign Policy
88-104	Decision Processes in American Government
88-109	Institutions and Individuals
88-110	Market Power and Market Failure: A Laboratory Approach

Category 3: Creative Production and Reflection

NOTE: Some of the courses in Category 3 are offered for less than nine units. Students must take a minimum of nine units to fulfill the minimum requirement in this category.

48-095	Architecture for Non-Majors
51-170	Communication Design Fundamentals
51-180	Industrial Design Fundamentals
51-210	Beginning Photography
51-233	Typography
57-107/108	Studio for Non-Majors (3-9 units)
57-227	Jazz Ensemble (3 units)
57-417	Concert Choir (6 units)
57-418	Wind Ensemble (6 units)
57-419	Repertory Chorus (6 units)
57-420	Jazz Choir (3 units)
57-430	Philharmonic Orchestra (6 units)
60-101	Concept Studio I - The Self and the Human Being (10 units)
60-110	Electronic Media Studio I (10 units)
76-206	Craft of Creative Writing
80-120	Reflections on Science
80-241	Ethical Judgments in Professional Life
80-260	Philosophy of Art
82-101	Elementary French I
82-102	Elementary French II
82-121	Elementary German I
82-122	Elementary German II
82-141	Elementary Spanish I
82-142	Elementary Spanish II
82-161	Elementary Italian I
82-162	Elementary Italian II
82-171	Elementary Japanese I
82-172	Elementary Japanese II
82-191	Elementary Russian I
82-192	Elementary Russian II

Category 4: Cultural Analysis

76-201	Cultural Practices and Literary Production
76-240	What is Cultural Studies?
79-104	Introduction to World History
79-110	Dynamics of Cultural Change
79-111	Cultural and Cross-Cultural Perspectives on Environment
79-112	Race, Nationality, and the Development of Cultures
79-113	Culture and Identity in American Social Life
79-200	Society and the Arts
80-100	What Philosophy Is
80-183	Language, Culture and Thought
82-107	Reflections of French Culture in Film
82-193	The Faust Legend from Europe to Russia
82-409	French Literature of the Nineteenth Century
82-412	Twentieth-Century French Theater
82-413	Twentieth-Century French Novel
82-415/416	Studies in French Literature
82-427	The New Germany
82-428	German Classical Literature
82-429	German Literature of the Nineteenth Century
82-430	German Literature of the Twentieth Century
82-431	Postwar German Literature
82-435/436	Studies in German Literature
82-441	Survey of Spanish Literature and Culture
82-451	Introduction to Latin American Literature and Culture
82-455	Studies in Spanish and Latin American Literature
82-465/466	Surrealism in France and Spain
82-491	Literature, Politics and Film in East Europe and Russia Today
82-492	The Historical Imagination in Nineteenth Century Russian Literature

C. Non-Introductory Elective (27 units)

Complete 3 non-introductory level courses of at least 9 units each from any of the departments in H&SS or CFA or non-technical courses in IM. Accounting, finance, management, marketing, production and statistics courses are considered technical courses and may not be used to satisfy this requirement.

Double Majors and Double Degrees

A double major is a single degree in two areas; for example, the degree of bachelor of science in Physics with an additional major in English. Double major degrees may be earned in bachelor of science or bachelor of arts degree programs.

A double degree program results in two bachelor's degrees. This requires 90 units of work in addition to the units required for the first degree.

The general principle used to measure eligibility for a double major is that the major requirements of both departments must be completed. The student is formally enrolled as an undergraduate in one of the departments (the "parent department") and that department is responsible for scheduling and other administrative actions for the student.

For clarification, a major is defined as a program, completion of which is necessary for the granting of a degree. The general requirements for such a program and suggestions for its administration are given below.

Requirements for the Double Major Program

The minimum number of units required for the double major is the number required by the parent department or major. The student completes a number of courses specified by the second department, usually using elective space available in the first program.

The second department then certifies to the home department that the student has completed the requirements for a major in the second department.

MCS then grants a degree stating that the student has a B.A. or a B.S. in (parent department) with an additional major in (second department).

Certain bachelor of science degree programs are designed to meet accreditation requirements of professional organizations. To ensure this condition is not lost, the student must adhere strictly to the published curriculum for the professional degree.

This restriction implies the following:

- No non-technical courses may be substituted for technical courses specified in the accredited curriculum.
- At the MCS adviser's discretion, equivalent technical electives may be substituted from either MCS or CIT departments.

The 3-1-1 Program with the H. John Heinz III School of Public Policy and Management

The 3-1-1 Program is a cooperative program sponsored by the H. John Heinz III School of Public Policy and Management and the Mellon College of Science. This program offers talented undergraduates the unique opportunity to pursue their undergraduate major and a Master of Science degree in Public Management and Policy. Application to this program is in the third (junior) year, while entry into the program occurs in the fourth (senior) year. During this fourth year, 3-1-1 students take a combination of undergraduate and Heinz School courses. Students receive the bachelor's degree at the end of the fourth year and, if they elect to continue, the master's degree at the end of the fifth year. The program effectively condenses into five years what would normally take six years to complete. For additional details, contact the 3-1-1 Program Director in the H. John Heinz III School of Public Policy and Management (HBH1100).

Academic Standards and Actions

Grading Practices

Grading regulations are detailed on page 48.

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 45 factorable units and earning no incomplete grades,

or

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.

Dean's List High Honors

The student must earn a quality point average of at least 3.75 while completing a minimum of 45 factorable units and earning no incomplete grades.

Transfer into MCS Departments

Undergraduate students admitted to MCS have the right to choose 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 a MCS department during their first year should consult with the MCS associate dean of undergraduate affairs. Undergraduate students will be considered for transfer throughout the freshman year.

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 our MCS department 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 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 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. Freshmen 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 freshman 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 freshman 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 person authorized by the dean of MCS to deal with such matters.
- Completing a "returning student's form" for the registrar; 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.*

A student who has been suspended is not eligible for employment by the university during the period of the suspension.

Drop

This is a permanent severance from the Mellon College of Science. Students are dropped when it seems clear that they will never be able to meet minimum standards. A student who has been suspended and who fails to meet minimum standards after returning to school is dropped.

If students have been suspended or dropped, they are required to absent themselves from the campus (including dormitories and fraternity 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 departure from part-time or summer courses for the duration of the period of the action.

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 freshman 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 must be recommended for a degree by the faculty of MCS.

Students will be required to meet the residence requirement and to have met all financial obligations to the university before being awarded a degree. (The residence requirement is detailed on page 49.)

A student may seek permission to modify graduation requirements by petition to the MCS College Council.

Other Regulations Affecting a Student's Status

Schedule Changes

The last date to add courses is the one stipulated for each semester on the university calendar — about two weeks after the beginning of a term. The last date to drop courses is two weeks after mid-semester grades are due in the Registrar's Office.

This applies to all courses with the following exceptions:

The final date to add a half-semester mini-course is the last class day of the second week of the course. The final date to drop a half-semester mini-course is the last class day of the fourth week of the course.

A student carrying a full time course load as of the 10th regularly scheduled class day is not permitted to drop below 36 units after that date.

A student carrying an overload may petition to drop the overload courses to bring the load down to normal up to and including the last day of classes, excluding the final examination period. In any case a full-time student will be expected to maintain a load of at least 36 units.

A student may add or drop courses within the above deadlines by filing with the registrar a Registration/Add/Drop form including appropriate signatures of instructors and advisers. When a student drops courses within the above time frame, the courses will be erased entirely from the records. If extenuating circumstances are established and approval to drop a course is given after the above deadlines, then the course dropped will appear on a student's grade report and transcript followed by a "W." This would also include students who are carrying overloads. (Add/drop procedures are found on page 46.)

Withdrawing from MCS

A student may petition to withdraw from the college at any time until and including the last day of classes and excluding the final examination period, with the understanding that "W" grades will be recorded if the withdrawal takes place after the official drop deadline. At the time of withdrawal a written statement will be placed on record setting forth the time and conditions under which the student may be permitted to return, with copies to the student, the parents, the dean's office and the department head. If a student is under 18 years of age, the signature of a guardian or parent must appear on the withdrawal form. At the time of withdrawal, the university will notify the student's parents by letter, except in the case of a student over 21 years of age. (see page 52 for withdrawal procedure.)

Exceptions to the regulations above will be granted only upon approval of a petition to the MCS College Council.

Department of Biological Sciences

William E. Brown, Acting Head
Edward P. Weisberg, Assistant Head
Office: Mellon Institute 414

A major revolution is now occurring in the field of biological sciences. Modern biology is undergoing unprecedented technological advances in biochemistry, biophysics, cell biology, genetics, molecular biology and developmental biology. Advances in basic research in these areas are already being used to solve problems, not only in medicine and public health, but also in areas such as agriculture, forestry, mining and energy, and in industrial and pharmaceutical manufacturing processes. The Department of Biological Sciences focuses on the areas of modern biology and is recognized as one of the outstanding departments in these areas. 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 degree in biological sciences. This degree program has a core curriculum that provides a foundation in modern biology, computer science, chemistry, mathematics and physics. In addition to the core courses, the program includes many electives — six biology electives, eight 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. Minors are offered in the other departments in the College, in the School of Computer Science and in H&SS, allowing students to explore several disciplines in depth. A bachelor of arts double major degree with the College of Humanities and Social Sciences is also available. The Department also offers a B.S. Biological Sciences/Computer Science Track for students with interests in computational modelling and analysis of biological systems. All university students are eligible to pursue a minor in Biological Sciences in conjunction with a major in any other department in the University.

For students who have or develop an interest in a particular field of biology and wish to have additional specialized education, the department has optional programs in biochemistry, biophysics, cell biology, developmental biology, genetics, and molecular biology. These are taken in order to provide the appropriate training in each area. The programs are recommended for students who are considering graduate school in one of the disciplines of modern biology. For those who wish to work in the area of genetic engineering, the department recommends either the genetics program or the molecular biology program. Either of these programs may be combined with a year of undergraduate research in one of our research laboratories in which recombinant DNA experiments are performed.

The B.S. or the B.A. double major degree in biological sciences provides excellent preparation for medical school and other graduate schools in the health professions. About one-third of the biology undergraduates go to medical school. These students are aided by the Carnegie Mellon Health Professions Program, an advisory service for all Carnegie Mellon students who are considering careers in the health fields.

One of the most important features of the Department of Biological Sciences is the opportunity that undergraduate students have to interact with faculty. These men and women are prominent research scientists who also teach beginning as well as advanced courses. The student teaching laboratories are located in the same building as the faculty research laboratories and often 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 accelerated introduction to research for eligible students. During the past four years, over 75 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. in Biological Sciences - Curriculum

Freshman Year

	Fall	Units
03-121	Modern Biology	9
09-105	Modern Chemistry I	10
21-121	Calculus 1	10
76-100 or 101	Designated Writing Course	9
xx-xxx	H&SS/FA Elective*	9
99-101	Computing Skills Workshop	3
		50
	Spring	
09-106	Modern Chemistry II	10
15-125	Introduction to Programming and Computation	
or		
15-127	Introduction to Programming and Computer Science	10
21-122	Calculus 2	10
33-111	Physics for Science Students I	10
xx-xxx	H&SS/FA Elective*	9
		49

Sophomore Year

	Fall	Units
03-240	Cell Biology	9
09-117	Organic Chemistry I	9
09-131	Experimental Techniques in Chemistry I	10
33-112	Physics for Science Students II	10
xx-xxx	H&SS/FA Elective*	9
		47
	Spring	
03-231	Biochemistry I	9
09-132	Experimental Techniques in Chemistry II	10
09-144	Physical Chemistry	9
09-218	Organic Chemistry II	9
xx-xxx	H&SS/FA Elective*	9
		46

Junior Year

	Fall	Units
03-243	Experimental Techniques in Genetics & Molecular Biology	12
03-330	Genetics	9
03-xxx	Biology Elective	9
xx-xxx	Free Elective	9
xx-xxx	H&SS/FA Elective*	9
		48
	Spring	
03-244	Experimental Techniques in Biochemistry	12
03-xxx	Biology Electives	18
xx-xxx	Free Elective	9
xx-xxx	H&SS/FA Elective*	9
		48

Senior Year

	Fall	Units
03-411	Seminar	1
03-xxx	Biology Electives	18
xx-xxx	Free Electives	18
xx-xxx	H&SS/FA Elective*	9
		46
	Spring	
03-412	Seminar	1
03-xxx	Biology Elective	9
xx-xxx	Free Electives	36
		46

*See Mellon College of Science's Humanities and Social Sciences (H&SS), and Fine Arts (FA) Requirements.

Minimum number of units required for degree: 360

Flexibility in course scheduling is offered in the junior and senior years when biology and free electives can be scheduled to fulfill the variety of options offered by the department. (See options for the B.S. in Biological Sciences). The schedule shown above includes more units than are required for graduation, allowing students increased flexibility in scheduling elective and required courses. The first semester of Physics may be postponed until the sophomore year, replacing it with an elective course. Typical schedules of courses are available in the biology undergraduate office, Mellon Institute 416.

Curriculum Notes

Distribution of Units for the B.S. Degree

The degree in biological sciences is built around a core program and elective units as shown below.

Core Requirements		Units
Biological Sciences		
03-121	Modern Biology	9
03-240	Cell Biology	9
03-231	Biochemistry	9
03-330	Genetics	9
03-243	Experimental Techniques in Genetics & Molecular Biology	12
03-244	Experimental Techniques in Biochemistry	12
03-411/412	Undergraduate Seminar	2
Mathematics, Physics and Computer Science		
21-121/122	Calculus	20
33-111/112	Physics	20
15-125 or		
15-127	Computer Science	10
99-101	Computing Skills Workshop	3
Chemistry		
09-105/106	Modern Chemistry I and II	20
09-117/218	Organic Chemistry I and II	18
09-131/132	Experimental Techniques in Chemistry	20
09-144	Physical Chemistry	9
	Total	**182**

Elective Units	
Free Electives	52
H&SS Electives	72
Biological Science Electives	54

Biological Science Electives can be any course listed in the Biology course descriptions, except those that are core requirements. The following specifications apply:

At least 18 units must be at the 03-3xx level or above, exclusive of 03-445.

Up to 18 units of Undergraduate Research (03-445) may count as biology electives and a maximum of 36 units can count toward graduation.

Up to three of the following courses may count as biology electives;

21-127	Introduction to Modern Mathematics
21-259	Calculus in Three Dimensions
21-260	Differential Equations
15-211	Fundamental Structures of Computer Science I
33-669	Biophysics I
33-670	Biophysics II
36-253	Introduction to Biostatistics
42-500	Physiology (emphasis on neuropohysiology)
42-501	Physiology (emphasis on circulatory system)

Courses in biology taken through cross-registration at another university may count as electives if prior permission has been obtained from the Carnegie Mellon Biological Sciences Department advisor.

Biological Sciences Electives

Following is a list of biology electives.

03-122	Organismic Botany
03-124	Modern Biology Laboratory
03-130	Biology of Organisms
03-310	Introduction to Computational Biology
03-311	Introduction to Computational Molecular Biology
03-332	Biochemistry II
03-350	Developmental Biology
03-360	Biology of the Brain
03-380	Virology
03-438	Physical Biochemistry
03-439	Introduction to Biophysics
03-441	Molecular Biology of Prokaryotes
03-442	Molecular Biology of Eukaryotes
03-445	Undergraduate Research
03-510	Computational Biology
03-533	NMR in Biomedical Sciences
03-534	Fluorescence Spectroscopy in Biological Research
03-545	Honors Research
03-550	Developmental Genetics
03-609	Fermentation Technology
03-620	Techniques in Electron Microscopy
03-730	Advanced Genetics
03-740	Advanced Biochemistry : Nucleic Acids
03-741	Advanced Cell Biology
03-742	Molecular Biology of Eukaryotes
03-751	Advanced Developmental Biology
03-760	Membrane Biochemistry and Biophysics
03-871	Structural Biophysics

Options for the B.S. in Biological Sciences

The curriculum in the department provides opportunity for choosing elective courses in biology in the junior and senior years. Students can either choose their six electives from among any of those offered in the department or they can select electives which are grouped into programs called options. Both plans lead to the B.S. in biological sciences. The options are for students who wish to specialize in a certain area of biology. These options need not be declared until the senior year, and there is no pressure from the department to choose one.

For each of the following options, the student should refer to the previous description of the curriculum for B.S. in biological sciences. Required courses are unchanged. The elective courses comprising each option are listed.

A student who completes the required biology electives for any option can have two of them noted on his or her transcript.

Biochemistry Option

Required Biology electives:

03-332	Biochemistry II
03-438	Physical Biochemistry
21-259	Calculus in Three Dimensions
or	
21-260	Differential Equations

Recommended Biology electives:

03-441	Molecular Biology of Prokaryotes
03-442	Molecular Biology of Eukaryotes
03-533	NMR in Biomedical Sciences
03-534	Fluorescence Spectroscopy in Biological Sciences
03-439	Introduction to Biophysics

Biophysics Option

Required Biology electives:

03-332	Biochemistry II
03-438	Physical Biochemistry
21-259	Calculus in Three Dimensions
or	
21-260	Differential Equations
03-439	Introduction to Biophysics

Recommended Biology electives:

03-533	NMR in Biomedical Sciences
03-534	Fluorescence Spectroscopy in Biological Research
03-560	Membrane Biochemistry and Biophysics
38-669	Biophysics I
38-670	Biophysics II

Cell Biology Option

Required Biology electives:

03-441	Molecular Biology of Prokaryotes
03-350	Developmental Biology
03-741	Advanced Cell Biology

Recommended Biology electives:

03-130	Biology of Organisms
03-332	Biochemistry II
03-360	Biology of the Brain
03-442	Molecular Biology of Eukaryotes
03-751	Advanced Developmental Biology

Developmental Biology Option

Required Biology electives:

03-350	Developmental Biology
03-442	Molecular Biology of Eukaryotes
03-550	Developmental Genetics

Recommended Biology electives:

03-332	Biochemistry II
03-360	Biology of the Brain
03-441	Molecular Biology of Prokaryotes
03-741	Advanced Cell Biology
03-751	Advanced Developmental Biology

Genetics Option

Required Biology electives:

03-441	Molecular Biology of Prokaryotes
03-442	Molecular Biology of Eukaryotes
03-550	Developmental Genetics
or	
03-730	Advanced Genetics

Recommended Biology electives:

03-332	Biochemistry II
03-350	Developmental Biology
03-380	Virology
03-438	Physical Biochemistry
03-550	Developmental Genetics
or	
03-730	Advanced Genetics

Molecular Biology Option

Required Biology electives:

03-332	Biochemistry II
03-441	Molecular Biology of Prokaryotes
03-442	Molecular Biology of Eukaryotes

Recommended Biology electives:

03-350	Developmental Biology
03-360	Biology of the Brain
03-380	Virology
03-550	Developmental Genetics
03-730	Advanced Genetics
03-751	Advanced Developmental Biology

Honors Program in Research Biology

The Honors Program offers, but does not require, an early opportunity to become involved in research; students may apply for this program at the end of the sophomore year or as late as the Spring term of the junior year. The program includes extensive research and a formal thesis, which is written and defended in the senior year. This program does not preclude a student completing any of the options within the department nor is it the only way in which students can participate in undergraduate research.

B.S. Biological Sciences/Computer Science Track

The field of computational biology has undergone tremendous growth in recent years. Not only are computers increasingly used by biological and biomedical researchers, but computational biology has emerged as a distinct discipline that involves the use of computers to solve biological problems. Important areas include i) analysis of nucleic acid and protein sequences, ii) modeling and simulation of biological systems (from enzyme systems to neuronal behavior to genetic adaptation), iii) analysis and display of the three-dimensional structure and behavior of biological macromolecules, and iv) analysis of multi-dimensional images of cells, tissues and organisms. In addition to providing important tools for research into the cause and treatment of human diseases such as Alzheimer's disease and AIDS, computational biology plays an essential role in the Human Genome project and the design of new drugs. The B.S. Biological Sciences/ Computer Science Track combines a solid foundation in biology, mathematics and computer science with interdisciplinary coursework. It is intended both for students planning to obtain employment in industry or academia after graduation and for those planning to continue their education in graduate school. The following schedule should be followed in order to complete this degree in four years.

Freshman Year

	Fall	Units
03-121	Modern Biology	9
09-105	Modern Chemistry I	10
21-121	Calculus 1	10
33-111	Physics I	10
99-101	Computer Skills Workshop	3
76-100 or 101	Designated Writing Course Requirement	9
		51
	Spring	
09-106	Modern Chemistry II	10
15-127	Intro. to Programming and Computer Science	10
21-122	Calculus 2	10
33-112	Physics II	10
xx-xxx	H&SS/FA Elective	9
		49

Sophomore Year

	Fall	Units
03-240	Cell Biology	9
09-117	Organic Chemistry I	9
21-127	Intro. to Mod. Math.	9
21-260	Differential Equations.	9
xx-xxx	H&SS/FA Elective	9
		45
	Spring	
03-231	Biochemistry I	9
09-218	Organic Chemistry II	9
15-211	Fundamental Structures of Computer Science I	12
or		
15-200	Survey Prog. Methods	
09-144	Physical Chemistry	9
xx-xxx	H&SS/FA Elective	9
		48

Junior Year

	Fall	Units
03-330	Genetics	9
09-131	Experimental Techniques in Chemistry I	10
03-xxx	Biology Elective	9
15-212	Fundamental Structures of Computer Science II	12
or		
21-369	Numerical Methods	9
or		
36-253	Intro. to Biostatistics	9
xx-xxx	H&SS/FA Elective	9
		46-49
	Spring	
03-xxx	Biology Elective	9
03-510	Computational Biology	12
09-132	Experimental Techniques in Chemistry II	10
xx-xxx	Free Elective	9
xx-xxx	H&SS/FA Elective	9
		49

Senior Year

	Fall	Units
03-243	Experimental Techniques in Genetics and Molecular Biology	12
03-411	Undergraduate Seminar	1
03-xxx	Biology Elective	9
xx-xxx	Computing Elective	9
xx-xxx	Free Elective	9
xx-xxx	H&SS/FA Elective	9
		49
	Spring	
03-244	Experimental Techniques in Biochemistry	12
03-412	Undergraduate Seminar	1
xx-xxx	Computing Elective	9
xx-xxx	Free Electives	18
xx-xxx	H&SS/FA Elective	9
		49

B.A. Double Major Degree

The Department of Biological Sciences offers a B.A. double major degree with the departments in the College of Humanities and Social Sciences. The degree is intended for high ability students who wish to combine their interest in science with one of the majors in the College of Humanities and Social Sciences. For students in the Department of Biological Sciences, the units for the degree are distributed as follows:

		Units
03-121	Modern Biology	9
03-240	Cell Biology	9
03-231	Biochemistry I	9
03-330	Genetics	9
03-xxx	Any Laboratory in Bio. Sci.	9-12
21-121/122	Calculus 1 & 2	10
33-111/112	Physics I and II	20
15-125	Introduction to Programming and Computation	10
or		
15-127	Introduction to Programming and Computer Science	
09-105/106	Modern Chemistry I and II	20
09-117/218	Organic Chemistry I and II	18
09-131/132	Experimental. Tech. in Chem. I and II	20
99-101	Computer Skills Workshop	3
Biological Science Electives (3)		27
Courses as specified by specific H&SS Department and Free Electives		177

Suggested Curriculum

Freshman Year

	Fall		Spring
03-121	Modern Biology	09-106	Modern Chemistry II
09-105	Modern Chemistry	15-125/127	Computer Science
21-121	Calculus 1	21-122	Calculus 2
	H&SS core course		H&SS core course
	H&SS core course		H&SS core course
99-101	Computing Skills Workshop		

Sophomore Year

	Fall		Spring
03-240	Cell Biology	03-231	Biochemistry
09-117	Organic Chemistry I	09-218	Organic Chemistry II
09-131	Experimental Techniques in Chemistry I	09-132	Experimental Techniques in Chemistry II
	H&SS core course		H&SS core course
	H&SS core course		H&SS core course

Junior Year

	Fall		Spring
03-330	Genetics	03-xxx	Biology lab or Elective
03-xxx	Biology lab or Elective	33-112	Physics II
33-111	Physics I		H&SS major course
	H&SS major course		H&SS major course
	H&SS major course		H&SS major course

Senior Year

	Fall		Spring
03-xxx	Biology Elective	03-xxx	Biology Elective
	H&SS major course		H&SS major course
	H&SS major course		H&SS major course
	H&SS major course		H&SS major course
	H&SS major course		H&SS major course

NOTE: If the student's H&SS major does not use all of the course slots noted above as "H&SS major course," remaining slots should be used for College Core Curriculum requirements and "free electives."

Minimum number of units for degree: 360

The Minor in Biological Sciences

A minimum of six Biological Sciences courses and two Chemistry courses must be completed to qualify for the minor. The curriculum includes 5 required courses (group A) and three elective courses. The electives must include either 03-130 or 03-240 (group B) and one 03-3xx course or above (group C). The third course may be from groups B, C, or D (Laboratory Electives). 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.

A. Required Courses — 46 units

03-121	Modern Biology
09-105	Modern Chemistry I
09-117	Organic Chemistry I
03-231	Biochemistry I
03-330	Genetics

B. Electives — 9 units

03-240	Cell Biology
or	
03-130	Biology of Organisms

C. Upper Level Electives

03-310	Computational Biology[1,2]
03-332	Biochemistry II
03-350	Developmental Biology
03-360	The Biology of the Brain[1,3]
03-380	Virology
03-438	Physical Biochemistry[1,4]
03-439	Introduction to Biophysics[1,3]
03-441	Mol. Biol. of Prokaryotes
03-442	Mol. Biol. of Eukaryotes[5]
03-533	NMR in Biomedical Sciences[4]
03-534	Fluorescence Spectroscopy in Biomedical Research[4,6,7]
03-550	Developmental Genetics[8]

D. Laboratory Electives (on an "as available" basis)

03-124	Modern Biology Laboratory
03-243	Experimental Techniques in Genetics and Molecular Biology[6,9]

Prerequisites

[1] 21-122 Calculus 2
[2] 15-125 Intro to Progr and Computation
[3] 33-112 Physics II
[4] 09-144 Physical Chemistry
[5] 03-441 Molecular Biology of Prokaryotes
[6] 03-240 Cell Biology
[7] 09-218 Organic Chemistry II
[8] 03-350 Developmental Biology
[9] 09-132 Exptl Tech Chem

Faculty

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WILLIAM E. BROWN, Professor of Biological Sciences — Ph.D., University of Minnesota; Carnegie Mellon, 1973—.

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DAVID D. HACKNEY, Associate Professor of Biological Sciences — Ph.D., University of California, Berkeley; Carnegie Mellon, 1978—.

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C. ROY WORTHINGTON, Professor of Biological Sciences and Physics — Ph.D., Adelaide University, Australia; Carnegie Mellon, 1969—.

Joint Appointments and Special Appointments:

EDWARD J. BENZ, Jr., Adjunct Professor of Biological Sciences — M.D., Harvard University; Carnegie Mellon, 1993—.

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ERIC W. GROTZINGER, Senior Lecturer in Biological Sciences; Associate Dean, Mellon College of Science — Ph.D., University of Pittsburgh; Carnegie Mellon, 1979—.

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LINDA R. KAUFFMAN, Senior Lecturer in Biological Sciences — Ph.D., University of Pittsburgh; Carnegie Mellon, 1977—.

FREDERICK LANNI, Senior Research Scientist — Ph.D., Harvard University; Carnegie Mellon, 1982 —.

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GEORGE S. ZUBENKO, Adjunct Professor of Biological Sciences — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1984—.

Department of Chemistry

Guy C. Berry, Head
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Chemistry is 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 computer engineering 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, with the biochemistry or pre-health professions option, is a particularly suitable major for pre-medical and pre-dental 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 for more information.) Chemistry is particularly attractive to pre-law majors anticipating a career in a legal department in a chemical industry, in patent law, or in environmental law.

The Department offers three degrees: the B.S., the B.S./Computer Science Track, and the B.A. The Computer Science Track is a highly structured program with relatively few free electives. By contrast, 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. 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. Both B.S. degrees also meet the requirements for certification by the American Chemical Society. (Nationwide, only about 40% of all chemistry baccalaureates are ACS certified.) 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. Students interested in graduate studies in chemistry may take 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 polymer science option is one of only a few that is certified by the American Chemical Society.

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 degree 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. A more advanced track, leading to the degree 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, students can complete the B.S. Honors/M.S. degree program in four years.

Double majors are available with nearly all other departments (except those in Fine Arts), provided the student can fit the required courses into the schedule. Generally, all the requirements for both departments must be met for a double major (except for some courses with similar content, see Double Major Degrees, page 244, for more information). A popular program is the double major degree in chemistry and biology. Programs are also available that lead to the degree B.S. in Chemistry with a minor in one of the following disciplines: biology, physics, mathematics, computer science, and engineering studies. Minors are also available in Industrial Management and certain departments in the H&SS 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. Double degree programs are available in which students receive two separate undergraduate degrees from two departments in the University. These require students to complete at least 90 units of work in addition to the units required for the first degree.

Several five-year programs have been developed to allow a student to earn both a B.S. in Chemistry and a Master of Science degree in either Chemistry, Polymer Science, or Public Management and Policy.

Students interested in teaching may pursue a program in which a B.A. degree in chemistry is earned at Carnegie Mellon with PA state certification for teaching at the secondary level being completed at Chatham College. A four year program is possible if it is started in the sophomore year.

Study abroad exchange programs are available for chemistry majors and may include spending two semesters at Ecole Polytechnique Federale de Lausanne (EPFL) in Switzerland, or one or more semesters at Instituto Tecnologico y de Estudios Superiores de Monterrey (ITESM, or Monterrey Tech), in Mexico. Language programs (3 months summer for EPFL, and 6 weeks summer for ITESM) are available to students for each of these programs 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.

One of the most attractive features of the Department of Chemistry is the opportunity for students to interact with prominent research chemists in beginning as well as advanced courses and in research. Participation in undergraduate research is encouraged and qualified students may begin projects as early as they wish. Approximately 80% of the graduating chemistry majors have taken part in research either for pay or for credit as part of their undergraduate training. Chemistry majors have been very sucessful in obtaining Small Undergraduate Research Grants (SURG) from the University to help support their research projects. Undergraduate and research laboratories are equipped with the latest scientific instrumentation. The use of computers is encouraged throughout the curriculum. All chemistry majors are encouraged to take additional writing classes as part of their humanities requirements or as free electives.

Curriculum — B.S. in Chemistry

The MCS curriculum requires seven Science Core Courses to be completed by the end of the junior year. These are: 21-121 (Calculus 1), 21-122 (Calculus 2), 33-111 (Physics for Science Students I), 33-112 (Physics for Science Students II), 09-105 (Modern Chemistry I), 03-121 Modern Biology), and 15-125/7 (Introduction to Computing). In the sample curriculum given below for chemistry majors, five of these are in the freshman year, while two are placed in the junior year. Students may wish to take the last two Science Core Courses as electives earlier in the curriculum. Course 09-106 (Modern Chemistry II) is defined as a Technical MCS Elective.

Freshman Year

	Fall	Units
09-105	Modern Chemistry I	10
21-121	Calculus 1	10
33-111	Physics for Science Students I	10
76-100 /1	H&SS Writing/Expression Course	9
xx-xxx	Free Elective (or Science Core Course)	9
99-101*	Computing Skills Workshop	3
		51

*Students interested in majoring in chemistry may wish to take 09-101, Introduction to Experimental Chemistry, in the first semester and postpone 99-101, Computing Skills Workshop, until the spring semester. Though not required, the laboratory course is recommended by the Chemistry Department for students expecting to major in chemistry.

	Spring	
09-106	Modern Chemistry II	10
21-122	Calculus 2	10
33-112	Physics for Science Students II	10
xx-xxx	Free Elective (or Science Core Course)	9
xx-xxx	H&SS Distribution Course 1	9
		48

Sophomore Year

	Fall	Units
09-111	Undergraduate Seminar I	1
09-117	Organic Chemistry I	9
09-131	Experimental Techniques in Chemistry I	10
21-259	Calculus in Three Dimensions	9
09-206	Physical Principles of Analytical Chemistry	9
xx-xxx	H&SS Distribution Course 2	9
		47

	Spring	
09-112	Undergraduate Seminar II	1
09-218	Organic Chemistry II	9
09-132	Experimental Techniques in Chemistry II	10
09-244	Physical Chemistry I	9
21-260	Differential Equations	9
xx-xxx	H&SS Distribution Course 3	9
		47

Junior Year

	Fall	Units
09-211	Undergraduate Seminar III	1
09-231	Experimental Techniques in Chemistry III	12
09-245	Physical Chemistry II	9
09-248	Inorganic Chemistry	10
15-125/7	Introduction to Programming	10
xx-xxx	H&SS Distribution Course 4	9
		51

	Spring	
09-212	Undergraduate Seminar IV	1
09-232	Experimental Techniques in Chemistry IV	12
03-121	Modern Biology	9
09-xxx	Chemical Elective	9
xx-xxx	Free Elective	9
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		49

Senior Year

	Fall	Units
09-411	Undergraduate Seminar V	1
09-xxx	Chemical Elective (see notes on electives)	9
xx-xxx	Free Electives	27
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		46

	Spring	
09-412	Undergraduate Seminar VI	3
09-xxx	Electives	36
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		48

Distribution of Units for the B.S. Degree

	Units
Minimum Total Chemistry Units	145
Biology	9
Computer Science	10
Mathematics	38
Physics	20
Humanities and Social Sciences or Fine Arts courses	72
Free Electives	63
Computing Skills Workshop	3

Minimum number of units required for the degree: 360

The above B.S. curriculum recommends an average course load of 46-51 units/semester. The total units will exceed the 360 unit minimum, but students are strongly encouraged to take the extra elective courses in whatever subjects they wish in order to enrich their backgrounds and enhance their educational experience.

Notes on Electives

Chemistry Electives

A minimum of 18 units of chemical electives is required. 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
03-244	Experimental Techniques in Biochemistry	12 units
06-211/311	Chemical Engineering Laboratory I/II	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 be satisfied by 09-445, Undergraduate Research, or by any other chemistry course, undergraduate or graduate, for which the student has the necessary prerequisites, or by 03-231 Biochemistry I and 03-332 Biochemistry II. 09-144 Physical Chemistry is not intended for the B.S. in Chemistry degree program and cannot be counted as a chemical elective but may be used as a free elective. Approved electives from the Department of Chemistry are listed below. Certain interdisciplinary courses (e.g. 38-xxx) relating to chemistry also can be used. The scheduling of these electives can vary and students should check with the Department to see which courses are offered in any given year or semester.

Elective Courses, Department of Chemistry		Units
09-246	Physical Chemistry III	9
09-441	Nuclear and Radiochemistry	9
09-445	Undergraduate Research	6-12
09-455	Honors Thesis (honors candidates only)	6-15
09-502	Organic Polymer Chemistry	9
09-505	Polymer Rheology	9
09-509	Physical Chemistry of Macromolecules	9
09-510	Introduction to Environmentally Benign Chemistry	9
09-511	Solid State and Materials Chemistry	9
09-517	Organotransition Metal Chemistry	9
09-522	Oxidation and Inorganic Chemistry	9
09-541	Spectroscopy	9
09-552	Introduction to Magnetic Resonance	9
09-560	Computational Chemistry	12
38-669	Biophysics I: Principles and Methods	9
38-670	Biophysics II: Structure and Dynamics	9
09-601	Principles of Chemical Instrumentation	9
09-701	Quantum Chemistry I	12
09-702	Statistical Mechanics and Dynamics	12
09-703	Chemical Thermodynamics	12
09-704	Chemical Kinetics	12
09-708	Quantum Chemistry II	12
09-709	Quantum Chemistry III	12
09-711	Physical Organic Chemistry	12
09-712	Synthetic Organic Chemistry	12
09-717	Organotransition Metal Chemistry	12
09-718	Bioorganic Chemistry	12
09-721	Physical Inorganic Chemistry	12
09-722	Oxidation and Inorganic Chemistry	12
09-731	Radiochemistry	12
09-732	Nuclear Chemistry	12
09-742	Physical Chemistry of Polymers	12
09-746	Linear Viscoelasticity	12
09-751	NMR: Techniques, Instrumentation and Signal Processing	12
09-752	Magnetic Resonance Spectroscopy	12
09-811	Solid State and Materials Chemistry	12
09-841	Spectroscopy	12

Free Electives

Free electives are defined as including any course offered by Carnegie Mellon except those primarily intended for non-majors in science or engineering. A maximum of 9 units total of Physical Education and/or ROTC courses can be counted as free elective units.

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 lead to the Bachelor's degree in Chemistry and will provide students with expertise in a specific area not covered by the normal undergraduate curriculum.

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		Units
03-231	Biochemistry I	9
03-330	Genetics	9
03-332	Biochemistry II	9
03-244	Experimental Techniques in Biochemistry	12

Management Option		Units
70-101	Elements of Industrial Administration	9
70-121	Accounting I	9
70-361	Foundations of Law	9
or		
70-363	Law in Modern American Society	9
73-100	Principles of Economics	9

Computational Chemistry Option		Units
15-125/7	Introduction to Programming	9
21-127	Introduction to Modern Mathematics	9
15-200	Data Structures	9
21-369	Numerical Methods	9
09-560	Computational Chemistry	9
xx-xxx	Two Senior Computing Electives *	18

*A list of approved courses for the senior electives for the option will be maintained and updated periodically by the department. At the present time the list includes:

18-133	Introduction to Digital Systems	12
09-751	Analog and Digital Signal Processing	12
36-253	Introduction to Biostatistics	9
36-225(6)	Introduction to Probability and Statistics I or II	9
36-xxx	Advanced data analysis or statistics courses	9

Note: The Chemistry - Computer Science Track 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.

Polymer Science Option		Units
09-502	Organic Polymer Chemistry	9
09-509	Physical Chemistry of Macromolecules	9
39-802	Colloids, Polymers and Surfaces Laboratory II	12
09-xxx	Elective in Polymer Science	9

[Elective may be 09-445, Undergraduate Research (polymer project), or an upper level course in polymer science such as 09-505, Polymer Rheology]

Pre-Health Professions Option		Units
03-130	Biology of Organisms	9
03-124	Modern Biology Lab*	9
03-331	Biochemistry I	9

One course taken from the following list:

19-420	Chemical Technologies, the Environment and Society	9
42-500	Physiology	9
42-604	Biological Transport and Pharmacokinetics	9
42-644	Medical Devices	9
36-253	Introduction to Biostatistics	9

or other appropriate courses as may be available

*Students choosing both the Biochemistry and Pre-Health Professions Options may substitute 03-244 for 03-124.

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, concluding with the student defense 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. However, students are strongly urged to complete all seven of the Science Core Courses in the freshman year. (This involves taking 03-121, Biology, and 15-125/7 , Introduction to Programming, as Science Core Electives in the Freshman Year) The honors program specifies that one of the two chemistry electives be a 12 unit graduate course, and that of the remaining electives required, at least two be undergraduate research (18 units) and one be 09-455, Honors Thesis. Students will be encouraged to do more than the minimum amount of research, so some stipends normally will be available for summer B.S. honors research.

At any time before the fall of the junior 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 will be formed for each candidate to monitor and evaluate the progress of the project at least twice a 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 an oral defense of the thesis before it approves the Honors degree. The Department expects that most students in the Honors B.S. program will maintain a QPA of 3.2.

Honors B.S./M.S. Program in Chemistry

Outstanding students are encouraged to apply for admission to the B.S./M.S. Honors program as early as they can, preferably before planning a schedule for the second semester of the freshman year. 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. Typical credentials of students invited to join the honors program are as follows: SAT Verbal, 650; SAT Math, 750; Chemistry Achievement Test score, 725; Math Level 2 Achievement Test score, 750; midterm QPA, 3.6. Some have a Chemistry AP score of 5.

The schedule of courses for the B.S./M.S. program generally moves as many courses as possible ahead by one year. 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 by advanced placement, and summer school.

Summer independent study for 8 to 12 weeks after the freshman year and thesis research for 12 weeks after the sophomore and junior years are required. Students normally will be given stipends for their summer work. Undergraduate research, including participation in group seminars, is also required during the junior and senior years. The student is expected to keep the research advisor selected in May of the sophomore year for the duration of the thesis project.

Each student is required to submit a formal Masters Degree dissertation to the Chemistry Department. 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 instructor in charge of the work and the Department Head.

B.S./M.S. candidates are required to enroll in an Honors Seminar course, 09-151, or an equivalent course(e.g. 09-700, Introduction to Research) in the sophomore year. The purpose of this requirement is to introduce the students to the different research projects of the Chemistry Department faculty. An Honors Committee will monitor the progress of each student. Students will be required to give written and oral presentations to the committee on a regular schedule to ensure the progress of their research projects. In April of the senior year the Honors Committee evaluates all theses and requires an oral defense before it approves the degrees.

Research productivity is the most important criterion for success at the evaluation points, but QPA is a strong secondary criterion. While we expect that most students will maintain a QPA of 3.5, a minimum of 3.2 must be maintained to remain in the program and will be acceptable only with a strong record of research. Candidates must also maintain a QPA of at least 3.0 in the 60 units of graduate courses required for the degree.

Curriculum — B.S. with Departmental Honors / M.S. in Chemistry

Freshman Year

	Fall	Units
03-121	Modern Biology	9
09-105	Modern Chemistry I	10
21-121	Calculus 1	10
33-111	Physics for Science Students I	10
76-100 /1	H&SS Writing/Expression Course	9
99-101	Computing Skills Workshop	3
		51
	Spring	
09-131	Experimental Techniques in Chemistry I	10
09-106	Modern Chemistry II	10
21-122	Calculus 2	10
33-112	Physics for Science Students II	10
xx-xxx	H&SS Distribution Course 1	9
		49
	Summer	
	Independent Study	

Sophomore Year

	Fall	Units
09-117	Organic Chemistry I	9
09-151	Honors Seminar	2
09-206	Physical Principles of Analytical Chemistry	9
21-259	Calculus in Three Dimensions	9
09-248	Inorganic Chemistry	10
xx-xxx	H&SS Distribution Course 2	9
		48
	Spring	
09-112	Undergraduate Seminar II	1
09-132	Experimental Techniques in Chemistry II	10
09-218	Organic Chemistry II	9
09-244	Physical Chemistry I	9
21-260	Differential Equations	9
xx-xxx	H&SS Distribution Course 3	9
		47
	Summer	
	Honors Research	

Junior Year

	Fall	Units
09-211	Undergraduate Seminar III	1
09-231	Experimental Techniques in Chemistry III	12
09-245	Physical Chemistry II	9
09-445	Undergraduate Research	9
09-xxx	Graduate Chemistry Course (see notes on Honors B.S./M.S. electives)	12
xx-xxx	H&SS Distribution Course 4	9
		52
	Spring	
09-212	Undergraduate Seminar IV	1
09-232	Experimental Techniques in Chemistry IV	12
09-445	Undergraduate Research	9
09-xxx	Graduate Chemistry Course	12
15-125/7	Introduction to Programming	10
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		53
	Summer	
	Honors Research	

Senior Year

	Fall	Units
09-412	Undergraduate Seminar VI	3
09-445	Undergraduate Research	10
09-xxx	Graduate Chemistry Course	12
09-xxx	Graduate Chemistry Course	12
xx-xxx	H&SS Elective	9
		46
	Spring	
09-411	Undergraduate Seminar V	1
09-455	Honors Thesis	15
09-xxx	Graduate Chemistry Course	12
xx-xxx	Free Elective	9
xxx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		46

Distribution of Units for the B.S. with Honors/M.S. Degrees

	Units
Core chemistry courses	128
Undergraduate Research (3 summers also required)	28
Graduate chemistry courses (see notes on B.S./M.S. electives)	60
Honors Thesis	15
Biology	9
Computer Science	10
Mathematics	38
Physics	20
Humanities and Social Sciences or Fine Arts courses	72
Free elective	9
Computing Skills Workshop	3

Minimum number of units required for degrees: 392

Notes on Honors B.S./M.S. Electives

In order not to penalize interdisciplinary studies which may be essential to a good thesis, up to 27 of the required 60 units of graduate chemistry courses may be advanced undergraduate courses in MCS and/or CIT departments.

B.S. in Chemistry/Computer Science 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/Computer Science Track degree is a response to society's need for bachelor's degree scientists who can apply computational sophistication to the practical problems of science. It is simultaneously a response to the large number of students who want not merely to learn computer science, but to apply that expertise in a subject area that gives them an edge in the job market.

As the student builds expertise in chemistry by taking the full ACS certified 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 student then selects one of these areas in which to specialize with a two-course sequence in the senior year.

The degree cited on the graduation diploma of students who complete the requirements for this program is: B.S. in Chemistry/Computer Science Track

Curriculum — B.S. in Chemistry/Computer Science Track

Freshman Year

	Fall	Units
09-105	Modern Chemistry I	10
21-121	Calculus 1	10
33-111	Physics for Science Students I	10
03-121	Modern Biology	9
76-100 /1	H&SS Writing/Expression Course	9
99-101*	Computing Skills Workshop	3
		51

*Students may wish to take 09-101, Introduction to Experimental Chemistry, in the first semester and postpone 99-101, Computing Skills Workshop, until the spring semester. Though not required, the laboratory course is recommended by the Chemistry Department for students expecting to major in chemistry.

	Spring	
09-106	Modern Chemistry II	10
99-101	Computing Skills Workshop	3
15-127	Introduction to Programming and Computer Science	10
21-112	Calculus 2	10
33-112	Physics for Science Students II	10
xx-xxx	H&SS Distribution Course 1	9
		52

Sophomore Year

	Fall	Units
09-111	Undergraduate Seminar I	1
09-117	Organic Chemistry I	9
09-131	Experimental Techniques in Chemistry I	10
21-127	Introduction to Modern Mathematics	9
09-206	Physical Principles of Analytical Chemistry	9
xx-xxx	H&SS Distribution Course 2	9
		47

	Spring	
09-112	Undergraduate Seminar II	1
09-132	Experimental Techniques in Chemistry II	10
09-218	Organic Chemistry II	9
09-244	Physical Chemistry I	9
15-211	Fundamental Structures of Computer Science I	12
xx-xxx	H&SS Distribution Course 3	9
		50

Junior Year

	Fall	Units
09-211	Undergraduate Seminar III	1
09-231	Experimental Techniques in Chemistry III	12
09-245	Physical Chemistry II	9
21-259	Calculus in Three Dimensions	9
15-212	Fundamental Structures of Computer Science II	12
xx-xxx	H&SS Distribution Course 4	9
		52

	Spring	
09-212	Undergraduate Seminar IV	1
09-232	Experimental Techniques in Chemistry IV	12
xx-xxx	Free Elective	19
21-260	Differential Equations	9
09-560	Computational Chemistry	12
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		52

Senior Year

	Fall	Units
09-411	Undergraduate Seminar V	1
09-248	Inorganic Chemistry	10
09-xxx	Chemical Elective (see previous notes on electives)	9
xx-xxx	Computing Elective**	9
xx-xxx	Free Elective	9
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		47

	Spring	
09-412	Undergraduate Seminar VI	3
xx-xxx	Computing Elective**	9
xx-xxx	Free Elective	9
xx-xxx	Free Electives (recommended)	18
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		48

**Senior Computing Electives

Each student in the computer science track will choose one of the specialty areas below and take *two* courses in that area.

Note: Course offerings may vary by semester and seniors in particular should plan ahead to be sure that their choices will be offered in the appropriate semester.

Programming

15-312	Comparative Languages	9
15-411	Compiler Design	12
15-412	Operating Systems	12
15-413	Software Engineering	12

Artificial Intelligence

15-381	Artificial Intelligence: Representation and Problem Solving	9
15-384	Artificial Intelligence: Robotic Manipulation	9
15-385	Artificial Intelligence: Computer Vision	9

Instrumentation Design*

18-133	Introduction to Digital Systems	12
09-751	NMR: Techniques, Instrumentation & Signal Processing	12
09-601	Principles of Chemical Instrumentation	9

*Note that both 09-751 and 09-601 are offered as fall semester courses. If these are your choice of electives, one should be taken in the fall of the junior year and the other in the fall of the senior year.

Numerical Methods

21-369	Numerical Methods	9
21-228	Discrete Mathematics	9
21-301	Combinatorial Analysis (note 21-228 prerequisite)	9

Graphics

15-462	Computer Graphics (or equivalent)	9
xx-xxx	Approved Elective	9

Distribution of Units for the B.S. in Chemistry/ Computer Science Track

	Units
Core chemistry courses	148
Biology	9
Computer Science	52
Mathematics	47
Physics	20
Humanities and Social Sciences or Fine Arts courses	72
Free electives	9
Computing Skills Workshop	3

Minimum number of units for the degree: 360

The above B.S. curriculum recommends an average course load of 47-52 units/semester. The total units will exceed the 360 unit minimum, but students are strongly encouraged to take the extra elective courses in whatever subjects they wish in order to enrich their backgrounds and enhance their educational experience.

B.A. in Chemistry

The curriculum for the B.A. degree provides students with the opportunity to take a substantial number of elective and non-technical courses. Certain chemistry, math, and other technical courses required for the B.S. degree are replaced by free electives, making this degree an ideal choice for those who wish to double major with one of the departments in the College of Humanities and Social Sciences or with the Department of Industrial Management. Students may earn one or more of the options as described for B.S. degree candidates, providing they complete the courses listed and all the necessary prerequisites.

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 double 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: 09-206 (Physical Principles of Analytical Chemistry), 09-117(Organic Chemistry I), 09-248 (Inorganic Chemistry), and 09-231 (Experimental Techniques in Chemistry III); and the spring-only courses: 09-144 (Physical Chemistry), 09-218 (Organic Chemistry II), and 09-232 (Experimental Techniques in Chemistry II).

Curriculum — B.A. in Chemistry

Freshman Year

	Fall	Units
09-105	Modern Chemistry I	10
21-121	Calculus 1	10
33-111	Physics for Science Students I	10
76-100 /1	H&SS Writing/Expression Course	9
xx-xxx	Free Elective (or Science Core Course)	9
99-101*	Computing Skills Workshop	3
		51

*Students interested in majoring in chemistry may wish to take 09-101, Introduction to Experimental Chemistry, in the first semester and postpone 99-101, Computing Skills Workshop, until the spring semester. Though not required, the laboratory course is recommended by the Chemistry Department for students expecting to major in chemistry.

	Spring	
09-106	Modern Chemistry II	10
xx-xxx	Free Elective (or Science Core Course)	9
21-122	Calculus 2	10
33-112	Physics for Science Students II	10
xx-xxx	H&SS Distribution Course 1	9
		48

Sophomore Year

	Fall	Units
09-111	Undergraduate Seminar I	1
09-117	Organic Chemistry I	9
09-131	Experimental Techniques in Chemistry I	10
xx-xxx	Free Elective (or Science Core Course)	9
09-206	Physical Principles of Analytical Chemistry	9
xx-xxx	H&SS Distribution Course 2	9
		47

	Spring	
09-112	Undergraduate Seminar II	1
09-218	Organic Chemistry II	9
09-132	Experimental Techniques in Chemistry II	10
xx-xxx	Free Elective (or Science Core Course)	9
09-144	Physical Chemistry	9
xx-xxx	H&SS Distribution Course 3	9
		47

Junior Year

	Fall	Units
09-211	Undergraduate Seminar III	1
09-231	Experimental Techniques in Chemistry III	12
03-121	Modern Biology	9
xx-xxx	Free Elective	9
09-248	Inorganic Chemistry	10
xx-xxx	H&SS Distribution Course 4	9
		50

	Spring	
09-212	Undergraduate Seminar IV	1
09-xxx	Chemical Elective	9
15-125	Introduction to Programming	10
xx-xxx	Free Elective	9
xx-xxx	Free Elective	9
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		47

Senior Year

	Fall	Units
09-411	Undergraduate Seminar V	1
xx-xxx	Free Electives	36
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		46

	Spring	
09-412	Undergraduate Seminar VI	3
xx-xxx	Free Electives	30
xx-xxx	H&SS Non Introductory Elective (includes CFA and non-technical IM courses)	9
		42

Distribution of Units for the B.A. Degree

	Units
Minimum Total Chemistry Units	115
Biology	9
Computer Science	10
Mathematics	20
Physics	20
Humanities and Social Sciences or Fine Arts courses	72
Free Electives	111
Computing Skills Workshop	3

Minimum number of units for the degree: 360

The above B.A. curriculum recommends an average course load of 42-51 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 designation "...with a Minor in Chemistry" in conjunction with a B.S. or B.A. degree from another (primary) department, the successful completion of six courses as distributed below is required. (Prerequisites for the courses, cited in [ ], are: [1] 09-105, [2] 09-106, [3] 09-206, [4] 09-117, and [5] 09-132.) Students pursuing the minor must inform the chemistry department of their intentions so that the minor designation can be approved prior to graduation.

A. Four Required Core Courses

1. Choice of one of the following courses.

09-106 Modern Chemistry II [1]
or
09-206 Physical Principles of Analytical Chemistry.[1]

(If 09-206 is chosen, it can not be used again for course 4)

2. 09-131 Experimental Techniques in Chemistry I [1, and 2 or 3]

3. 09-117 Organic Chemistry [1]

4. Choice of one of the following courses*.

09-248 Inorganic Chemistry [4]
09-206 Physical Principles of Analytical Chemistry [1]
09-244 Physical Chemistry I [1, 2]
09-144 Physical Chemistry [1, 2]

*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.

B. Two Elective Courses from the following list.

1. 09-244 Physical Chemistry I [1, 2] or 09-144 Physical Chemistry [1, 2]
2. 09-245 Physical Chemistry II [1, 2]
3. 09-206 Physical Principles of Analytical Chemistry [1]
4. 09-248 Inorganic Chemistry [4]
5. 09-132 Experimental Techniques in Chemistry II [4]
6. 09-231 Experimental Techniques in Chemistry III [5]
7. 09-218 Organic Chemistry II [4]
8. 03-231 Biochemistry I [1, 4]
9. 09-xxx Approved Upper level Course

Courses in this section (part B) can not be counted toward the minor if they are required by the student's primary department. For example, students majoring in biological sciences can not count 09-144, 03-231, 09-132, or 09-218 toward the elective courses for the minor in chemistry. Chemical engineers can not use 09-244 or 09-144 due to the similarity of these courses to courses required by the chemical engineering department.

The 3-1-1 Program with the H. John Heinz III School of Public Policy and Management

The 3-1-1 Program is a cooperative program sponsored by the H. John Heinz III School of Public Policy and Management and the Mellon College of Science. This program offers talented undergraduates the unique opportunity to pursue their undergraduate major and a Master of Science degree in Public Management and Policy. Application to this program is in the third (junior) year, while entry into the program occurs in the fourth (senior) year. During this fourth year, 3-1-1 students take a combination of undergraduate and Heinz School courses. Students receive the bachelor's degree at the end of the fourth year and, if they elect to continue, the master's degree at the end of the fifth year. The program effectively condenses into five years what would normally take six years to complete. For additional details, contact the 3-1-1 Program Director in the H. John Heinz III School of Public Policy and Management (HBH1100).

Faculty

GUY C. BERRY, Professor of Chemistry and Polymer Science; Head, Department of Chemistry — 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 — Ph.D., University of Rochester; Carnegie Mellon, 1959—.

EDWARD F. CASASSA, Professor of Chemistry — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1956—.

TERRENCE J. COLLINS, Professor of Chemistry - Ph.D., University of Auckland, New Zealand; Carnegie Mellon, 1987-.

JOSEF DADOK, Professor of Chemical Instrumentation — Ph.D., Czechoslovak Academy of Sciences; Carnegie Mellon, 1967—.

SUSAN T. GRAUL, Assistant Professor of Chemistry — Ph.D., Purdue University; Carnegie Mellon, 1992—.

MICHAEL P. HENDRICH, Assistant Professor of Chemistry — Ph.D., University of Illinois; Carnegie Mellon, 1994—.

MORTON KAPLAN, Professor of Chemistry — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1970—.

PAUL J. KAROL, Associate Professor of Chemistry — Ph.D., Columbia University; Carnegie Mellon, 1969—.

HYUNG J. KIM, Assistant Professor of Chemistry — Ph.D., State University of New York at Stony Brook; Carnegie Mellon, 1992—.

JONATHAN S. LINDSEY, Associate Professor of Chemistry — Ph.D., Rockefeller University; Carnegie Mellon, 1984—.

MIGUEL LLINAS, Professor of Chemistry — Ph.D., University of California at Berkeley; Carnegie Mellon, 1976—.

KRZYSZTOF MATYJASZEWSKI, Professor of Chemistry — Ph.D., Polish Academy of Sciences; Carnegie Mellon, 1985—.

RICHARD D. McCOLLOUGH, Assistant Professor of Chemistry - Ph.D. , The Johns Hopkins University; Carnegie Mellon, 1990-

ECKARD MUNCK, Professor of Chemistry - Diploma, Technical University of Darmstadt, Germany; Carnegie Mellon, 1990 -.

GARY D. PATTERSON, Professor of Chemistry — Ph.D., Stanford University; Carnegie Mellon, 1984—.

STUART W. STALEY, Professor of Chemistry — Ph.D., Yale University; Carnegie Mellon, 1986—.

ROBERT F. STEWART, Professor of Chemistry — Ph.D., California Institute of Technology; Carnegie Mellon, 1978—.

CHARLES H. VAN DYKE, Associate Professor of Chemistry — Ph.D., University of Pennsylvania; Carnegie Mellon, 1963—.

JAMES W. WHITTAKER, Associate Professor of Chemistry — Ph.D., University of Minnesota; Carnegie Mellon, 1986—.

DAVID YARON, Assistant Professor of Chemistry — Ph.D., Harvard University; Carnegie Mellon, 1992—.

Joint Appointments and Special Appointments

WILLIAM E. BROWN, Professor of Biological Sciences — Ph.D., University of Minnesota; Carnegie Mellon, 1973—.

DAVID J. MOSES, Director of Computer Facilities and Research Associate - Ph.D., Carnegie Mellon University; Carnegie Mellon, 1986-.

JOHN F. NAGLE, Professor of Physics and Biological Sciences — Ph.D., Yale; Carnegie Mellon, 1967-.

KAREN H STUMP, Senior Lecturer and Director of Undergraduate Laboratories - M.S., Carnegie Mellon University; Carnegie Mellon, 1983-.

ALAN S. WAGGONER, Professor of Biological Sciences - Ph.D., University of Oregon; Carnegie Mellon, 1982-.

Department of Mathematics

William O. Williams, Head
Russell C. Walker, Assistant Head
Office: Wean Hall 6113

Mathematics is a dynamic subject, undergoing continual evolution as the result both of the changes in the disciplines relying on mathematics as a tool and of the curiosity of mathematicians leading to new areas of investigation. Undergraduate education in mathematics is therefore continually challenged to meet the changing roles of mathematicians. To prepare students to meet the future demands for mathematics, the Department offers three degrees with specializations in pure mathematics, operations research and statistics.

The program leading to the degree Bachelor of Science in Mathematics is the least structured of the mathematics degree programs in recognition of the variety of interests that can be productively coupled with mathematics. The student may choose four mathematics electives and three mathematical science electives from among the Departments of Mathematics, Computer Science, ad Statistics, and an additional seven electives may be chosen from virtually any available courses. Thus, the Bachelor of Science in Mathematics lends itself particularly well to double majors as well as to preparation for graduate study in mathematics. It is the best choice for the student who seeks a program that he or she can freely adapt to serve individual needs.

The Department also recognizes that there are areas of application that are sufficiently well-defined to merit a degree program specifically oriented in their direction.

One such area which offers opportunities at the bachelor's degree level is operations research. Mathematicians with a background in this area are especially valuable in such diverse activities as project planning, production scheduling, market forecasting and finance. People with these qualifications are needed in virtually all industrial and governmental settings, and it is expected to be among the growth occupations over the next decade. The Applied Mathematics Operations Research Track prepares students to enter this area.

A closely related degree, the Applied Mathematics Statistics Track, prepares students for employment opportunities in statistics. Important applications range from design and data analysis in the physical sciences, engineering, and social sciences, to modeling and forecasting in business and government, and to actuarial applications in the financial and insurance areas.

Each of these degrees can be modified by participation in the Mathematical Studies program. This pair of intensive courses is usually begun in the Fall of the Sophomore year and is an excellent preparation for graduate study in mathematics. Admission to Mathematical Studies is by invitation. Interested students should apply during the Spring of their Freshman year. For a description of the content, see the description of the courses 21-235/6/356/374 in the section of course descriptions.

A final program for undergraduates is the Honors Degree Program, which qualifies the student in a very demanding four-year curriculum for two degrees: the Bachelor of Science in Mathematics and the Master of Science in Mathematics. Most frequently this is taken in conjunction with the Mathematical Studies Program.

The Department places a great emphasis on the advising of students. This is a critical matter if students are to make the most of their years at the university. An advisor is assigned to each student immediately after the student has elected mathematics as a major. Students are urged to work carefully with their advisor to formulate their degree program.

Suggested Curricula

In the suggested curricula below, a Mathematical Science Elective refers to a course from the Departments of Mathematics, Computer Science, or Statistics. The only restrictions on Mathematical Science electives are that a mathematics course must be beyond the calculus sequence, a computer science course must be at the 200 level or higher (excluding 15-347), and a statistics course must have at least 36-225 as a prerequisite. An H&SS Elective refers to a course in the Humanities and Social Science requirements as described in the catalog section on the Mellon College of Science. A course listed as an Elective is a free elective subject only to the restriction that the maximum total number of ROTC and Physical Education units that will be accepted for graduation is nine.

Suggested Curriculum - B.S. in Mathematics

The program for a B.S. in Mathematics is especially suited to a preparation for graduate study in mathematics. The seven free electives also facilitate combination of this program with another major.

The only restrictions on Mathematical Science electives are that a mathematics course must be beyond the calculus sequence, a computer science course must be at the 200 level or higher excluding 15-347, and a statistics course must have at least 36-225 as a prerequisite. This freedom to choose courses from the three departments allows the student to design a program emphasizing applications of mathematics and computing in a variety of disciplines.

In recent years, students have combined the B.S. in Mathematics with majors in Economics, German, English, Psychology, and Professional Writing. A variety of other double majors are possible within the minimum 360 units by carefully allocating the free electives.

The requirements for the B.S. in Mathematics are:

Mathematics

21-121	Calculus
21-122	Calculus 2
21-127	Introduction to Modern Mathematics
21-228	Discrete Mathematics
21-241	Linear Algebra I
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-342	Linear Algebra II
21-355	Advanced Calculus I
21-356	Advanced Calculus II
21-373	Algebraic Structures

four mathematics electives

Other courses

15-125	Intro. to Programming & Computation (or 15-127)
36-225	Introduction to Probability and Statistics I

three mathematical science electives

MCS humanities, social science, and science core (114 units)

seven free electives

Freshman Year

	Fall	Units
21-121	Calculus 1	10
33-111	Physics for Science Students I	10
15-127	Intro. to Prog. and Computer Science (or 15-125)	10
03-121	Modern Biology	9
xx-xxx	Designated Writing course	9
99-101	Computer Skills Workshop	3
		51

	Spring	
21-122	Calculus 2	10
21-127	Introduction to Modern Mathematics	9
33-112	Physics for Science Students II	10
09-105	Modern Chemistry I	10
xx-xxx	H&SS Elective	9
		48

Sophomore Year

	Fall	Units
21-228	Discrete Mathematics	9
21-241	Linear Algebra I	9
21-259	Calculus in Three Dimensions	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		45

	Spring	
21-260	Differential Equations	9
21-342	Linear Algebra II	9
xx-xxx	Mathematical Science Elective	9
xx-xxx	H&SS Elective	9
		36

Junior Year

	Fall	Units
21-355	Advanced Calculus I	9
36-225	Introduction to Probability and Statistics I	9
xx-xxx	Mathematical Science Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		45

	Spring	
21-356	Advanced Calculus II	9
21-373	Algebraic Structures	9
21-xxx	Mathematics Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		45

Senior Year

	Fall	Units
21-xxx	Mathematics Elective	9
21-xxx	Mathematics Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
		45

	Spring	
21-xxx	Mathematics Elective	9
xx-xxx	Mathematical Science Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
		45

Minimum number of units for the degree: 360

Students preparing for graduate study in mathematics should consider the following courses as mathematical science electives, choosing among them according to the desired area of graduate study:

21-301	Combinatorial Analysis
21-371	Functions of a Complex Variable
21-372	Partial Differential Equations
21-374	Field Theory
21-460	Topology
21-476	Ordinary Differential Equations
21-484	Applied 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, and that courses numbered in the 600's are designed as transitional courses to graduate study. A student preparing for graduate study should also consider undertaking an independent reading course in his or her area of interest. The Department offers 21-599 Undergraduate Reading and Research for this purpose. A student including Mathematical Studies in the B.S. in Mathematics program is encouraged to discuss the selection of courses with his or her Mathematical Studies instructors.

Double Major Requirements

The B.S. in Mathematics is available as a second major to students majoring in other departments. The following courses are required:

15-127	Intro. to Prog. and Computer Science (or 15-125)
21-121	Calculus 1
21-122	Calculus 2
21-127	Introduction to Modern Mathematics
21-228	Discrete Mathematics
21-241	Linear Algebra I
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-342	Linear Algebra II
21-355	Advanced Calculus I
21-356	Advanced Calculus II
21-373	Algebraic Structures
36-225	Introduction to Probability and Statistics I (or 36-325)

Four Mathematics Electives

Three Mathematical Science Electives taken from among the following departments: Mathematics, Computer Science, and Statistics.

The Applied Mathematics degrees offered by the Mathematics Department are also available as second majors. 21-356, 21-373 and the Mathematics Electives and Mathematical Science electives from the list immediately above are replaced by the specific requirements of the other degree. Interested students should contact the Department.

The Minor in Mathematics

The Minor in Mathematics includes six courses. Introduction to Modern Mathematics is a prerequiste for 21-228 and 21-241. The other five named courses introduce fundamental areas of mathematics.

21-127	Introduction to Modern Mathematics
21-228	Discrete Mathematics
21-241	Linear Algebra I
21-355	Advanced Calculus I
21-373	Algebraic Structures
21-xxx	Mathematics Elective

A student who completes the two semester Mathematical Studies sequence plus two recommended electives (21-356 Advanced Calculus II and 21-374 Field Theory are the standard recommendations) should receive a minor.To get into 21-355 Advanced Calculus I, a student would need to complete at a minimum 21-121 Calculus 1 and 21-122 Calculus 2, or equivalent courses.Excluded as acceptable electives are the following courses: The H&SS calculus sequence: 21-105, 21-111, and 21-112; the MCS/CIT calculus sequence: 21-121, 21-122, 21-259, and 21-260; and courses intended for H&SS students such as 21-110 Problem Solving in Recreational Mathematics and 21-257 Optimization for the Social Sciences.

Suggested Curriculum - B.S. in Applied Mathematics Operations Research Track

This track seeks to develop modeling and computer-based solution skills in areas such as network design, transportation scheduling, allocation of resources, environmental protection, probabilistic applications and optimization.

In addition to the mathematics and statistics courses, the background in economics and accounting which is often involved with many operations research applications is included. Since problems are often solved by teams, the program also includes a group project in the Operations Research II course in the senior year.

The requirements for the B.S. in Applied Mathematics (Operations Research) are:

Mathematics

21-121	Calculus 1
21-122	Calculus 2
21-127	Introduction to Modern Mathematics
21-228	Discrete Mathematics
21-241	Linear Algebra I
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-292	Operations Research I
21-342	Linear Algebra II
21-355	Advanced Calculus I
21-369	Numerical Methods
21-393	Operations Research II

two mathematics electives

Statistics

36-225	Introduction to Probability and Statistics I
36-226	Introduction to Probability and Statistics II
36-401	Advanced Data Analysis I
36-402	Advanced Data Analysis II
36-410	Elementary Applied Probability

Other courses

15-125	Intro. to Programming & Computation (or 15-127)
70-121	Financial Accounting
70-422	Cost Accounting
73-100	Principles of Economics
73-250	Intermediate Microeconomics

one mathematical science elective

MCS humanities, social science, and science core (114 units, including 73-100 and 73-250)

five free electives

Freshman Year

	Fall	Units
21-121	Calculus 1	10
33-111	Physics for Science Students I	10
15-127	Intro. to Prog. and Computer Science (or 15-125)	10
03-121	Modern Biology	9
xx-xxx	Designated Writing course	9
99-101	Computing Skills Workshop	3
		51
	Spring	
21-122	Calculus 2	10
21-127	Introduction to Modern Mathematics	9
33-112	Physics for Science Students II	10
09-105	Modern Chemistry I	10
xx-xxx	H&SS Elective	9
		48

Sophomore Year

	Fall	Units
21-228	Discrete Mathematics	9
21-241	Linear Algebra I	9
21-259	Calculus in Three Dimensions	9
73-100	Principles of Economics	9
		36
	Spring	
21-260	Differential Equations	9
21-292	Operations Research I	9
21-342	Linear Algebra II	9
70-121	Financial Accounting	9
xx-xxx	H&SS Elective	9
		45

Junior Year

	Fall	Units
21-369	Numerical Methods	9
21-xxx	Mathematics Elective	9
36-225	Introduction to Probability and Statistics I	9
73-250	Intermediate Microeconomics	9
xx-xxx	Elective	9
		45
	Spring	
21-355	Advanced Calculus I	9
36-226	Introduction to Probability and Statistics II	9
36-410	Elementary Applied Probability	9
70-422	Cost Accounting	9
xx-xxx	H&SS Elective	9
		45

Senior Year

	Fall	Units
21-393	Operations Research II	9
21-xxx	Mathematics Elective	9
36-401	Advanced Data Analysis I	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		45
	Spring	
36-402	Advanced Data Analysis II	9
xx-xxx	Mathematical Science Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
xx-xxx	Elective	9
		45

Minimum number of units required for the degree: 360

The 3-1-1 Program with the H. John Heinz III School of Public Policy and Management

The 3-1-1 Program is a cooperative program sponsored by the the H.John Heinz III School of Public Policy and Management and the Mellon College of Science. This program offers undergraduates the unique opportunity to pursue their undergraduate major and a Master of Science degree in Public Management and Policy. See p. 235 for more information.

Suggested Curriculum - B.S. in Applied Mathematics Statistics Track

The Applied Mathematics Statistics Track is jointly administered by the Department of Mathematics, which advises students through the end of their sophomore year, and by the Department of Statistics, which advises students in the junior and senior years. The first two years of the program are virtually identical with those for the other undergraduate programs of the Department of Mathematics.The sciences are unified by their method. In every area of scientific investigation, theories are formulated, phenomena are observed, and conclusions are drawn. Statistics is concerned with the process by which inferences are made from data. Because they are not logically restricted to any one area of application, statistical methods find use 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 the reason for the current strong demand for well-trained statisticians.

The course sequence 36-225/226 Introduction to Probability and Statistics I & II taken in the junior year serves as the basis for all further statistics courses. The sequence 36-325/326 Probability and Mathematical Statistics I & II has similar content to the 36-225/226 sequence but is presented at a more mathematically rigorous level. This sequence is recommended for students in this track.

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 B.S. in Applied Mathematics (Statistics) are:

Mathematics

21-121	Calculus 1
21-122	Calculus 2
21-127	Introduction to Modern Mathematics
21-228	Discrete Mathematics
21-241	Linear Algebra I
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-292	Operations Research I
21-342	Linear Algebra II
21-355	Advanced Calculus I
21-369	Numerical Methods
21-393	Operations Research II

two mathematics electives

Statistics

36-225	Introduction to Probability and Statistics I
36-226	Introduction to Probability and Statistics II
36-401	Advanced Data Analysis I
36-402	Advanced Data Analysis II
36-410	Elementary Applied Probability

one statistics elective

Other courses

15-125	Introduction to Programming & Computation (or 15-127)
15-200	Data Structures
73-100	Principles of Economics

one mathematical science elective

MCS humanities, social science, and science core (114 units, including 73-100)

four free electives

Freshman Year

	Fall	Units
21-121	Calculus 1	10
33-111	Physics for Science Students I	10
15-127	Intro. to Prog. and Computer Science (or 15-125)	10
03-121	Modern Biology	9
xx-xxx	Designated Writing course	9
99-101	Computing Skills Workshop	3
		51
	Spring	
21-122	Calculus 2	10
33-112	Physics for Science Students II	10
09-105	Modern Chemistry I	10
21-127	Introduction to Modern Mathematics	9
xx-xxx	H&SS Elective	9
		48

Sophomore Year

	Fall	Units
21-228	Discrete Mathematics	9
21-241	Linear Algebra I	9
21-259	Calculus in Three Dimensions	9
73-100	Principles of Economics	9
		36
	Spring	
15-200	Data Structures	9
21-260	Differential Equations	9
21-292	Operations Research I	9
21-342	Linear Algebra II	9
xx-xxx	H&SS Elective	9
		45

Junior Year

	Fall	Units
21-369	Numerical Methods	9
21-xxx	Mathematics Elective	9
36-225	Introduction to Probability and Statistics I	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		45
	Spring	
21-355	Advanced Calculus I	9
36-226	Introduction to Probability and Statistics II	9
36-410	Elementary Applied Probability	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		45

Senior Year

	Fall	Units
21-393	Operations Research II	9
36-401	Advanced Data Analysis	9
36-4xx	Statistics Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		45
	Spring	
21-xxx	Mathematics Elective	9
36-402	Advanced Data Analysis II	9
xx-xxx	Mathematical Science Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		45

Minimum number of units required for the degree: 360

Honors Degree Program

This is a very demanding program whose reward is the granting of both the B.S. and M.S. in mathematics on its successful completion, normally in four years.

Suggested Curriculum:

Freshman Year

	Fall	Units
21-131	Analysis I	10
33-111	Physics for Science Students I	10
15-127	Intro. to Prog. and Computer Science (or 15-125)	10
03-121	Modern Biology	9
xx-xxx	Designated Writing course	9
99-101	Computer Skills Workshop	3
		51
	Spring	
21-132	Analysis II	10
33-112	Physics for Science Students II	10
09-105	Modern Chemistry I	10
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		48

Sophomore Year

	Fall	Units
21-235	Mathematical Studies I	20
xx-xxx	Mathematical Science Elective	9
xx-xxx	H&SS Elective	9
xx-xxx	Elective	9
		47
	Spring	
21-236	Mathematical Studies II	20
xx-xxx	Mathematical Science Elective	9
xx-xxx	Elective	9
xx-xxx	H&SS Elective	9
		47

Junior Year

	Fall	Units
21-356	Advanced Calculus II	9
xx-xxx	Mathematical Science Elective	9
21-xxx	Mathematics Elective	9
xx-xxx	Elective	9
xx-xxx	H&SS Elective	9
		45
	Spring	
xx-xxx	Graduate course in Mathematics	12
xx-xxx	Graduate course in Mathematics	12
21-374	Field Theory	9
xx-xxx	Elective	9
xx-xxx	H&SS Elective	9
		51

Senior Year

	Fall	Units
xx-xxx	Graduate course in Mathematics	12
xx-xxx	Graduate course in Mathematics	12
xx-xxx	Thesis seminar	3
21-xxx	Mathematics Elective	9
xx-xxx	Elective	9
xx-xxx	H&SS Elective	9
		54
	Spring	
xx-xxx	Graduate course in Mathematics	12
xx-xxx	Thesis	15
xx-xxx	Elective	9
xx-xxx	Elective	9
xx-xxx	H&SS Elective	9
		54

Minimum number of units required for degrees: 397

Distribution of Units for the Honors Degree Program

General Requirements:	Units
Analysis I & II	20
Physics	20
Chemistry	10
Biology	9
H&SS and Fine Arts	72
Computer Skills Workshop	3
	134

Mathematical Science:

Mathematical Studies	40
Introduction to Computing	10
Electives	63
Graduate Courses	60
Thesis	18
	191
Free Electives	72
	total 397

Requirements of the Honors Degree Program

The key element in the program is the sequence in Mathematical Studies (see course descriptions). Students enter this concentrated, accelerated sequence by invitation in the Fall semester of the Sophomore year. Admission to and completion of this sequence does not imply automatic admission to the second part of the program. Admission to the second part, the graduate stage, in the junior year, is by invitation, and the Department will, in this invitation, hold to the same high standards which apply to admission to any graduate program. Note: Students who have not taken or not completed Mathematical Studies (this includes transfer students), but whose preparation is judged to be substantially comparable, may be admitted to the program at this stage.

Each student in the honors degree program will have an academic adviser and, when the time comes, a thesis adviser. They need not be the same person. Most important in the Mathematical Studies stage of the program is advice to the student on selecting electives. Not all students will go on to the graduate stage; many students will want to pursue specialized tracks in applied mathematics rather than complete the honors program. Therefore, a student majoring in mathematics and enrolled in Mathematical Studies should choose electives in specialized areas not covered in that sequence, e.g., advanced computer science, combinatorial analysis, graph theory, logic, probability and statistics, numerical methods, and operations research, which will permit the student any option without delay.In the graduate stage, of the five graduate courses, we require at least one course from each of the following areas:

- Analysis,- e.g., Measure and Integration, Complex Analysis, Introduction to Functional Analysis, Introduction to Numerical Analysis I.

- Algebra, Geometry and Topology,- e.g., Algebra I; Differential Geometry; General Topology; Discrete Mathematics, Mathematical Logic I.

- Applied Mathematics,- e.g., Introduction to Continuum Mechanics, Introduction to Probability and Stochastic Processes, Graphs and Network Flows, Ordinary Differential Equations.

In practice, the student must start thinking about the thesis as early as possible. For this reason we set some thesis work in the seventh semester to allow for exploratory work under supervision

Faculty

MICHAEL H. ALBERT, Associate Professor of Mathematics — Ph.D., Oxford University; Carnegie Mellon, 1987—.

PETER B. ANDREWS, Professor of Mathematics — Ph.D., Princeton University; Carnegie Mellon, 1963—.

EGON BALAS, GSIA Alumni Professor of Industrial Administration and Applied Mathematics — Ph.D., University of Brussels; Carnegie Mellon, 1968—.

ALBERT A. BLANK, Professor of Mathematics, Emeritus — Ph.D., New York University; Carnegie Mellon, 1969—.

CHARLES V. COFFMAN, Professor of Mathematics — Ph.D., Johns Hopkins University; Carnegie Mellon, 1962—.

GERARD P. CORNUEJOLS, Professor of Operations Research — Ph.D., Cornell University; Carnegie Mellon, 1978—.

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ROGER N. PEDERSON, Professor of Mathematics — Ph.D., University of Minnesota; Carnegie Mellon, 1960—.

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JUAN J. SCHÄFFER, Professor of Mathematics — Sc.D., Techn., Swiss Federal Institute of Technology; Ph.D., University Zurich; Carnegie Mellon, 1968—.

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DANA SCOTT, Hillman University Professor of Computer Science, Philosophy, and Mathematical Logic — Ph.D., Princeton University; Carnegie Mellon, 1981—.

ROBERT F. SEKERKA, Professor of Physics and Mathematics — Ph.D., Harvard University; Carnegie Mellon, 1969—.

STEVEN E. SHREVE, Professor of Mathematics — Ph.D., University of Illinois; Carnegie Mellon, 1980—.

H. METE SONER, Professor of Mathematics — Ph.D., Brown University; Carnegie Mellon, 1986—.

RICHARD STATMAN, Professor of Mathematics and Computer Science — Ph.D., Stanford University; Carnegie Mellon, 1984—.

SHLOMO TA'ASAN, Associate Professor of Mathematics — Ph.D., Weizmann Institute; Carnegie Mellon 1994—.

LUC TARTAR, Professor of Mathematics — Ph.D., University of Paris; Carnegie Mellon, 1987—.

GERALD L. THOMPSON, Professor of Applied Mathematics and Industrial Administration — Ph.D., Columbia University; Carnegie Mellon, 1959\^(Q).

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WILLIAM O. WILLIAMS, Professor of Mathematics; Head, Department of Mathematics — Ph.D., Brown University; Carnegie Mellon, 1966—.

OSWALD WYLER, Professor of Mathematics, Emeritus — Sc.D., Swiss Federal Institute of Technology; Carnegie Mellon, 1965—.

KONSTANTINE ZELATOR, Lecturer of Mathematics — Ph.D., Brown University; Carnegie Mellon, 1990—.

Department of Physics

Robert H. Swendsen, Head
Office: Wean Hall 7325

Physics, one of the basic sciences, has its origin in the irrepressible human curiosity to explore and understand the natural world. This fundamental urge to discover has led to the detailed understanding of a remarkable variety of physical phenomena. Our knowledge now encompasses the large-scale movement of galaxies as well as the minute and complex motions within atoms and nuclei. The spectacular enlargement 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 also make decisive contributions. The interplay of pure and applied physics has always been fruitful and, today, ensures many rewarding career opportunities for physics students.

The undergraduate curriculum in physics has been carefully planned 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 the study of physical phenomena in the laboratory. Those wishing to go beyond the formal theoretical or experimental courses are encouraged to become involved in research projects under the guidance of individual members of the faculty.

Programs leading to the Bachelor of Science and Bachelor of Arts degrees in physics are offered. Each allows considerable latitude in the choice of electives. The student, with the help of faculty advisers, can easily build a program which aims at specific career objectives. 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 serves as 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, work in industrial or governmental research and development, or other employment in business or industry with a significant scientific component. 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 are majoring in another discipline.

The use of computers is emphasized in the computer science track, where the students learn programming methods for the solution of scientific problems and are encouraged to delve into computer-related areas ranging from control and real-time programming to software engineering and compiler and operating system design. Courses from the Computer Science Department are included, along with specially designed computational physics courses. Since Carnegie Mellon, in cooperation with the University of Pittsburgh and the Westinghouse Corporation, has been designated by the National Science Foundation as a National Supercomputer Center, advanced undergraduate students in this track learn programming techniques for the CRAY YMP/C90 vector supercomputer and the CRAY T3D massively-parallel processor.

General requirements for all students in the Mellon College of Science are outlined on, p. 218. The curricula shown below are typical programs incorporating these requirements. Other programs may be arranged, provided they meet these requirements and include the specific required courses in the programs shown.

Whether students follow the standard curriculum or not, there should be consultation with their departmental advisors at least once per semester.

Course Numbering Scheme

The numbers for the physics courses adhere to the following scheme:

100 - 199: courses generally taken in the freshman year or by students outside the department.

200 - 299: courses generally taken in the sophomore year.

300 - 399: courses generally taken in the junior year.

400 - 499: courses generally taken in the senior year.

500 - 599: courses cross-listed with other departments.

600 - 699: advanced undergraduate courses suitable for graduate students.

This numbering scheme is to help the student better understand the curriculum but should not be thought of as imposing a rigid schedule on when to take a particular course. In addition, odd-numbered courses are generally taught in the Fall semester and even-numbered ones in the Spring semester.

B.S. in Physics - Curriculum

All of the courses listed below are required for a B.S. in physics except for the free electives, where only three courses are required.

Freshman Year

	Fall	Units
21-121	Calculus	10
15-125	Introduction to Programming & Computation*	10
or		
15-127	Introduction to Programming & Computer Science*	(10)
33-111	Physics for Science Students I	10
xx-xxx	Designated Writing Course	9
99-101	Computing Skills Workshop	3
xx-xxx	Free Elective	9
		51
	Spring	
21-122	Calculus with Linear Algebra	10
09-105	Modern Chemistry*	10
33-112	Physics for Science Students II	10
xx-xxx	Humanities, Social Science, or Fine Arts Course	9
xx-xxx	Elective Course (recommended for prospective physics majors: 33-104 or 33-102)	9
		48

*Students who wish to exchange 03-121 Modern Biology, or 09-105 Modern Chemistry I, for 15-125 Introduction to Programming and Computation, or 15-127 Introduction to Programming and Computer Science, may do so. But 03-121, 09-105 and 15-125 or 15-127 must be completed by the end of the junior year.

Sophomore Year

	Fall	Units
21-260	Differential Equations	9
33-211	Physics III	10
33-201	Undergraduate Colloquium I	1
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
03-121	Modern Biology*	9
33-104	Experimental Physics (required if not taken in Freshman year)	(9)
or		
xx-xxx	Free Elective**	9
		47

**Students may delay the Free Elective and replace it here with another H&SS Elective.

	Spring	
21-259	Calculus in Three Dimensions	9
33-228	Electronics I	10
33-202	Undergraduate Colloquium II	1
33-234	Quantum Physics I	10
33-232	Physical Analysis	9
or		
xx-xxx	Free Elective	(9)
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
		48

Junior Year

	Fall	Units
33-335	Quantum Physics II	10
33-331	Physical Mechanics I	10
33-345	Mathematical Methods of Physics	9
or		
xx-xxx	Mathematics Elective	(9)
33-301	Undergraduate Colloquium III	1
33-341	Thermal Physics I	10
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
		49

	Spring	
33-340	Modern Physics Laboratory	10
33-338	Intermediate Electricity and Magnetism I	10
33-302	Undergraduate Colloquium IV	1
xx-xxx	Mathematics Elective or Free Elective	9
33-332	Physical Mechanics II	10
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
		49

Senior Year

(See Note at end of this section.)

	Fall	Units
33-439	Intermediate Electricity and Magnetism II	10
33-401	Undergraduate Colloquium V	2
xx-xxx	Physics Elective	9
xx-xxx	Technical Elective (See Note at end of this section.)	9
xx-xxx	Free Elective	9
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
		48

	Spring	
xx-xxx	Physics Elective	9
xx-xxx	Technical Elective (See Note at end of this section.)	9
33-402	Undergraduate Colloquium VI	2
xx-xxx	Free Elective	9
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
		38

Notes

The senior year consists mainly of electives. However, optics is an important component of fundamental physics, and, increasingly, in many areas of applied science and engineering. Students are strongly advised to include 33-453. Students planning to undertake graduate study in physics should consider taking Advanced Quantum Physics (33-446) in addition.

For Mellon College of Science H&SS/FA requirements, see p 219.

Technical electives are any courses in MCS or CIT for which the student fulfills the prerequisites. They may include, but are not limited to, physics courses. A few courses in H&SS also satisfy this requirement, especially in the Department of Statistics. See the Physics Department faculty advisor for details.

Minimum number of units required for degree: 360

Distribution of Units Required for B.S. in Physics

	Units
Minimum Total Physics Units (33-104, 111, 112, 201, 202, 211, 228, 234, 301, 302, 331, 332, 335, 338, 340, 341, 401, 402, 439 and two electives)	155
Technical Electives (2 courses)	18
Mathematics (21-121, 122, 259, 260 and two electives which may include 33-232 and 33-345)	56
Chemistry (09-105)	10
Introduction to Computing (15-125 or 127)	10
Biology (03-121)	9
Computing Skills Workshop (99-101)	3
Humanities and Social Sciences (8 courses)	72
Free Electives (3 courses)	27
Total:	**360**

Electives in Physics

Freshman Year

	Fall	Units
33-104	Experimental Physics	9

	Spring	
33-102	Concepts of Modern Physics	9
33-104	Experimental Physics	9
33-114	Physics of Musical Sound	9
33-126	Introduction to Astronomy	9

Sophomore Year

	Fall	Units
33-104	Experimental Physics	9
33-241	Introduction to Computational Physics	9
33-350	Undergraduate Research	Var.

	Spring	
33-114	Physics of Musical Sound	9
33-126	Introduction to Astronomy	9
33-232	Physical Analysis	9
33-350	Undergraduate Research	Var.

Junior Year

	Fall	Units
33-241	Introduction to Computational Physics	9
33-345	Mathematical Methods of Physics	9
33-350	Undergraduate Research	Var.
33-449	Electronics II	9
33-453	Intermediate Optics	12
33-463	Special Relativity	9
33-467	Introduction to Astrophysics (Alternate years)	9

	Spring	
33-342	Thermal Physics II	10
33-350	Undergraduate Research	Var.
33-444	Introduction to Nuclear Physics (Alternate years)	9
33-446	Advanced Quantum Physics	9
33-448	Introduction to Solid State Physics	9
33-454	Physics of Continua (Alternate years)	9
33-456	Advanced Computational Physics (Alternate years)	9
33-466	Introduction to Cosmology (Alternate years)	9
33-650	General Relativity (Alternate years)	9

Senior Year

	Fall	Units
33-345	Mathematical Methods of Physics	9
33-449	Electronics II	9
33-451	Senior Research	9
33-453	Intermediate Optics	12
33-458	Special Problems in Computational Physics	9
33-463	Special Relativity	9
33-467	Introduction to Astrophysics (Alternate years)	9
33-755	Quantum Mechanics I	12
33-757	Classical Mechanics	12
33-759	Introduction to Theoretical Physics I	12
33-761	Classical Electrodynamics I	12

	Spring	
33-342	Thermal Physics II	10
33-444	Introduction to Nuclear Physics (Alternate years)	9
33-446	Advanced Quantum Physics	9
33-448	Introduction to Solid State Physics	9
33-451	Senior Research	9
33-454	Physics of Continua (Alternate years)	9
33-456	Advanced Computational Physics (Alternate years)	9
33-458	Special Problems in Computational Physics	9
33-466	Introduction to Cosmology (Alternate years)	9
33-650	General Relativity (Alternate years)	9
33-756	Quantum Mechanics II	12
33-762	Classical Electrodynamics II	12

B.A. in Physics

Distribution of Units Required for B.A. in Physics

	Units
Minimum Total Physics Units (33-104, 111, 112, 201, 211, 228, 234, 301, 302, 331, 332, 335, 338, 340, 341, 401, 402, 439 and two electives)	155
Mathematics (21-121, 122, 259, 260)	38
Introduction to Computing (15-125 or 127)	10
Chemistry (09-105)	10
Biology (03-121)	9
Computing Skills Workshop (99-101)	3
Humanities,Social Science, or Fine Arts Course (8 courses)	72
Free Electives (7 courses)	63
Total:	**360**

Requirements for B.A. in Physics

The required courses in physics, which include two physics electives, are the same as for the B.S. degree. The B.A. degree differs from the B.S. degree in that the technical electives are now designated as free electives and thereby need not be technical subjects. Also two fewer mathematical courses are required. They are replaced by free electives. With these free electives a student may, for example, double major with a department in the College of Humanities and Social Sciences or the College of Fine Arts.

B.S. in Physics/Computer Science Track

The Bachelor of Science in Physics/Computer Science 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 realtime 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 will be done on machines ranging from high function workstations through supercomputers. The degree program includes courses from the Mathematics and Computer Science Departments as well as special courses in computation from the Physics Department. The program can be adapted to special requirements of individual students.

Physics/Computer Science Track Curriculum

All of the courses listed below are required for the Physics/Computer Science track except for the free electives.

Freshman Year

	Fall	Units
21-121	Calculus 1	10
03-121	Modern Biology*	9
15-127	Introduction to Programming & Computer Science*	10
33-111	Physics for Science Students I	10
xx-xxx	Designated Writing Course	9
99-101	Computing Skills Workshop	3
		51
	Spring	
21-122	Calculus 2	10
09-105	Modern Chemistry*	10
33-112	Physics for Science Students II	10
xx-xxx	Humanities, Social Science, or Fine Arts Course	9
33-104	Experimental Physics	9
or		
21-127	Introduction to Modern Mathematics	(9)
		48

*Students who wish to exchange 03-121 (Modern Biology) or 09-105 (Modern Chemistry I) with 15-127 (Introduction to Programming & Computer Science) may do so. But 03-121, 09-105 and 15-127 must be completed by the end of the junior year.

Sophomore Year

	Fall	Units
33-211	Physics III	10
21-260	Differential Equations	9
33-201	Undergraduate Colloquium I	1
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
21-127	Introduction to Modern Mathematics	9
or		
33-104	Experimental Physics (required if not taken in the Freshman year.)	(9)
33-241	Introduction to Computational Physics	9
		47
	Spring	
33-234	Quantum Physics I	10
15-211	Fundamental Structures of Computer Science	12
21-259	Calculus in Three Dimensions	9
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
33-202	Undergraduate Colloquium II	1
33-228	Electronics I	10
		51

Junior Year

	Fall	Units
33-335	Quantum Physics II	10
33-331	Physical Mechanics I	10
15-212	Computer Science II	12
33-345	Mathematical Methods of Physics	9
or		
xx-xxx	Mathematics Elective	(9)
33-301	Undergraduate Colloquium III	1
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
		51
	Spring	
33-338	Intermediate Electricity and Magnetism I	10
33-302	Undergraduate Colloquium IV	1
33-332	Physical Mechanics II	10
21-369	Numerical Methods	9
33-457	Advanced Computational Physics**	9
or		
xx-xxx	Free Elective	(9)
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
		48

**Advanced Computational Physics, a required course in this program, is offered in alternate years.

Senior Year

	Fall	Units
15-xxx	Computer Science Elective	9
33-341	Thermal Physics I	10
33-439	Intermediate Electricity and Magnetism II	10
33-401	Undergraduate Colloquium V	2
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
xx-xxx	Free Elective	9
		49
	Spring	
33-xxx	Physics Elective	9
33-458	Advanced Computational Physics**	9
or		
xx-xxx	Free Elective	(9)
xx-xxx	H&SS/FA Elective (See Note at end of this section.)	9
xx-xxx	Technical Elective (See Note at end of this section.)	9
33-402	Undergraduate Colloquium VI	2
		38

**Advanced Computational Physics, a required course in this program, is offered in alternate years.

Notes

It is strongly recommended that Special Problems in Computational Physics be taken as one of the electives in the senior year. A wide variety of excellent elective offerings is also available from various departments. Because of the variability in career goals, it is best to discuss elective choices with your departmental advisor.

Technical electives are any courses in MCS or CIT for which the student fulfills the prerequisites. They may include, but are not limited to, physics courses. A few courses in H&SS also satisfy this requirement, especially in the Department of Statistics. See the Physics Department faculty advisor for details.

For Mellon College of Science H&SS/FA requirements, see p. 219.

Minimum number of units required for degree: 365

Distribution of Units Required for B.S. in Physics/ Computer Science Track

	Units
Minimum Total Physics Units (33-104, 111, 112, 201, 202, 211, 228, 234, 241, 301, 302, 331, 332, 335, 338, 341, 401, 402, 439, 456 and one elective)	154
Technical Elective (1 course) including but not limited to physics courses	9
Computer Science (15-127, 211, 212, and one elective)	43
Mathematics (21-121, 122, 127, 259, 260, 369 and one elective which may be 33-345)	65
Chemistry (09-105)	10
Biology (03-121)	9
Computer Skills Workshop (99-101)	3
Humanities, Social Sciences and Fine Arts Courses (8 courses)	72
Total:	**365**

The Minor in Physics

This minor is designed to provide first a solid foundation in physics at the introductory level. In the elective courses the student will become familiar with a sample of the many modern areas of physics, and the concepts and techniques employed therein. The sequence consists of two introductory level courses followed by five electives at the non-introductory level. 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 of non-calculus based majors should be aware of the mathematics requirements for many physics courses (Calculus I & II, Differential Equations, Calculus in Three Dimensions).

Requirements (7 courses of at least 9 units each)

1. Introductory Courses
Choose *one* course:

33-111 Physics for Science Students I
33-106 Physics for Engineering Students I

Choose *one* course:

33-112 Physics for Science Students II
33-107 Physics for Engineering Students II

2. Elective Courses
Choose *five* courses:
33-104 Experimental Physics (*)
33-234 Quantum Physics I
33-335 Quantum Physics II
33-241 Computational Physics
33-331 Physical Mechanics I
33-332 Physical Mechanics II
33-338 Intermediate Electricity and Magnetism I
33-439 Intermediate Electricity and Magnetism II
33-340 Modern Physics Laboratory
33-341 Thermal Physics I
33-342 Thermal Physics II
33-363 Special Relativity
33-444 Nuclear & Particle Physics
33-448 Introduction to Solid State Physics
33-453 Intermediate Optics
33-466 Cosmology
33-467 Astrophysics

or other suitable courses listed under 33-xxx.

(*) *required if the student does not complete any other laboratory course in science or engineering.*

Faculty

LUC BERGER, Professor of Physics — Ph.D., University of Lausanne, Switzerland; Carnegie Mellon, 1960—.

RICHARD M. EDELSTEIN, Professor of Physics — Ph.D., Columbia University; Carnegie Mellon, 1960—.

ARNOLD ENGLER, Professor of Physics — Ph.D., University of Berne, Switzerland; Carnegie Mellon, 1962—.

THOMAS A. FERGUSON, Associate Professor of Physics — Ph.D., University of California at Los Angeles; Carnegie Mellon, 1985—.

JOHN G. FETKOVICH, Professor of Physics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1959—.

GREGG B. FRANKLIN, Associate Professor of Physics — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1984—.

STEPHEN GAROFF, Professor of Physics — Ph.D., Harvard University; Carnegie Mellon, 1988—.

ROBERT B. GRIFFITHS, Otto Stern Professor of Physics — Ph.D., Stanford University; Carnegie Mellon, 1964—.

RICHARD F. HOLMAN, Associate Professor of Physics — Ph.D., Johns Hopkins University; Carnegie Mellon, 1987—.

BRADLEY D. KEISTER, Associate Professor of Physics — Ph.D., Stanford University; Carnegie Mellon, 1975—.

LEONARD S. KISSLINGER, Professor of Physics — Ph.D., Indiana University; Carnegie Mellon, 1969—.

GEORGE KLEIN, Lecturer æ Ph.D., New York University; Carnegie Mellon, 1993æ.

ROBERT W. KRAEMER, Professor of Physics — Ph.D., Johns Hopkins University; Carnegie Mellon, 1965—.

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—.

BARRY B. LUOKKALA, Senior Lecturer/Laboratory Demonstrator — M.S., University of Pittsburgh; Carnegie Mellon, 1980—.

SARA A. MAJETICH, Assistant Professor of Physics — Ph.D., University of Georgia; Carnegie Mellon, 1990—.

TADEUSZ B. MASSALSKI, Professor of Physics and Metallurgy and Materials Science — Ph.D., D.Sc., University of Birmingham, England; Carnegie Mellon, 1959—.

CURTIS MEYER, Assistant Professor of Physics æ Ph.D., University of California, Berkeley; Carnegie Mellon, 1993æ.

JOHN F. NAGLE, Professor of Physics and Biological Sciences — Ph.D., Yale University; Carnegie Mellon, 1967—.

JEFFREY B. PETERSON, Associate Professor of Physics æ Ph.D., University of California, Berkeley; Carnegie Mellon, 1993æ.

MICHAEL PROCARIO, Assistant Professor of Physics — Ph.D., University of Wisconsin at Madison; Carnegie Mellon, 1990—.

BRIAN P. QUINN, Associate Professor of Physics — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.

JOHN A. RAYNE, Professor of Physics — Ph.D., University of Chicago; Carnegie Mellon, 1963—.

JAMES S. RUSS, Professor of Physics — Ph.D., Princeton University; Carnegie Mellon, 1967—.

MARTIN SAVAGE, Assistant Professor of Physics æ Ph.D., California Institute of Technology; Carnegie Mellon, 1993æ.

REINHARD A. SCHUMACHER, Associate Professor of Physics — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1987—.

ROBERT T. SCHUMACHER, Professor of Physics — Ph.D., University of Illinois; Carnegie Mellon, 1957—.

ROBERT F. SEKERKA, Professor of Physics and Mathematics — Ph.D., Harvard University; Carnegie Mellon, 1969—.

BRUCE A. SHERWOOD, Principal Research Scientist, Center for Design of Educational Computing & Professor of Physics — Ph.D., University of Chicago; Carnegie Mellon, 1984—.

RAYMOND A. SORENSEN, Professor of Physics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1961—.

ROBERT M. SUTER, Associate Professor of Physics — Ph.D., Clark University; Carnegie Mellon, 1981—.

ROBERT H. SWENDSEN, Professor of Physics, Head, Department of Physics — Ph.D., University of Pennsylvania; Carnegie Mellon, 1984—.

NED S. VANDER VEN, Professor of Physics — Ph.D., Princeton University; Carnegie Mellon, 1961—.

HELMUT VOGEL, Professor of Physics — Ph.D., University of Erlangen-Nuremberg; Carnegie Mellon, 1983—.

MICHAEL WIDOM, Associate Professor of Physics — Ph.D., University of Chicago; Carnegie Mellon, 1985—.

LINCOLN WOLFENSTEIN, University Professor of Physics — Ph.D., University of Chicago; Carnegie Mellon, 1948—.

C. ROY WORTHINGTON, Professor of Physics and Biological Sciences — Ph.D., Adelaide University; Carnegie Mellon, 1969—.

HUGH D. YOUNG, Professor of Physics — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1959—.

School of Computer Science

School of Computer Science

Raj Reddy, Dean
Allan Fisher, Associate Dean for Undergraduate Education
Mark Stehlik, Assistant Dean for Undergraduate Education
Undergraduate Office: Wean 4105

Curriculum — B.S. in Computer Science

The School of Computer Science is the product of the evolution of the Carnegie Mellon University Department of Computer Science, founded almost 30 years ago as one of the first Computer Science departments in the world. Today, the School of Computer Science comprises the Computer Science Department, the Robotics Institute, and the Center for Machine Translation. In addition to granting Ph.D.s in Computer Science and Robotics, the M.S. in Software Engineering, and the B.S. in Computer Science, the School of Computer Science also participates in the Ph.D. programs in Pure and Applied Logic and in Algorithms and Combinatorial Optimization. Together, these units make the School of Computer Science a world leader in research and education.

The B.S. program in Computer Science combines a solid core of Computer Science courses with the ability to gain real depth in another area through a required minor in a second subject. In addition, there are numerous choices in the curriculum for science and humanities courses. As computing is a discipline with strong links to many fields, this provides students with unparalleled flexibility to pursue allied (or non-allied) interests. The curriculum's mathematics and statistics component ensures that students have the formal tools to remain current as technologies and systems change, rather than be limited by a narrow focus on programming alone. At the same time, students gain insight into the practical issues of building and maintaining systems by participating in intensive project-oriented courses. Due to the tremendous number of ongoing research projects within the School, many students obtain part-time or summer jobs, or receive independent study credit, working on research while pursuing an undergraduate degree. Students seeking a research/graduate school career may pursue an intensive course of research, equivalent to four classroom courses, culminating in the preparation of a senior research honors thesis.

Students apply to, and are directly admitted into, the B.S. program, but the major is not formally declared until Spring of the freshman year. If space is available, suitably prepared students from other Carnegie Mellon Colleges are also eligible to apply for internal transfer to the School of Computer Science at that time. Academic policies for the School of Computer Science are detailed in the CMU Student Handbook.

Computation-oriented programs are also available within the Departments of Biology, Chemistry, Physics, Electrical and Computer Engineering, Philosophy, Psychology, and Social and Decision Sciences.

The requirements of the B.S. in Computer Science are:

Computer Science

15-127	Introduction to Programming and Computer Science
15-211	Fundamental Structures of Computer Science I
15-212	Fundamental Structures of Computer Science II
15-347	Introduction to Computer Architecture
15-451	Algorithms

one Fundamentals of Programming course:

15-312	Programming Languages Design and Processing
15-414	Structured Programming and Program Proving
15-453	Formal Languages and Automata
15-671	Models of Software Systems
15-xxx	others as listed each semester

one Systems Programming course:

15-412	Operating Systems
15-679	Introduction to Real-Time Software Systems
18-349	Concurrency and Real-Time Systems
15-xxx	others as listed each semester

one Applications course:

15-381	Artificial Intelligence: Representation and Problem Solving
15-384	Robotic Manipulation
15-385	Computer Vision
15-413	Software Engineering
15-462	Computer Graphics
15-xxx	others as listed each semester

one Computer Science elective

Mathematics/Statistics

21-121	Calculus 1
21-122	Calculus 2
21-127	Introduction to Modern Mathematics
21-228	Discrete Mathematics

one of the following Statistics sequences:

36-217	Probability Theory and Random Processes
36-225/226	Introduction to Probability and Statistics I & II

Engineering and Natural Sciences

18-240	Fundamentals of Computer Engineering

Four additional science courses are required, of which at least one must have a laboratory component and at least two must be from the same department. At present, courses meeting the lab requirement are:

09-101	Introduction to Experimental Chemistry (this 3 unit lab must be taken together with 09-105, Modern Chemistry I)
27-100	Materials in Engineering
33-104	Experimental Physics (must be taken after or concurrent with 33-111, Physics for Science Students I)

Required Minor

Six courses (minimum) as prescribed by the requirements of the particular minor. 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.

Other Courses

99-101	Computing Skills Workshop

SCS Humanities, Social Sciences, and Fine Arts Requirement (8 courses / 72 units)

three free electives

Humanities, Social Sciences, and Fine Arts Requirement

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. The humanities, social science, and fine arts courses for SCS students are to meet the following distribution requirements:

A. Common Course Requirement, Writing/Expression (9 units)

Complete one of the following:

76-100	Introduction to English Studies: Argument
76-101	Introduction to English Studies: Interpretation

B. Breadth Requirement (27 units)

Complete three courses, one each from Category 1, Category 2, and Category 3.

Category 1: Cognition Choice and Behavior

80-150	Nature of Reason
80-180	Nature of Language
80-182	Language and Thought
80-242	Conflict and Dispute Resolution
85-100	Cognitive Processes: Theory and Practice
85-101	General Psychology (self-paced)
85-102	Introduction to Psychology
85-150	Introduction to Social Problems
85-211	Cognitive Psychology
85-221	Principles of Child Development
85-241	Social Psychology
85-251	Introduction to Personality

Category 2: Economic, Political and Social Institutions

36-203	Sampling, Surveys and Society
73-100	Principles of Economics
73-110/88-110	Social Decision-Making: A Laboratory Approach
79-114	Causal Models and Historical Explanation
79-115	Education and Inequality
80-136	Social Structure, Public Policy and Ethical Dilemmas
88-104	Decision Processes in American Political Institutions
88-109	Institutions and Individuals

Category 3: Cultural Analysis

76-201	Cultural Practices and Literary Production
76-240	What is Cultural Studies?
79-104	Introduction to World History
79-110	Issues in Cultural Change: The Atlantic World
79-111	Cultural and Cross-Cultural Perspectives on the Environment
79-112	Race, Nationality, and the Development of American Cultures
79-113	Culture and Identity in American Social Life
79-200	Society and the Arts
80-100	What Philosophy Is
80-183	Language, Culture and Thought
82-107	Reflections of French Culture in Film
82-182	Language and Culture: Language in Its Social Context
82-193	The Faust Legend from Europe to Russia
82-405	Contemporary French Culture
82-407	Moliere and the Traditions of Comedy
82-409	French Literature of the Nineteenth Century
82-412	Twentieth-Century French Theater
82-413	Twentieth-Century French Novel
82-414	Modern French Poetry
82-415/416	Studies in French Literary and Cultural Studies
82-427	The New Germany
82-428	German Classical Literature
82-429	German Literature of the Nineteenth Century
82-430	German Literature of the Twentieth Century
82-431	Postwar German Literature
82-436	Studies in German Literature
82-441	Survey of Spanish Literature
82-451	Introduction to Latin American Literature and Culture
82-455	Studies in Spanish and Latin American Literature
82-456	Studies in Spanish Literature
82-465/466	Surrealism in France and Spain
82-491	Literature, Politics and Film in Russia and East Europe Today
82-492	The Historical Imagination in Nineteenth Century Russian Literature

C. Electives (36 units)

Complete 4 non-technical courses of at least 9 units each from any of the departments in the College of Humanities & Social Sciences, the College of Fine Arts, or Industrial Management. Accounting, finance, management, marketing, production, and statistics courses are considered technical courses and may not be used to satisfy this requirement.

Suggested course sequence:

Freshman Year

	Fall	Units
15-127	Introduction to Programming and Computer Science	10
21-121	Calculus 1	10
21-127	Introduction to Modern Mathematics	9
76-100/101	Writing Course	9
99-101	Computing Skills Workshop	3
xx-xxx	Science/Engineering Course	9
		50
	Spring	
15-211	Fundamental Structures of Computer Science I	12
21-122	Calculus 2	10
xx-xxx	Science/Engineering Course	9
xx-xxx	Humanities/Social Sciences/Fine Arts Elective	9
		40

Sophomore Year

	Fall	Units
15-212	Fundamental Structures of Computer Science II	12
21-228	Discrete Mathematics	9
xx-xxx	Science/Engineering Course	9
xx-xxx	Science/Engineering Course	9
xx-xxx	Humanities/Social Sciences/Fine Arts Elective	9
		48
	Spring	
15-xxx	Restricted Computer Science Elective	9
18-240	Fundamentals of Computer Engineering	12
xx-xxx	Minor Requirement	9
xx-xxx	Humanities/Social Sciences/Fine Arts Elective	9
		39

Junior Year

	Fall	Units
15-xxx	Restricted Computer Science Elective	9
36-217	Probability Theory and Random Processes	9
xx-xxx	Minor Requirement	9
xx-xxx	Humanities/Social Sciences/Fine Arts Elective	9
xx-xxx	Free Elective	9
		45
	Spring	
15-451	Algorithms	9
15-347	Introduction to Computer Architecture	12
xx-xxx	Minor Requirement	9
xx-xxx	Humanities/Social Sciences/Fine Arts Elective	9
		39

Senior Year

	Fall	Units
15-xxx	Restricted Computer Science Elective	9
xx-xxx	Minor Requirement	9
xx-xxx	Minor Requirement	9
xx-xxx	Humanities/Social Sciences/Fine Arts Elective	9
xx-xxx	Free Elective	9
		45
	Spring	
15-xxx	Computer Science Elective	8
xx-xxx	Minor Requirement	9
xx-xxx	Humanities/Social Sciences/Fine Arts Elective	9
xx-xxx	Free Elective	9
		36

Minimum number of units required for the degree: 342

Suggested Options

The flexibility in the curriculum allows many different schedules, of which the above is only one possibility. It is possible, for example, to finish your minor requirements before the senior year, thus leaving both senior semesters with only four courses. Likewise, one could trade minor and science courses in the Sophomore year depending on what the student wishes to take and when the courses are offered. 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.

Scientific Computation

15-412	Operating Systems
15-413	Software Engineering
21-241	Linear Algebra I
21-259	Calculus in Three Dimensions
21-260	Differential Equations
21-355	Advanced Calculus
21-369	Numerical Methods
21-371	Functions of a Complex Variable
21-476	Ordinary Differential Equations
33-111/112	Physics for Science Students I and II
36-410	Elementary Applied Probability

Artificial Intelligence/Robotics

15-312	Programming Languages Design and Processing
15-381	Artificial Intelligence: Representation and Problem Solving
15-384	Robotic Manipulation
15-385	Computer Vision
15-413	Software Engineering
21-241	Linear Algebra I
21-260	Differential Equations

Artificial Intelligence/Cognition

15-381	Artificial Intelligence: Representation and Problem Solving
15-38x	Robotic Manipulation OR Computer Vision
15-413	Software Engineering
15-681	Machine Learning
21-600	Mathematical Logic I

To further concentrate in the formal foundations of artificial intelligence, one might want to take:

21-292	Operations Research I
21-393	Operations Research II
21-301	Combinatorial Analysis
21-484	Applied Graph Theory
21-700	Mathematical Logic II

To further concentrate in artificial intelligence and psychology, one might want to take:

85-211	Cognitive Psychology
85-411	Cognitive Processes and Problem Solving
85-419	Introduction to Parallel Distributed Processing

To further concentrate in natural language, one might want to take:

80-280	Introduction to Linguistic Analysis
80-680	Introduction to Computational Linguistics
80-681	Natural Language Processing I
80-682	Natural Language Processing II
80-683	Natural Language Processing III

Software Systems

15-312	Programming Languages Design and Processing
15-411	Compiler Design
15-412	Operating Systems
15-413	Software Engineering
15-414	Structured Programming and Program Proving
21-600	Mathematical Logic I

Computer Systems

15-411	Compiler Design
15-412	Operating Systems
36-225/6	Introduction to Probability and Statistics I and II
36-410	Elementary Applied Probability

Theory

15-312	Programming Languages Design and Processing
15-414	Structured Programming and Program Proving
15-453	Formal Languages and Automata
15-85x	Graduate theory course
21-301	Combinatorial Analysis
21-484	Applied Graph Theory
21-600	Mathematical Logic I
21-700	Mathematical Logic II

Graduate School Preparation

15-312	Programming Languages Design and Processing
15-381	Artificial Intelligence: Representation and Problem Solving
15-412	Operating Systems
15-453	Formal Languages and Automata
21-241	Linear Algebra I
21-301	Combinatorial Analysis
21-373	Algebraic Structures
21-484	Applied Graph Theory
21-600	Mathematical Logic I
36-410	Elementary Applied Probability

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 and a public poster session each semester, 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 both a Double Major and a Minor in Computer Science.

Double Major in Computer Science

The following courses are required for a Double Major in Computer Science:

Prerequisites:

15-127	Introduction to Programming and Computer Science
18-240	Fundamentals of Computer Engineering
21-121	Calculus 1
21-122	Calculus 2
21-127	Introduction to Modern Mathematics
21-228	Discrete Mathematics

Double Major requirements:

15-211	Fundamental Structures of Computer Science I
15-212	Fundamental Structures of Computer Science II
15-347	Introduction to Computer Architecture
15-451	Algorithms

one Fundamentals of Programming course:

15-312	Programming Languages Design and Processing
15-414	Structured Programming and Program Proving
15-453	Formal Languages and Automata
15-671	Models of Software Systems

one Systems Programming course:

15-412	Operating Systems
15-679	Introduction to Real-Time Software Systems
18-349	Concurrency and Real-Time Systems

one Applications course:

15-381	Artificial Intelligence: Representation and Problem Solving
15-384	Robotic Manipulation
15-385	Computer Vision
15-413	Software Engineering
15-462	Computer Graphics

one Computer Science elective

one of the following Statistics sequences:

36-217	Probability Theory and Random Processes
36-225/226	Introduction to Probability and Statistics I & II

Students pursuing a Double Major in Computer Science must complete at least eight Computer Science courses that are not applied to any other degree requirement except free electives.

Minor in Computer Science

The School of Computer Science also offers a Minor in Computer Science. The following courses are required:

Prerequisites:

15-127	Introduction to Programming and Computer Science
21-127	Introduction to Modern Mathematics

Minor requirements:

15-211	Fundamental Structures of Computer Science I
15-212	Fundamental Structures of Computer Science II

one software project course of

15-411 Compiler Design
15-412 Operating Systems
15-413 Software Engineering
15-462 Computer Graphics I

two Computer Science electives at the 300-level or higher

Students pursuing a Minor in Computer Science must complete at least four Computer Science courses that are not applied to any other degree requirement except free electives.

Research and Teaching Faculty

JOHN ANDERSON, Professor of Psychology and Computer Science — Ph.D., Stanford University; Carnegie Mellon, 1978—.

MARIO BARBACCI, Senior Research Computer Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1974—.

JOSEPH BATES, Senior Research Computer Scientist — Ph.D., Cornell University; Carnegie Mellon, 1987—.

LYNN BAUMEISTER, Lecturer — B.S., Carnegie Mellon University; Carnegie Mellon, 1985—.

ADAM BEGUELIN, Research Computer Scientist — Ph.D., University of Colorado; Carnegie Mellon, 1992—.

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THOMAS GROSS, Associate Professor — Ph.D., Stanford University; Carnegie Mellon, 1984—.

ANDREW GRUSS, Systems Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1975—.

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LILY HOU, Lecturer — M.S., Kansas State University; Carnegie Mellon, 1986—.

KATSUSHI IKEUCHI, Principal Research Computer Scientist — D.Eng., University of Tokyo; Carnegie Mellon, 1986—.

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BONNIE JOHN, Assistant Professor — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1988—.

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DEAN POMERLEAU, Research Computer Scientist — Ph.D., Carnegie Mellon University; Carnegie Mellon, 1987—.

RAJ REDDY, Herbert A. Simon University Professor of Computer Science and Robotics; Dean, School of Computer Science— Ph.D., Stanford University; Carnegie Mellon, 1969—.

JOHN REYNOLDS, Professor — Ph.D., Harvard University; Carnegie Mellon, 1986—.

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EUGENE ROLLINS, Systems Scientist — Ph.D., State University of New York at Stony Brook; Carnegie Mellon, 1985—.

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ANDREW WITKIN, Professor — Ph.D., Massachusetts Institute of Technology; Carnegie Mellon, 1988—.

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SHERYL YOUNG, Research Computer Scientist — Ph.D., University of Colorado; Carnegie Mellon, 1987—.

Course Descriptions

Biological Sciences

Undergraduate Courses

03-121
Modern Biology — **Fall or Spring: 9 units**
This is an introductory course that provides the basis for further studies in biochemistry, cell biology, genetics and molecular biology. Throughout the course, the similarities and differences of the various life forms are emphasized. This is the introductory biology course for all science and non-science majors. 3 hrs. lec. Prerequisite: fundamental knowledge of high school chemistry and biology.

03-122
Organismic Botany — **Spring: 9 units**
This course will provide an integrated overview of organismic botany, including historical perspectives. It surveys the organization of the plant kingdom above the cellular level, focusing particularly on the vascular plants, both fossil and extant. On a subdisciplinary basis, the course will include introductions to the basic principles of anatomy, morphology, evolution, phytogeography, ecology and systematics. 3 hrs. lec. Prerequisite: 03-121.

03-124
Modern Biology Laboratory — **Fall or 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. Students will be introduced to techniques of microscopy, cell biology, gross anatomy, embryology and ecology. The latter includes field trips and small group projects in the local area. 1 hr. lec., 3 hrs. lab. Prerequisite (or concurrently): 03-121.

03-130
Biology of Organisms — **Spring: 9 units**
It is intended that this course, in combination with Modern Biology (03-121), will provide a basic background in biology. It will include a survey of the anatomy and physiology of organ systems (emphasizing mammals) and vertebrate embryology as it relates to development of organ systems. There will be an introduction to major concepts in animal behavior and evolution. 3 hrs. lec. Prerequisite: 03-121.

03-240
Cell Biology — **Fall: 9 units**
The structure and function of cells and cell components are discussed. Experimental methods employed in the study of cells, such as microscopy, cell culture and biochemical techniques, are presented. Among the topics emphasized are the functions of cell organelles such as the nucleus, ribosomes, microtubules and membranes and the properties and functions of several types of cells including nerve cells. 3 hrs. lec. Prerequisite: 03-121 or permission of instructor.

03-231
Biochemistry I — **Spring: 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. 3 hrs. lec. Prerequisite: 09-117.

03-243
Experimental Techniques in Genetics and Molecular Biology — **Fall: 12 units**
This laboratory course is designed to teach experimental methods of modern biology. Experiments in microbial genetics and physiology, molecular biology and eukaryotic genetics are performed. This course is designed to be taken during the junior year and is intended to prepare students for undergraduate research. 1 hr. lec., 8 hrs. lab. Prerequisites: 03-330 (or concurrently), 03-231, 09-132.

03-244
Experimental Techniques in Biochemistry — **Spring: 12 units**
This course is designed to be taken as a sequel to 03-243. Experiments cover a variety of methods for investigating the structure and function of biological molecules. During the last five weeks students plan and carry out an original research project. 1 hr. lec., 8 hrs. lab. Prerequisites: 03-231 and 03-243 or consent of instructor.

03-310
Introduction to Computational Biology — **Spring: 9 units**
This course presents an overview of typical applications of computers to solve problems in biology and medicine. 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 will be computational molecular biology (analysis of protein and nucleic acid sequences), biological modeling and simulation (including computer models of single and multiple neuron behavior, biochemical kinetics, and simulation of mutation), graphics and statistics, and biological imaging. Course work consists of homework assignments making use of software packages for these applications. Prerequisites: 03-121, 21-122 and 99-101 or equivalents.

Course Descriptions

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 use of these methods. It is intended for students without computer programming experience. Topics covered will be sequence entry and editing, restriction enzyme analysis, finding protein coding regions (open reading frames), sequence alignment, homology searching, finding sequence feature (e.g., promoters), and elementary protein structure prediction. Course work consists of lectures, in class demonstrations, homework assignments making use of software packages for these applications, and creation of a report describing analysis of a sequence of the student's choice. Prerequisites: 03-121 and 99-101 or equivalents.

03-330
Genetics — **Fall: 9 units**
The mechanisms of inheritance are discussed at the organismal and molecular levels. Topics include the genetics of bacteria, viruses, animals and plants. 3 hrs. lec. Prerequisite: 03-231 or permission of instructor.

03-332
Biochemistry II — **Spring: 9 units**
This course completes Introduction to Biochemistry I (03-231). Topics include intermediary metabolism of synthetic and degradative pathways, including detailed mechanism of selected enzymes; biochemical view of molecular biology from a structural perspective; and aspects of molecular physiology. Prerequisite: 03-231.

03-350
Developmental Biology — **Spring: 9 units**
Developmental biology is the study of how organisms arise from a single cell - the fertilized egg. Cellular, molecular and genetic aspects of embryonic development are discussed with the aim of understanding the morphogenesis of tissues and organs, cell fate specification and differentiation, and the control of pattern formation The course consists of lectures, computer-based tutorials and discussion of original scientific papers. 3 hrs. lec. Prerequisites: 03-231, 03-240, and 03-330.

03-360
The Biology of the Brain — **Fall: 9 units**
This course will survey topics found in the vast expanses of the science of neurobiology. Neurobiology is the study of the nervous system, its development, its function and its diseases. Aspects of the development and cell biology of the nervous system from the formation of the nervous system in the embryo to the demise of the brain (as in Alzheimer's disease) will be discussed. The physiology and molecular genetics of the function of a neuron and the nervous system will also be discussed with the aim of understanding current and classical topics of neurobiology from a modern point of view. 3 hrs. lec. Prerequisites: 03-231, 03-330 (or concurrently registered), 21-122 and 33-112 or permission of instructor.

03-380
Virology — **Fall: 9 units**
The concepts and methods of virology are studied with emphasis on animal viruses. DNA and RNA viruses are discussed within the framework of genetics, molecular biology, cell biology and immunology. Discussions of viral and cellular oncogenes and the processes of oncogenic transformation are included. 3 hrs. lec. Prerequisites: 03-240 and 03-330 (or concurrently).

03-411/412
Undergraduate Seminar — **Fall or Spring: 1 unit**
During the year students attend weekly seminars given by outside speakers or members of the Biology Department on current research topics in modern biology.

03-438
Physical Biochemistry — **Spring: 9 units**
The physical properties of proteins and nucleic acids and the methods used to analyze their structure and function are discussed. Topics covered include the thermodynamic and kinetic basis of structure and folding, ligand-receptor interactions, catalysis, cooperativity and biological spectroscopy with emphasis on absorption; fluorescence and NMR. Case studies from the recent literature are highlighted. 3 hrs. lec. Prerequisites: 33-112, 03-231 and 09-144 or permission of instructor.

03-439
Introduction to Biophysics — **Fall: 9 units**
This course introduces the role of biophysics and biophysical methods in the study of biological systems. The biological systems to be studied include muscle, membranes, nerves, photosynthetic systems and visual systems. The biophysical methods will be selected from among the techniques of x-ray and neutron diffraction, light scattering, birefringence, microscopy, three-dimensional image reconstruction, Raman and IR spectroscopy, dielectric response and calorimetry. The selection of topics will be coordinated with Physical Biochemistry. The emphasis in the discussion of methods is on principles. The relevant physical principles will be treated together with some mathematical development when necessary. The biological systems to which the methods are applied will be surveyed and current interpretations will be discussed. Prerequisites: MCS science core courses in Biology, Mathematics and Physics.

Course Descriptions

03-441
Molecular Biology of Prokaryotes **Spring: 9 units**
The course covers the molecular biology 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* and *Salmonella typhimurium*, the structure and function of flagella, the molecular mechanisms of bacterial chemotaxis and motility, and the principles of self-assembly and catalyzed assembly of virus particles. 3 hrs. lec. Prerequisites: 03-231 and 03-330.

03-442
Molecular Biology of Eukaryotes **Fall: 9 units**
The structure and expression of eukaryotic genes are discussed, focusing on model systems from a variety of organisms. Current topics discussed include (1) isolation of specific DNA sequences using recombinant DNA technology, (2) the control of gene expression at the level of transcription, splicing and translation, (3) chromosome structure, including origins of replication, centromeres, telomeres and transposons, and (4) molecular biology of humans. 3 hrs. lec. Prerequisite: 03-441.

03-445
Undergraduate Research **Fall or Spring: 6-15 units**
Properly qualified students may undertake short research problems under the supervision of members of the staff. 6 to 15 hrs. Prerequisite: permission of the instructor.

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 single and multiple neuron behavior, biochemical kinetics, and simulation of mutation), graphics and statistics, and biological imaging. Course work will include use of software packages for these applications, reading of scientific papers, and programming assignments in a language chosen by the student from FORTRAN, C or PASCAL. Prerequisites: 15-200 or 15-211, or permission of instructor.

03-533
NMR in Biomedical Sciences **Fall: 9 units**
The aim of this course is to introduce the students to new advances in the field of NMR in biomedical sciences. This course covers the following topics: (1) fundamentals of NMR; (2) new techniques such as NMR imaging and *in vivo* spectroscopy as well as pulse techniques and NMR microscopy; and (3) applications of NMR to investigate macromolecular structures, interactions and dynamics. This course is open to graduate and advanced undergraduate students. Graduate students are expected to carry out an independent project in addition to fulfilling the usual requirements of the course. Prerequisites: 03-231 and 09-144 or 09-245 (or an intermediate level physics course).

03-534
Fluorescence Spectroscopy in Biological Research **Fall: 9 units**
This course will introduce the theory and applications of modern fluorescence techniques as used in biology. Half of the course will emphasize general principles and theory. The other half will emphasize applications of these principles in modern biology. 3 hrs. lec. Prerequisites: 03-240, 03-231, 09-218, 09-144 or permission of the instructor.

03-545
Honors Research **Fall or Spring: 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. Prerequisites for admission to Honors Research are a QPA of 3.2 or greater and completion of at least 18 units of Undergraduate Research or equivalent research experience. Credit for 03-545 may be given for adequate research and writing effort, even in the event that an acceptable thesis is not presented and defended. However, the successful completion and defense of the thesis will be required for granting the Honors in Biological Research notation on the diploma. This course will ordinarily be taken in the second semester of the senior year.

03-550
Developmental Genetics **Spring: 9 units**
This course will examine in detail the genetic basis of specific developmental processes and the use of genetic methods to investigate general problems in developmental biology. Lectures and readings will focus primarily on studies using *Drosophila melanogaster*, *Caenorhabditis elegans* and the laboratory mouse, but work with other species will also be discussed when appropriate. Consideration will be given to both the identification and the functional dissection of genes involved in a variety of developmental processes ranging from the establishment of embyonic polarity to the control of cell proliferation. Questions concerning the evolutionary continuity of developmental regulatory mechanisms and the links between different developmental processes will also be explored. 3 hrs. lec. Prerequisites: 03-330 or consent of the instructor.

03-609
Fermentation Technology **Fall: 9 units**
The first half of the course covers microbial physiology and metabolism, fermentations and respiration, metabolic regulation, bioconversions and recombinant DNA methodology and gene cloning. The second half covers separation and purification, kinetics and design of biological reactors, mass transfer limitations within cell suspensions and control of fermentation processes. 3 hrs. lec. Prerequisites: 03-231, 03-441, 21-260, or permission of instructor.

03-620
Techniques in Electron Microscopy **Spring: 9 units**
This course is designed to teach basic methods in transmission electron microscopy to graduate students and advanced undergraduate students. 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 3 hours of laboratory each week. Students will learn basic methods in specimen preparation for transmission electron microscopy (fixation embedding and ultramicrotomy) and will be trained in the operation of the electron microscope (Phillips 300 TEM). A short session at the end of class will introduce the students to a special technique (e.g., immunoelectron microscopy or cryoultramicrotomy) or will allow them to work with samples from their own research. Lectures will supplement the laboratory work by discussing the theoretical basis of these techniques and the interpretation of electron micrographs. 1 hr. lec. and 4 hrs. lab. Prerequisites: Permission of the instructor.

Graduate Courses

The graduate courses listed below are available to undergraduate students who have appropriate prerequisites and permission of the instructor

38-669
Biophysics I: Principles and Methods **Fall: 9 units**
Courses 38-669 and 38-670 constitute a two-semester sequence. Both courses deal with the biophysical principles and methods for the determination and description of structure and dynamic behavior of biomolecular systems. The principles are mainly based on spectroscopy and optics. Although the treatment is formally rigorous, the level is introductory. The foundations of Fourier analysis are discussed in parallel with biophysical applications. The physical techniques of microscopy and polarized light analysis are described followed by a series of dynamical techniques including absorbtion, dispersion, correlation and transient response methods. The Laplace transform is introduced in relation to the kinetic and relaxation properties of biological macromolecules. Examples will deal with the properties of proteins, enzymes and nucleic acids. Prerequisite: senior standing in the Sciences or in Engineering or permission of instructor.

38-670
Biophysics II: Structure and Dynamics **Spring: 9 units**
The physical basis of scattering experiments in biology is introduced. Emphasis is placed on the Fourier optical approach of linear systems. Diffraction methods are described in some detail. The structure analysis of biological molecules is presented from a historical perspective beginning with X-ray diffraction patterns of the fibrous proteins and including helical and lamellar diagrams. The elements of determination of important biological complexes such as chromatin, viruses and the ribosomes will be discussed. Some aspects of advanced methods of biological structure analysis such as three-dimensional imaging will be treated as time permits. Prerequisite: knowledge of 38-669.

03-730
Advanced Genetics **Spring: 9 units**
This course considers selected current topics in genetics at an advanced level. Emphasis is on classroom discussion of research papers. Topics change yearly. Prerequisites: 03-441, 03-642 and permission of instructor.

03-740
Advanced Biochemistry: Nucleic Acids **Fall: 9 units**
This course emphasizes structural chemistry and enzymology. Lectures cover topics from the recent biochemical literature including nucleic acid sequencing, the enzymes of nucleic acid biosynthesis and degradation, restriction endonucleases and *in vivo* control of DNA and RNA biosynthesis. 3 hrs. lec. Prerequisite: 03-231 or permission of instructor. 03-230 and 03-441 are recommended.

03-741
Advanced Cell Biology **Spring: 9 units**
This course covers in depth two related topics in modern cell biology. Topics covered in previous years have included pathways of receptor-mediated endocytosis, stimulus-response coupling in mammalian cell systems (with emphasis on mechanism of growth factor action), and Golgi body structure and function. Emphasis is on critical reading of research papers and classroom discussion. Prerequisites: 03-240 and 03-231 or instructor's permission.

03-742
Molecular Biology of Eukaryotes **Fall: 9 units**
The structure and expression of eukaryotic genes are discussed, focusing on model systems from a variety of organisms. Current topics discussed include (1)

isolation of specific DNA sequences using recombinant DNA technology, (2) the control of gene expression at the level of transcription, splicing and translation, (3) chromosome structure, including origins of replication, centromeres, telomeres and transposons, and (4) molecular biology of humans. 4 hrs. lec. Prerequisite: 03-441 or instructor's permission.

03-751
Advanced Developmental Biology **Fall: 9 units**
This course will examine selected topics in developmental biology at an advanced level. Each year three new topics will be examined; previous topics have included pattern formation in insects, cell lineage analysis, cell-cell interactions and the specification of cell fates, cell adhesion molecules, genetic approaches to mammalian embryogenesis and the extracellular matrix in development. Emphasis is on critical reading of original research papers and classroom discussion. Within each subject, significant research papers will be assigned and discussed, with students acting as discussion leaders. Prerequisite: 03-350 or permission of instructor.

03-760
Membrane Biochemistry and Biophysics **Fall: 9 units**
Work in this course includes the study of membranes by chemical and physical means. Selected topics in membrane biochemistry and biophysics are considered in detail. Prerequisite: permission of instructor.

03-871
Structural Biophysics **Fall and Spring: 9 units**
This 2-semester course provides a graduate level introduction to the use of biophysical methods in studying the structure of biological macromolecules such as DNA and proteins and assemblies of these molecules including DNA-protein complexes, viruses and membranes. Lecture material will cover the study of macromolecules, both *in vitro* and *in vivo*. Topics covered include X-ray crystallography, NMR, microscopy, molecular dynamics and spectroscopic methods. 3 hrs. lec.

Course Descriptions

Chemical Engineering

Undergraduate Courses

06-100
Introduction to Chemical Engineering **Fall and Spring: 12 units**
In this course, students develop their problem-solving skills by using the principles of material balance in modeling chemical processes. Topics include definition of processes and process variables, analysis of experimental data, and balances of single- and multiple-unit processes with and without chemical reactions. Examples from areas such as environmental engineering, bioengineering, and materials processing are used throughout the course to illustrate these principles as well as their application to design. Process synthesis concepts are introduced via discussion of reaction path synthesis and separation task selection. Co-requisites: 09-105, 09-101 and 21-121.

06-151
Thermodynamics **Fall: 12 units**
The objective of this course is to introduce students to the basic concepts of chemical thermodynamics. Topics include temperature and thermometry; work, heat, and the first law; pressure-volume-temperature behavior; heat capacities , phase changes, heat of reaction,enthalpy-concentration relations; the second law, absolute temperature, entropy; thermodynamics properties, Helmholtz and Gibbs functions, Maxwell relations, generalized correlations; application of first and second laws to processes important in chemical processing; flow processes, conversion of heat into work by power cycles and refrigeration. Prerequisites: 33-106 and 06-100 (or concurrently).

06-152
Principles of Transport Processes I **Spring: 9 units**
This course covers fluid dynamics and conductive heat transfer. The principles of fluid statics and dynamics are presented and applied to problems such as flow in conduits, flow around submerged objects, turbulence, and flow measurement. Principles of heat transfer are introduced and steady state heat conduction in various geometries is discussed. Prerequisite: 06-100, 21-259, 06-155 concurrently.

06-155
Chemical Engineering Mathematics I **Spring: 6 units**
Mathematical techniques for the solution of ordinary differential equations are introduced using examples relevant to chemical engineering: linear and non-linear first-order equations, higher-order linear equations with constant coefficients, Cauchy-Euler equations, nonhomogeneous equations, variation-of-parameters method, Laplace- and Fourier-transform methods, power-series method, numerical methods. Prerequisites: 21-122 and 06-151.

06-156
Chemical Engineering Mathematics II **Fall:6 units**
Statistical analysis of experimental data and mathematical techniques for the solution of partial differential equations are introduced using examples relevant to chemical engineering: Gaussian distributions and uncertainty in the mean, uncertainty in calculated values, uncertainty in regression coefficients, confidence intervals; boundary-layer singularity, similarity transforms, separation of variables, numerical methods. Prerequisites: 21-259 and 06-155.

06-201
Principles of Transport Processes II **Fall: 9 units**
The fundamentals of heat and mass transfer are covered, including unsteady conduction and diffusion, convection, and thermal radiation. Prerequisites: 06-152, 06-155.

06-202
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. Prerequisites: 06-201, 06-204.

06-204
Chemical Engineering Thermodynamics **Spring: 6 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, equilibrium conversions, and Gibbs energy minimization. Prerequisites: 06-100 and 06-151.

06-205
Chemical Engineering Process Control **Fall:6 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. Prerequisite:06-204

06-211
Transport Processes Laboratory **Spring: 6 units**
A series of laboratory experiments to 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 emphasized. Prerequisites: 06-152 and 06-201

Course Descriptions

06-300
Projects — **Fall or Spring: variable 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 for review by the academic advisor of the student. Usually a final written report and an oral presentation of the results are required. Prerequisite: Permission of the faculty supervisor.

06-301
Chemical Engineering Kinetics — **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. Prerequisite: 06-202.

06-302
Process Engineering and Synthesis — **Fall: 12 units**
Screening of processing alternatives. Computational strategies for doing preliminary material and heat balances in large chemical processes. Preliminary sizing of process equipment. Cost estimation and evaluation for chemical plants. Strategies for synthesizing energy networks and separation sequences. Preliminary design of a large industrial project. Prerequisites: 06-202, 06-204; 06-301 concurrently.

06-303
Design Project — **Spring (mini session I): 6 units**
Computer-aided design of a large industrial project involving synthesis of process, heat and material balances and economic evaluation. Extensive report on the project must be submitted. Prerequisite: 06-302.

06-304
Economics and Optimization — **Spring (mini session II): 6 units**
Mathematics of cost comparison, including interest, taxes, depreciation, profitability and inflation. Unconstrained and constrained optimization techniques including multivariable search and linear programming. Prerequisite: 06-303.

06-305
Process Dynamics and Control — **Spring: 9 units**
Principles of dynamic response applied to simple systems. Goals and modes of control; Laplace transformations; representation, analysis and synthesis of simple control schemes; closed loop response; dynamic testing; role of modern computing machinery in process control. Prerequisites: 06-156, 06-202.

06-306
Applied Problems in Chemical Engineering — **Spring: 9 units**
Analysis of problems involving various elements of processing equipment. Optimum sizing of units; selection of operating conditions and methods; prediction of performance. Interaction of process principles. Course is designed particularly for students desiring additional work in the applied aspects of engineering. Prerequisite: 06-202.

06-308
Chemical Engineering Seminar — **Fall : 3 units**
A senior level course that emphasizes the planning, preparing, and delivering of oral reports for laboratory experiments, independent research and design projects in chemical engineering. Prerequisite: 06-211.

06-310
Transport Phenomena — **Spring: 9 units**
Transport processes from an advanced point of view. Review of vector analysis and the divergence theorem. Concept of a continuum; equation of linear momentum; stress tensor; Newtonian and non-Newtonian fluids; Navier-Stokes equations; introduction to turbulent flow; Fourier's and Fick's laws; convective flow of heat and mass. Prerequisites: 06-152, 06-201.

06-311
Unit Operations Laboratory — **Fall: 9 units**
A series of laboratory courses designed to illustrate the principles of unit operations or process control.Compared with 06-211, experiments tend to be more complex and are chosen on the basis of industrial relevance. Examples include a pilot-scale bubble-cap tray tower for distilling mixtures of methanol and water; a packed tower for stripping ammonia from air by contact with water; PID control of the temperature of water heated by steam in a heat exchanger; and a hollow-fiber membrane for separating oxygen and nitrogen in air. Oral and written reports are emphasized.Prerequisites: 06-202 and 06-205.

06-313
Experimental Colloid and Surface Science — **Fall: 9 units**
Laboratory exercises will deal with preparation and stabilization of colloids, flocculation, micellar aggregates, surface tension, contact angle, spreading and adsorption. Basic concepts will be related to practical problems of wetting, lubrication, foaming, adhesion, coatings and corrosion. Prerequisites: 09-131 and 06-607

06-314
Experimental Polymer Science — **Spring: 9 units**
Macromolecular behavior in bulk and in solution will be explored in experiments on tensile strength, elasticity, swelling of networks, solution viscosity, melt flow, and polymerization reactions. Particular reference will be made to aspects affecting production and fabrication of polymeric materials. Prerequisites: 09-131 and 06-609.

06-317
Problems and Prospects of Environmental Quality — **Spring: 9 units**
A problem-oriented course intended for juniors and seniors from all departments of CIT. Readings, class discussions, and visiting lecturers will be used to develop a general perspective for environmental problems. Approximately one-third of the semester will be spent on each of three problem analyses: regional problems of air and water pollution and problems caused by the internal combustion engine. Student teams will be organized, and each team will perform specific problem definitions, invent and analyze alternative solutions, and evaluate costs and prospects for implementing those solutions. Each student is expected to apply the perspective and methods of his major discipline.

06-606
Computational Methods for Large Scale Process Design and Analysis — **Fall: 9 units**
This course deals with the underlying computer-aided design techniques for steady state and dynamic simulation, numerical solution and decomposition strategies for large systems of sparse nonlinear algebraic equations, stiff ordinary differential equations, strategies for mixed algebraic/differential systems and computer architectures for flowsheeting systems. Prerequisites: 06-202, 06-156.

06-607
Physical Chemistry of Colloids and Surfaces — **Spring: 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; colloid stability, flocculation kinetics, micelles, electrokinetic phenomena and emulsions. Prerequisites: 06-151, 09-245 or equivalent.

06-608
Safety Issues in Science and Engineering Practice — **Fall: 3 units**
This course will expose students to personal safety issues encountered in normal science and engineering practice. Topics to be discussed include mechanical, electrical, chemical, radiation , and biological hazards to provide an awareness of these hazards and to inform students of appropriate action to be taken in the event of accidents.

06-609
Physical Chemistry of Macromolecules — **Fall: 9 units**
This course develops fundamental principles of polymer science at an introductory level. Emphasis is placed on physical chemical concepts associated with the macromolecular chain nature of polymeric materials. Engineering aspects of the physical, mechanical and chemical properties of these materials are discussed in relation to chain microstructure. Topics include an historical introduction to polymer science and a general discussion of commercially important polymers; chain structure and molecular weight; condensation and addition synthesis mechanisms with emphasis on molecular weight distribution (MWD); methods for determining MWD; dilute solution thermodynamics and chain conformation; rubber elasticity; introduction to semi-concentrated systems; review of Newtonian fluid mechanics and linear elasticity; flow phenomena in polymeric systems; polymer processing; introductory aspects of polymer rheology; glass transition and introductory crystallization. Prerequisite: 09-246 or equivalent, or permission of instructor.

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 IC process engineering. Topics include elementary theory of semiconductor devices; adsorption and reaction on semiconductor surfaces; process principles in crystal growth, diffusion, oxidation, and vapor deposition. Prerequisites: 06-301, 09-245 or equivalent, or permission of instructor.

Graduate Courses

The following graduate courses are available to undergraduate students who have appropriate prerequisites and permission of the instructor. Descriptions of these and other graduate courses may be found in the graduate catalog.

06-701	Equilibrium Stage Process
06-702	Advanced Reaction Kinetics
06-703	Advanced Fluid Dynamics
06-704	Advanced Heat and Mass Transfer
06-705	Advanced Chemical Engineering Thermodynamics
06-708	Advanced Process Dynamics and Control
06-709	Polymeric Materials
06-710	Molecular Theory of Transport Phenomena
06-711	Polymeric Materials Laboratory

06-712 Colloids and Dispersions
06-713 Mathematical Techniques in Chemical Engineering
06-714 Surfaces and Adsorption
06-715 Advanced Process Synthesis
06-716 Electrochemical Engineering
06-717 Fermentation Technology
06-718 Underground Processing
06-720 Advanced Process System Engineering
06-815 Special Topics in Advanced Process Systems Engineering
06-902 Advanced Topics in Heat and Mass Transfer
06-903 Advanced Topics in Fluid Mechanics
06-904 Advanced Mathematical Applications
06-905 Advanced Colloid and Surface Phenomena

Chemistry

Undergraduate Courses

09-101
Introduction to Experimental Chemistry **Fall: 3 units**
Students gain experience in fundamental laboratory skills and techniques (e.g., keeping a detailed laboratory notebook, weighing, titrating, pipetting) as well as the operation and use of equipment commonly found in a chemistry laboratory (e.g., electronic balance, pH meter, centrifuge, spectrophotometer). The experiments provide an opportunity to apply basic theory and principles to practical applications in the laboratory. Experiments include examples of polymer synthesis and qualitative and quantitative analysis. Prerequisite: 09-105 (may be taken concurrently).

09-103
Atoms, Molecules, and Chemical Change **Fall: 9 units**
This one semester course is designed for non-science majors who have had a high school course in chemistry. Major topics include: measurements, matter and energy, atomic theory, chemical bonding, quantitative relationships in chemical reactions, gases, acid/base theory, and properties of aqueous solutions. Some of the physical concepts that will be covered include reaction rates, chemical equilibrium, radioactivity, oxidation and reduction, and buffer solutions. 3 hrs. lec., 1 hr. rec.

09-104
Fundamental Aspects of Organic Chemistry and Biochemistry **Spring: 9 units**
This course is designed to follow 09-103 for non-science majors although it is possible for students with a good high school chemistry course to enter directly into 09-104. The course covers the structure, nomenclature and properties of organic molecules at a depth required to understand the function of lipids, carbohydrates, proteins and nucleic acids. Considerable emphasis is given to an understanding of structural and stereoisomerism and their importance in biochemical processes. Ecological processes are also covered in some detail. 3 hrs. lec., 1 hr. rec.

09-105
Modern Chemistry I **Fall or Spring: 10 units**
This course begins with a survey of the principles of stoichiometry, solution chemistry, and elementary kinetic theory of gases in order to give students an appreciation of the experimental basis of chemistry. The major emphasis in the course deals with the structure of matter and covers the principles of atomic structure, chemical bonding and molecular structure. Fascinating advances are currently being made in chemistry and students should acquire enough background in this course to make intelligent interpretations of recent research work. 3 hrs. lec., 2 hr. rec.

09-106
Modern Chemistry II **Fall or Spring: 10 units**
The course provides an introduction to some basic concepts of chemical equilibria and thermodynamics. Topics include gas phase equilibria, acid-base chemistry, solubilities, oxidation- reduction reactions, enthalpy, entropy, free energy, colligative properties and electrochemistry. Chemical kinetics is introduced to complement the study of thermodynamics. 3 hrs. lec., 2 hr. rec. Prerequisite: 09-105.

09-111/2
Undergraduate Seminar I, II **Fall/Spring: 1 unit**
Issues and topics of importance to beginning chemistry majors are discussed in this course. It provides a general introduction to the facilities and faculty of the Chemistry Department and covers career and research opportunities in the field of chemistry. Some pointers on how to organize and present an effective seminar on a topic in chemistry are given. Students attend and evaluate seminars of fourth-year students. 1 hr.

Course Descriptions

09-117
Organic Chemistry I **Fall: 9 units**
This course presents an overview of structure and bonding as it pertains to organic molecules. Selected topics include: introduction to functional group chemistry, stereochemistry, conformational analysis, reaction mechanisms and use of retrosynthetic analysis in the development of multistep syntheses. Methods for structure determination of organic compounds by modern spectroscopic techniques are introduced. 3 hrs. lec., 1 hr. rec. Prerequisite: 09-105.

09-131
Experimental Techniques in Chemistry I **Fall or Spring: 10 units**
This course serves as the first in the sequence of four laboratory courses on experimental techniques in chemistry. A significant portion of the course involves experiments in which students develop quantitative analytical skills. Acid-base and redox titrations are covered along with spectrophotometric analyses and kinetics. Students are also introduced to common synthetic and purification techniques. 1 hr. lec., 6 hrs. lab. Prerequisites: 09-105 and 09-106 (or 09-206), or consent of instructor.

09-132
Experimental Techniques in Chemistry II **Spring: 10 units**
This second course in the laboratory sequence is devoted to experiments illustrating important methods used in organic synthesis together with applications of gas chromatography, infrared, ultraviolet and nuclear magnetic resonance spectroscopy to the characterization of organic compounds. 1 hr. lec., 6 hrs.lab. Prerequisites: 09-131, 09-117, 09-218 concurrently.

09-144
Physical Chemistry **Spring: 9 units**
This is a one-semester course intended primarily for students in Biological Sciences, students in the B.A. degree program in Chemistry, and students from other departments interested in pursuing graduate studies in the health professions. Topics include an introduction to formal chemical thermodynamics; applications of thermodynamics to chemical and biochemical equilibria, electrochemistry, phase equilibria, solutions, surfaces, and chemical and enzyme kinetics. 3 hrs. lec. Prerequisites: 09-105 and 09-106 (or 09-206), 21-122, 33-122, or consent of instructor.

09-151
Honors Seminar **Fall or Spring: 2 units**
This course is mostly devoted to a survey of the current areas of important research in the field of chemistry. Included are problems under investigation by the faculty of the Chemistry Department. The course may be combined with graduate course 09-700, Introduction to Chemical Research.

09-206
Physical Principles of Analytical Chemistry **Fall: 9 units**
This course provides an in-depth understanding of the important physical principles used in analytical chemistry. Fundamental concepts of physical chemistry will be covered that explain the procedures used in the separation and analysis of a variety of gas, liquid and solid chemical systems. Topics will include thermodynamic relationships in analytical chemistry, solution equilibria, theory of separations and chromatography, phase equilibria, mobility and rates, acid-base equilibria, metal-complex equilibria, solubilities and redox equilibria. 3 hrs. lec., 1 hr. rec. Prerequisites, 09-105, 21-122, 33-122, or consent of instructor.

09-211/2
Undergraduate Seminar III, IV **Fall/Spring: 1 unit**
Students evaluate seminars of fourth year students. Attendance at the seminars familiarizes the student with special topics in chemistry . The course points out what should be included in a good seminar. 1 hr.

09-218
Organic Chemistry II **Spring: 9 units**
This course further develops many of the concepts introduced in Organic Chemistry I, 09-117. Emphasis is placed on the utilization of reaction mechanisms for understanding the outcome of chemical transformations, and the recruitment of a wide variety of functional groups and reaction types in the synthesis of organic molecules. Also included in the course will be special topics selected from the following; polymers, heterocyclic compounds and biomolecules such as lipids, carbohydrates, amino acids and proteins. 3 hrs lec., 1 hr rec. Prerequisite: 09-117.

09-231
Experimental Techniques in Chemistry III **Fall: 12 units**
This third course in the laboratory sequence is an advanced synthesis course covering a variety of synthetic methods including vacuum and inert atmosphere methods to prepare organic, inorganic, organometallic, and polymeric compounds. Methods may involve resolution procedures to prepare optically active compounds, separation of mixtures and isolation of products by use of column and thin-layer chromatography, sublimation and extraction techniques. Experiments on characterization and identification by chemical and spectroscopic methods form an important part of the course. Use of the chemical literature is included. 2 hr. lec., 6 hrs. lab. Prerequisites: 09-132, 09-218.

Course Descriptions

09-232
Experimental Techniques in Chemistry IV — **Spring: 12 units**
The terminal course in the laboratory sequence is devoted to physical chemistry experiments which involve the use of modern instrumentation. The experiments include the use of vacuum techniques, high resolution infrared spectroscopy, laser light scattering, and emission spectroscopy. Experiments that involve the measurement of electric and magnetic susceptibilities, heat capacities of gases, phase equilibria and enzyme-catalyzed reaction rates are also in the course. 1 hr. lec., 8 hrs. lab. Prerequisites: 09-131, 09-246 concurrently.

09-244
Physical Chemistry I:
The Physical Chemistry of Macroscopic Systems — **Spring: 9 units**
The measurement and theoretical descriptions of the equilibrium properties of chemical systems are presented. Chemical thermodynamics is introduced at the upper division level. The phases of matter are discussed. The quantitative treatment of mixtures is developed. The detailed description of chemical equilibrium is elaborated. The measurement and theoretical description of the nonequilibrium properties of chemical systems are presented. Elementary transport properties are introduced. The principles of classical chemical kinetics are developed in great detail. 3 hrs lec., 1 hr rec. Prerequisites: 09-106, 21-259

09-245
Physical Chemistry II:
The Microscopic Basis of Chemical Structure — **Fall: 9 units**
The measurement and theoretical description of the properties of atoms and molecules are presented. The elementary principles of quantum chemistry are developed. The many types of spectroscopy used to study atoms and molecules are described. Methods of atomic structure determination are discussed. The structure and properties of solids are also presented. The basic results of statistical chemistry are outlined. The microscopic basis of chemical reactions rates is discussed. 3hr. lec. 1 hr rec. Prerequisites: 09-105; 21-259; 21-260 or 06-155

09-246
Physical Chemistry III: Statistical Chemistry — **Spring: 9 units**
The methods of statistical mechanics are used to calculate the macroscopic equilibrium and transport properties of chemical systems from the microscopic properties of atoms, molecules, and solids. The microscopic basis of pressure and temperature is presented. The fundamental thermodynamic functions, such as energy and entropy, are calculated from a knowledge of the quantum states of the system. Chemical equilibrium is developed from a microscopic perspective and the equilibrium constant is calculated from a knowledge of the energy states of the atoms and molecules. The phase behavior of single component systems is calculated from a knowledge of the intermolecular potential energy. The colligative properties and solution phase behavior of mixtures are calculated from the intermolecular potential energies. The transport properties of gases are calculated in terms of the collisions of particles. The transport properties of liquids and solutions are calculated in terms of Brownian motion of the solute particles. The microscopic theory of chemical reaction rates is developed for both gas phase and solution phase systems. 3 hrs. lec. Prerequisites: 09-245, or consent of instructor.

09-248
Inorganic Chemistry — **Fall: 10 units**
This course is generally suitable for juniors. The central issues are the study of the structure, theories of bonding, and reaction chemistry of inorganic compounds. Special attention is given to the fundamental concepts of inorganic chemistry and the language used to convey these concepts. Symmetry and point groups are a recurrent theme throughout the course. The concepts of isomerism and selectivity are presented in detail. Descriptive chemistry is an underlying theme receiving specific attention for several p-block elements. Crystal field, ligand field, and molecular orbital treatments of complex ions are presented. 3 hrs. lec., 1 hr. rec. Prerequisite: 09-117.

09-411
Undergraduate Seminar V — **Fall or Spring: 1 unit**
Attendance at the seminars of fourth-year students familiarizes the student with special topics in chemistry. Students evaluate speakers and begin to plan their own seminars. 1 hr.

09-412
Undergraduate Seminar VI — **Fall or Spring: 3 units**
Each student presents a thirty minute oral report on a current topic in chemistry. Thoroughness in the use of the chemical literature is emphasized. 1 hr.

09-441
Nuclear and Radiochemistry — **Spring: 9 units**
This course is designed for upper level science and engineering students, and provides an introduction to the fundamentals and applications of nuclear phenomena. Among the topics discussed are the systematics of stable and unstable nuclei, nature and energetics of radioactivity, detection and measurement of nuclear radiation, tracer techniques in chemical applications, nuclear processes as chemical probes, and nuclear energy. 3 hrs. lec. Prerequisite: 09-246 or equiv.

09-445
Undergraduate Research — **Fall or Spring: 6-12 units**
Properly qualified students may undertake research projects under the direction of members of the faculty. 6 to 12 hrs. A written, detailed report describing the project and results is required. Prerequisite: Consent of the instructor.

09-455
Honors Thesis — **Fall and Spring: 6 or 15 units**
Students enrolled in the departmental honors program are required to enroll in this course to complete the honors degree requirements. A thesis written in an acceptable style describing an original research project, and a successful oral defense of the thesis topic before an honors committee are required. Limited to students accepted into the honors program. (B.S. Honors candidates nromally enroll for 6 units; B.S./M.S. candidates enroll for 15 units.)

09-502
Organic Polymer Chemistry — **Spring: 9 units**
A study of the synthesis and reactions of high polymers. Emphasis is on practical polymer preparation and on the fundamental kinetics and mechanisms of polymerization reactions. Topics include: relationship of synthesis and structure, step-growth polymerization, chain-growth polymerization via radical, ionic and coordinate intermediates, thermodynamics of polymerization, discussions of important specialty polymers and reactions of polymers. 3 hrs. lec. Prerequisite: 09-218.

09-505
Polymer Rheology — **Fall: 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 on structure of viscosity, viscoelasticity, and plasticity failure. The role of rheological properties in characterization, testing, fabrication, and use of polymeric materials. 3 hrs. lec. Prerequisites: 09-105 (or 09-107)and 09-106 (or 09-206), 33-122, or consent of instructor.

09-509
Physical Chemistry of Macromolecules — **Fall: 9 units**
The nature of the chemical, mechanical, optical, and other properties of polymeric materials is discussed in relation to their molecular and supermolecular structure. Dilute solutions of macromolecules. Structure, size and conformation of polymer molecules. The crystalline state in polymers. Glass transition. Rheology. Mechanical failure. Processing of polymers. 3 hrs. lec. Prerequisite: 09-245 or consent of instructor.

09-510
Introduction to Environmentally Benign Chemistry — **Spring: 9 units.**
This course covers emerging chemical and biological approaches to environmentally benign chemistry. Topics include: environmental toxicology, metabolism of xenobiotics, mechanisms of chemical carcinogenesis and mutagenesis, and factors influencing toxicity. The course considers the chemical nature and action of pollutants of the atmosphere, land, and water sources, prospects for their minimization, and approaches to their remediation. Prerequisites: Organic Chemistry I (09-117), or with permission of instructor.

09-511
Solid State Materials Chemistry — **Spring: 9 units**
The course will interface general principles in solid state physics and chemistry as applied to novel organic and inorganic materials. The general focus of the course will be on electronic materials. Specific topics to be covered include: solid state structures, the free electron model, energy bands (Bloch theory, tight binding model, etc.) and electrical conductivity. Techniques for defining both the electronic and physical structures and properties of solids will be discussed throughout the course. Magnetic and optical properties of some organic and inorganic materials will be covered. Prerequisites: 09-218, 09-245

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 catalysts for industrial processes and organic synthesis. (The course may be taken for 12 units at the graduate level, for which a written report on an assigned literature topic is required.)

09-522
Oxidation and Inorganic Chemistry. — **Fall: 9 units**
The roles of metal complexes in oxidation processes (inorganic, organic, biological) will be presented. Special attention is given to processes involving the activation of molecular oxygen from a mechanistic viewpoint. The electronic structures of metal complexes of dioxygen and its reduced species superoxide, peroxide, and oxide are reviewed, as are the relationships between electronic structure and oxidation reactivity. Prerequisite: 09-248. (The course may be taken for 12 units at the graduate level, for which a written report on an assigned literature topic is required.)

09-541
Spectroscopy
This course provides an introduction both to modern optical spectroscopic techniques and to the types of scientific problems currently being investigated with these methods. Prerequisites: 09-244 and 09-245.

09-552
Introduction to Magnetic Resonance Spectroscopy **Fall: 9 units**
The phenomenon of magnetic resonance spectroscopy is described by resorting to classical vector models and a simple quantum picture. The origin and interpretation of the chemical shift, spin-spin coupling constants, and nuclear relaxation are presented. Fourier spectroscopy in one and two dimension is discussed. Applications to chemical structures and to the dynamics of simple and complex mechanisms are explored. Examples stemming from inorganic, organic, and biochemical systems will be discussed. Prerequisites: Physical Chemistry I and II (09-244 and 09-245), or equivalent courses in physics and engineering, or with permission of instructor.

09-560
Computational Chemistry **Spring: 12 units**
Computer modeling is playing an increasingly important role in chemical research. This course will provide an overview of computational chemistry techniques including molecular mechanics, molecular dynamics and both semi-empirical and ab initio electronic structure theory. Sufficient theoretical background will be provided for students to understand the uses and limitations of each technique. An integral part of the course will be hands on experience with state-of-the-art computational chemistry tools running on graphics workstations. 4 hrs. lec. Prerequisites: 09-245 and 15-125 (or 15-127), or with permission of instructor.

09-601
Principles of Chemical Instrumentation **Fall or Spring: 9 units**
Introductory course into the fundamentals behind modern laboratory instruments and their operation. Students will learn how to read schematics and how to use modern electronic components to build basic blocks of instrumentation in the chemistry laboratory. Theoretical background will be presented in short lectures and notes, but the "hands on" approach will be emphasized around a number of laboratory measurements and small projects. As an example students will build a sensitive electronic voltmeter which can be used for bridge measurements and measurement of pH. They will learn how to use operational amplifiers and how to apply negative feedback. In connection with the usage of modern oscilloscopes they will build a linear timebase and learn the principles of A/D conversion. Project on synchronous detection will enable them to understand the operation of commercial lock-in amplifiers and the detection of signals in NMR and IR spectroscopy. A section on frequency measurement will expose the students to frequency translation, division and counting. One section will be devoted to R.F. circuitry where the concept of tuned filters, transmission lines and impedance matching will be explored with the use of network analyzer. Another section will deal with the digital circuits as building blocks of modern computers. Finally, spectral analysis as used in NMR and IR will be performed on a P.C. or on a laboratory computer. Graphic presentation of the individual steps will facilitate the understanding of such concepts as data acquisition, fast Fourier transform, convolution and correlation, and the basic ideas behind digital filtering.

38-669
Biophysics I: Principles and Methods **Fall: 9 units**
09-569 and 09-570 constitute a two-semester sequence. Both courses deal with the biophysical principles and methods for the determination and description of structure and dynamic behavior of biomolecular systems. The principles are mainly based on spectroscopy and optics. Although the treatment is formally rigorous, the level is introductory. The foundations of Fourier analysis are discussed in parallel with biophysical applications. The physical techniques of microscopy and polarized light analysis are described followed by a series of dynamical techniques including absorption, dispersion, correlation and transient response methods. The Laplace transform is introduced in relation to the kinetic and relaxation properties of biological macromolecules. Examples will deal with the properties of proteins, enzymes and nucleic acids. 3 hrs. lec. Prerequisite: Senior standing in the sciences or engineering or consent of instructor.

38-670
Biophysics II: Structure and Dynamics **Spring: 9 units**
The physical basis of scattering experiments in biology is introduced. Emphasis is placed on the Fourier optical approach of linear systems. Diffraction methods are described in some detail. The structure analysis of biological molecules is presented with a historical prospective beginning with x-ray diffraction patterns of the fibrous proteins and including helical and lamellar diagrams. The elements of protein crystal structure analysis is given. Progress in the structure determination of important biological complexes such as chromatin, viruses and the ribosomes will be discussed. Some aspects of advanced imaging will be treated as time permits. 3 hrs. lec. Prerequisite: Senior standing in the sciences or engineering or consent of instructor.

Course Descriptions

Graduate Courses

The following graduate courses are available to undergraduate students who have appropriate prerequisites and permission of the instructor. Descriptions of these and other graduate courses may be found in the graduate catalog of the Chemistry Department.

09-701	Quantum Chemistry I
09-702	Statistical Mechanics and Dynamics
09-703	Chemical Thermodynamics
09-704	Chemical Kinetics
09-708	Quantum Chemistry II
09-709	Quantum Chemistry III
09-711	Physical Organic Chemistry
09-712	Synthetic Organic Chemistry
09-717	Organotransition Metal Chemistry
09-721	Physical Inorganic Chemistry
09-722	Oxidation and Inorganic Chemistry
09-723	Theoretical Inorganic Chemistry
09-731	Radiochemistry
09-732	Nuclear Chemistry
09-741	Organic Chemistry of Polymers
09-742	Physical Chemistry of Polymers
09-745	Polymer Rheology
09-746	Linear Viscoelasticity
09-751	NMR: Technique, Instrumentation and Signal Processing
09-752	Magnetic Resonance Spectroscopy

Civil and Environmental Engineering

Undergraduate Courses

12-101
Innovation and Design in Civil Engineering **Spring or Fall: 12 units**
An overview of engineering in general and discussion of the complexities of civil engineering projects from inception to completion. The first part introduces the working media of engineers (energy and materials), and the characteristic forms of engineering design (mechanisms, structures and systems). The basic principles of solid and fluid mechanics will be emphasized and illustrated with laboratory demonstrations to provide an understanding of the use and role of analysis courses that follow in the curriculum. The second part applies the basic principles to open-ended engineering problems with emphasis on problem definitions and creative development of alternative solutions. The relations of economy, form and beauty, and those pertaining to production, reproduction and evolution of design, will be discussed. Student projects will be coupled with class discussions. 2 hrs. lecture, 2 hrs. recitation/laboratory. Co-requisites: 21-121 and 33-106.

12-207
Statics and Kinematics **Fall: 9 units**
Introduction to vector mechanics; kinematics of simple rigid bodies; equivalent systems of forces; equilibrium of rigid bodies; distributed forces; hydrostatics; effective forces; centroids and moments of inertia; friction; applications to simple trusses, cables and other physical systems. 3 hrs. rec. Prerequisites: 21-122, 33-106.

12-208
Dynamics **Spring: 9 units**
Equations of motion; principles of work and energy; impulse and momentum; elements of mechanical vibrations, examination of nonlinear solutions and other applications. 3 hrs. rec. Prerequisite: 12-207.

12-212
Solid Mechanics **Spring: 12 units**
Analysis of deformable bodies incorporating concepts of equilibrium, force-deformation and geometric compatibility; definitions and Mohr's circle representations of stress and strain; stress-strain-temperature relationships; torsion of solid and hollow, thin-walled shafts; stresses and deformations due to bending and combined bending, axial load and torsion. Laboratory experiments and reports associated with theoretical concepts. 2-1/2 hrs. rec., 2 hrs. lab. Prerequisite: 12-207.

12-241
Introduction to Computer Applications in Civil Engineering **Fall: 9 units**
Introduction to the use of computer-based applications in Civil Engineering, using generic tools such as spread-sheets, equation solvers and computer graphics. Introduction of automated laboratory data acquisition and processing. Development of problem formulation skills in civil engineering, involving linear algebra, linear programming, network analysis, critical path scheduling, and others. Discussion of the role of computer-based methods in civil engineering practice. Pre-requisite: 21-121, 33-121.

Course Descriptions

12-310
Engineering Economics **Spring: 9 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 alternative. Uncertainty and risk in operation and financing. Important factors affecting investment decisions for private and public projects. Prerequisite: 21-121 and Junior standing.

12-315
Materials **Spring: 9 units**
An introduction to applied materials science with consideration of phenomena of elasticity, plasticity and fracture mechanics. Properties of cements, structural steels, concrete mixes, and reinforced plastics. Selection of materials for design. 3 hrs. rec. Prerequisites: 09-105, 33-107.

12-320
Structural Mechanics I **Fall: 9 units**
Introduction to analysis of statically determinate structures. Shear and bending moments in beams and frames; axial forces in trusses, cables and arches; deflections and influence lines; moment distribution method and approximate analysis of statically indeterminate structures. Laboratory demonstration and computer simulation of structures subjected to various loading conditions. 3 hrs. rec. Prerequisite: 12-212.

12-325
Soil Mechanics **Spring: 12 units**
Sampling, testing and identification of soils. Physical, chemical and hydraulic characteristics. Stress-strain-strength relationships for soils. Permeability, seepage, consolidation, and shear strength with applications to deformation and stability problems, including earth dams, foundations, walls and slopes. 3 hrs. rec., 3 hrs. lab. Prerequisites: 12-212, 12-331.

12-331
Fluid Mechanics **Fall: 12 units**
Fluid characteristics; continuity, momentum, and energy equations; dynamic similitude; laminar and turbulent boundary layers; flow in pipes; lift and drag on immersed bodies. Laboratory experiments illustrating the basic principles. 3 hrs. rec., 1 hr. lab. Prerequisite 21-259 and 12-208.

12-400
Civil Engineering Design **Fall: 12 units**
Methods of problem identification, definition and formulation applied to the field of civil engineering. Development of the ability to synthesize innovative solutions to realistic open-ended problems and to evaluate feasible alternatives. Participation in several student projects will reinforce the lectures on design methodology and allow students to pursue their own specialty in greater depth. Project reports and oral presentation form an integral part of the course to reflect professional practice. 2 hrs. rec., 2 hrs. lab. Prerequisite: Senior standing in Civil Engineering.

12-607
Project Management for Construction **Fall: 9 units**
Introduction to construction project management from owner's perspective in organizing planning, design, construction and operation as an integrated process. Examination of labor productivity, material management and equipment utilization. Cost estimation, economic evaluation and financing of constructed facilities. Contracting, construction planning and fundamental scheduling procedures. Cost control, monitoring and accounting for construction. 3 hrs. rec. Prerequisites 36-211, or equivalent.

12-609
Traffic Flow Theory and Operations **Fall: 9 units**
Consideration of mathematical models of traffic flow phenomena including deterministic and probabilistic models for queuing, car-following theory and hydrodynamic theories of traffic flow, stream characteristics of volume, density, speed and headways and application to operation and control strategies and simulation. Applications of the theory to the analysis of intersections and transportation planning are presented as well as the role of new technologies in data collection, modeling and traffic control. 3 hrs. rec. Prerequisite: 36-211 or equivalent.

12-621
Structural Mechanics II **Spring: 9 units**
Energy principles in structural mechanics. Basic concepts of force and displacements methods for analyzing redundant structural systems. Matrix methods utilizing the flexibility and stiffness concepts, with emphasis on the direct stiffness method. 3 hrs. rec. Prerequisite: 12-320.

12-623
Structural Design **Fall: 12 units**
Selection, development, and proportioning of design solutions for structural systems. Exercises include synthesis of system geometry, interaction with other design requirements, and practice of modeling and analysis. Proportioning is treated for member design in steel and in reinforced concrete. 4 hrs. rec. Prerequisite: 12-315, 12-320.

12-627
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. Prerequisite: 12-325.

12-630
Design and Construction **Spring: 9 units**
Introduction to steel, concrete, wood, and masonry construction methods and material selection; integration of design and constructability criteria; conformance of designs to applicable building and fire codes; preparation of plans and specifications; laboratory demonstration and experiments. 9 hrs. lab. Prerequisites or concurrent: 12-315, 12-320, permission of instructor.

12-632
Water Resources Engineering **Spring: 9 units**
Principles and applications of open channel flow. Hydrology of surface and groundwater sources and the estimation of water requirements. Planning and design of water distribution and wastewater and stormwater collection systems. 3 hrs. rec. Prerequisite: 12-331.

12-634
Water Quality Engineering Laboratory **Spring: 3 units**
Examination of water quality using titrimetric, spectrometric, potentiometric and reductive/oxidative techniques. Illustration of principles of dilute aqueous chemistry and processes for affecting water quality. 3 hrs. lab. Prerequisite: 12-635 concurrently or permission of instructor.

12-635
Water Quality Engineering **Spring: 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 application of these concepts to a description of water quality chances that may occur in treatment processes and in natural-water environments including water and wastewater treatment systems and groundwater. 3 hrs. rec. Prerequisite: 09-105.

12-636 (42-636)
Environmental Engineering: Air Pollution **Fall: 9 units**
Problems and methodologies for studies of environmental management, with an emphasis on air pollution; characterization of pollutant sources; behavior of aerosol and gaseous pollutants in the atmosphere; micrometeorology as it relates to pollutant transport; human health effects, focusing on the respiratory system; methods of air pollutant measurement; statistical treatment of data; regulation of air pollutants, including procedures by which standards are developed and enforced by regulatory agencies. Prerequisite: 12-330 or equivalent. 3 hrs. rec.

12-640
Computer-Aided Tools for Civil Engineers **Spring: 9 units**
Use of computer-aided engineering and design tools in various areas of civil engineering. Analysis and design problems will be drawn from project management and structural, geotechnical and environmental engineering. Role of computer-aided tools in problem-solving, analysis and design. Criteria for selection of computer hardware and software for civil engineering practice. Pre-requisites: Senior Standing in Civil Engineering.

12-645
Independent Study **Fall or Spring: 3 to 12 units**
In-depth investigation of a special topic in Civil Engineering under the direction of a faculty member . The topic usually involves open-ended problems whose solution requires some elements of syntheses, analysis, construction, testing and evaluation of an engineering device or system. Prerequisite: Senior standing in Civil Engineering.

12-647
Civil Engineering Project Seminar **Spring: 3 units**
Seminar for discussion and selection of a senior project, which must be designed to integrate one or more aspects of engineering practice such as planning, analysis, design and construction. The project will be conducted, either individually or via a team approach, in the following semester (12-648) with the advice and approval of the course instructor. 1 hr. rec. Prerequisite: Junior standing in Civil Engineering.

12-648
Civil Engineering Project **Fall: 9 units**
The development of a student-initiated project integrating some aspects of engineering practice. Each project involves the planning, synthesis and investigation of a device, system or process to meet desired needs under the supervision of the faculty. Periodic oral presentations and a comprehensive written report of the completed project are required. Prerequisite: Senior standing in Civil Engineering.

Graduate Courses

The following graduate courses are available to undergraduate students who have appropriate prerequisites and permission of the instructor. Descriptions of these and other graduate courses may be found in the graduate catalog of Civil and Environmental Engineering.

12-702	Infrastructure Management
12-704	Probability and Estimation Methods for Engineering Systems
12-705	Advanced Techniques in Project Management
12-706	Public Investment Planning and Pricing
12-710	Management and Practice for Environmental Engineering
12-712	Robotics in Civil Engineering
12-713	Special Topics in Engineering Planning and Management
12-720	Water Resources Chemistry
12-721	Groundwater Hydrology and Chemistry
12-722	Wastewater Treatment: Design and Practice
12-724	Advanced Topics in Air Pollution
12-725	Organic Compounds in Aquatic Systems
12-726	Mathematical Modeling of Environmental Quality Systems
12-732	Special Topics in Environmental Engineering: Air Pollution
12-739	Special Topics in Environmental Engineering
12-740	CAE Tools
12-741	Advanced Programming Concepts in CAE
12-742	Engineering Databases for CAE
12-743	Expert Systems in CAE
12-744	Fundamentals of Graphics for CAE
12-745	Geometric Modeling in CAE
12-746	Design Interfaces in CAE
12-747	Design Grammars in CAE
12-748	Design of CAE Systems
12-749	Special Topics in CAE
12-750	Programming in C
12-755	Finite Element Methods in Mechanics I
12-756	Finite Element Methods in Mechanics II
12-757	Vibrations of Elastic Systems
12-758	Boundary Element Methods in Mechanics
12-759	Optimization in Mechanics
12-760	Earthquake Engineering and Soil Dynamics
12-762	Environmental Geotechnics
12-767	Special Topics in Solid Mechanics and Structural Mechanics
12-768	Special Topics in Geotechnical Engineering

Computer Science

Undergraduate Courses

15-121
Introduction to Programming for Architecture **Spring: 10 units**
Introduction to programming and problem solving for Architecture students. Emphasis is on problem solving, programming methodology, and style which is reinforced by writing a large graphics-based application. Credit is by mastery examination. Students who take 15-121 may not take 15-125, or 15-127 for credit.

15-125
Introduction to Programming and Computation **Fall and Spring: 10 units**
Introduction to programming and problem solving for students who are planning to take 15-200 to satisfy a degree requirement or MCS students not planning to take 15-211/212. Emphasis is on basic computer science concepts: problem solving, program structure and style, and programming applications in several domains. Credit is by mastery examination. Students who take 15-125 may not take 15-121 or 15-127 for credit. Students who take 15-125 but subsequently need 15-127 to satisfy degree requirements should contact the CS Undergraduate Office.

15-127
Introduction to Programming and Computer Science **Fall and Spring: 10 units**
Introduction to programming and problem solving for Computer Science majors, all CIT students, and any other students intending to continue on to 15-211. The course is taught in C with an emphasis on programming methodology and style: problem analysis, program structure, algorithm analysis, data abstraction, and dynamic data. Credit is by mastery examination. Students who take 15-127 may not take 15-121 or 15-125 for credit.

15-200
Data Structures **Spring: 9 units**
A sophomore-level course designed for students who desire to expand their knowledge of computer science and sharpen their programming skills, but do not desire a concentration in Computer Science. The course focuses on data abstraction, data structures (including graphs and trees), and implementing and analyzing the algorithms that utilize those data structures. Some time is also spent on object-oriented concepts. Prerequisite: 15-125 or 15-127.

Course Descriptions

15-211
Fundamental Structures of Computer Science I **Fall and Spring: 12 units**
Fundamental programming concepts are presented together with supporting theoretical bases and practical applications. This course emphasizes the practical application of techniques for writing and analyzing programs: data abstraction, program verification, and performance analysis. These techniques are applied in the design and analysis of fundamental algorithms and data structures. Prerequisites: 15-127 and 21-127.

15-212
Fundamental Structures of Computer Science II **Fall and Spring: 12 units**
The course continues the presentation of fundamental programming concepts begun in 15-211, focusing on more sophisticated methods for describing and reasoning about computer programs. High-level languages are introduced including language mechanisms for user-defined data types, and formal methods are presented for reasoning about program specifications and correctness. Prerequisite: 15-211.

15-312
Programming LanguagesDesign and Processing **Fall and Spring: 9 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 wide variety of paradigms are covered, including imperative, functional, logic, and concurrent programming paradigms. 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. An emphasis is also placed on pragmatic issues related to how languages are implemented on modern hardware. Prerequisite: 15-212.

15-347/18-347
Introduction to Computer Architecture **Spring: 12 units**
The goal of this course is to develop an understanding of the structure and operation of contemporary computer systems from the instruction set architecture level through the register transfer implementation level. We explore: theory of computation, levels of abstraction, instruction set design, assembly language programming, processor data paths, data path control, pipeline design, design of memory hierarchies, memory management, input/output. Several of the principles presented in lecture are reinforced through laboratory projects including assembly language programming, evaluation of instruction set architectures by benchmarks, behavioral simulation of an instruction set architecture, and design/simulation of a register transfer implementation of an instruction set architecture. A contemporary behavioral/functional/logical simulator will be used for the laboratory projects. Prerequisites: 15-211 and 18-240.

15-381
Artificial Intelligence: Representation and Problem Solving **Fall and Spring: 9 units**
Intelligent computer programs can solve problems, process natural language, reason about their actions, and learn from experience. The methods for achieving such behaviors involve the manipulation of internal symbolic representations. The course will focus on the main types of symbolic knowledge representation and the main techniques for search, planning and problem solving. It will also cover the essentials of natural language processing and machine learning. The course includes programming assignments in LISP, and students are expected either to have knowledge of LISP or Scheme, or are prepared to acquire that knowledge in the first part of the course. Prerequisite: 15-212.

15-384/18-384
Robotic Manipulation **Fall: 9 units**
Foundations and principles of robotic manipulation. Topics include computational models of objects and motion, the mechanics of robotic manipulators, the structure of manipulator control systems, planning and programming of robot actions. Prerequisites: 15-212 and 21-241, or permission of the instructor.

15-385
Computer Vision **Spring: 9 units**
The course deals with the science and engineering of computer vision, that is, the principles and techniques by which computers "see" and "understand" the world. The emphasis is on physical, mathematical, and information-processing aspects of vision, rather than biological, psychological, or cognitive aspects. Topics covered include line drawing understanding, image formation, early processing of images, region analysis, shape-from methods, 3D vision, vision architecture and applications. Prerequisites: 15-212 and 21-241, or permission of the instructor.

15-411
Compiler Design **Spring: 12 units**
The course covers the design and implementation of compiler and run-time systems for high-level languages, and examines the interaction between language design, compiler design, and run-time organization. Topics covered include syntactic and lexical analysis, handling of user-defined types and typechecking, context analysis, code generation and optimization, and memory management and run-time organization. Prerequisite: 15-312.

Course Descriptions

15-412
Operating Systems — **Fall and Spring: 12 units**
Operating systems monitor the execution of user programs and the allocation of various resources such as memory space and peripheral devices. The course introduces the basic concepts of multiprogramming, timesharing and asynchronous processes. These concepts lead to interesting problems of synchronization, scheduling, memory management, information sharing and protection. Emphasis of the course is on the design aspects of operating systems. Prerequisite: 15-212 and 18-240.

15-413
Software Engineering — **Fall and Spring: 12 units**
The field of software engineering deals with problems that arise when programs are large, when they involve many programmers, and when they exist over long periods of time. This course will be organized around group projects to give students practical experience in applying techniques learned in previous courses to large programs. Topics will include organizing and designing a programming project, testing, and program reliability, identifying the nature and sources of software costs, coordinating multiple programmers, documentation and design of friendly user interfaces. Prerequisites: one of 15-411, 15-412, or 15-462.

15-414
Structured Programming and Program Proving — **Spring: 9 units, Offered intermittently**
This course concerns structured programming and program proving as practical tools for program construction. Formal methods are studied, not as an end in themselves, but to reveal what constitutes a precise specification of program behavior, and what constitutes a rigorous argument that a program meets such a specification. The fundamental goal of this course is the ability to write concise, clearly documented, and logically correct programs, without using the computer as a crutch. Students are expected to write short programs without executing them on the computer, and these exercises are evaluated for style as well as logical correctness. Prerequisite: 15-212.

15-451
Algorithms — **Fall and Spring: 9 units**
This course is about the design and analysis of algorithms. We study specific algorithms for a variety of problems, as well as general design and analysis techniques. Specific topics include searching, sorting, algorithms for graph problems, efficient data structures, lower bounds and NP-completeness. A variety of other topics may be covered at the discretion of the instructor. These include parallel algorithms, randomized algorithms, geometric algorithms, low level techniques for efficient programming, cryptography, and cryptographic protocols. Prerequisites: 15-212 and 21-228.

15-453
Formal Languages and Automata — **Fall: 9 units**
An introduction to the fundamental ideas and models underlying computing: finite automata, regular sets, pushdown automata, context-free grammars, Turing machines and undecidability. The mainly mathematical and conceptual content of the course is supplemented by the study of its relevance to text processing and compiling applications. Prerequisites: 15-212 and 21-228; 21-373 is recommended.

15-462
Computer Graphics I — **Fall: 12 units**
This course provides a comprehensive introduction to computer graphics modeling, rendering, and animation. Topics covered include raster algorithms, geometric transformations, keyframe animation, 3-D viewing and projection, geometric modeling of curves and surfaces, shading, and hidden-surface elimination. Prerequisites: 15-212, 21-122, and 21-259.

15-463
Computer Graphics II — **Spring: 12 units**
This course is the second semester of computer graphics, with emphasis on rendering and image processing. Topics include: image filtering, image warping, Fourier transforms, visibility algorithms, spatial data structures, reflection, ray tracing, antialiasing, texture mapping, radiosity, and volume rendering. Prerequisite: 15-462.

15-499
Special Topics in Computer Science — **Fall and Spring: 6-12 units**
Offered from time to time on various topics. Prerequisites, hours and units to be announced at the time of registration.

15-5x9
Independent Study — **Fall and Spring: 3-12 units**
Specially selected projects and readings in programming systems, computer systems, theory, and artificial intelligence. Prerequisite hours and units to be negotiated with individual instructors.

15-599
Undergraduate Thesis Research — **Fall and Spring: 18 units**
Available only to students registered in the Senior Research Thesis Program. More information is available in the CS Undergraduate Office.

15-612
Distributed Systems — **Spring: 12 units**
This is an advanced course focusing on the design, implementation and management of distributed systems. It covers fundamental topics such as naming, security, reliability, resource sharing, and remote execution. It addresses network protocol issues above the transport level and discusses information sharing mechanisms such as electronic mail, file systems, and databases. Prerequisites: 15-412, or 15-347 and permission of the instructor.

15-681
Machine Learning — **Fall: 12 units**
Machine Learning is concerned with computer programs that automatically improve their performance through experience. Machine Learning methods have been applied to problems such as learning to drive an autonomous vehicle, learning to recognize human speech, and learning strategies for game playing. This course covers the primary approaches to machine learning, including inductive inference of decision trees, neural network learning, statistical learning methods, genetic algorithms, and explanation-based learning. The course covers algorithms, applications, and theoretical concepts such as inductive bias, PAC learning, and Occam's Razor. Programming assignments will include experimenting with various learning problems and algorithms. Prerequisite: 15-381 or permission of the instructor.

Graduate Courses

All graduate courses are available to undergraduate students who have appropriate prerequisites and permission of the instructor. Descriptions of graduate courses may be obtained from the School of Computer Science.

Electrical and Computer Engineering

Undergraduate Courses

18-100
Introduction to Electrical and Computer Engineering — **Fall and Spring: 12 units**
The goals of the introductory course are: to introduce basic concepts in Electrical and Computer Engineering in an integrated manner; to motivate basic concepts in the context of real applications; to illustrate a logical way of thinking about problems and their solutions; and to convey the excitement of the field. These goals are attained through analysis, construction, and testing of an electromechanical system (e.g. a robot) that incorporates concepts from a broad range of areas within Electrical and Computer Engineering. Some of the specific topics that will be covered include system decomposition, real and ideal sources, Kirchoff's and Ohm's Laws, Linear and Nonlinear circuit elements, Ideal Op-Amp characteristics, combinational logic circuits, Karnaugh Maps, and Flip-Flops. The course will culminate in a final project that will provide an opportunity for creative design. 3 hr. lec., 1 hr. rec., 3 hr. lab. Corequisites: 15-127 and 21-121.

18-113
Basic Electrical Engineering — **Spring: 9 units**
The objective of this course is to provide solid understanding of the basic sciences underlying electrical circuits; dielectric and magnetic devices, rotating machinery, and the development of capacity to apply this science with creative skill in a variety of applications selected from the fields of electrical engineering. 2 hrs. lec., 3 hrs. lab. Prerequisites: Junior standing in Mechanical Engineering, 33-107, 24-245.

18-220
Fundamentals of Electrical Engineering: Introductory Circuit Analysis — **Fall and Spring: 12 units**
The course thoroughly covers the fundamentals of linear circuit analysis necessary to perform design of digital and analog electronic circuits: Kirchhoff's Voltage and Current Laws; Superposition and Convolution; Series, Parallel, and Ladder Circuit Analysis; Thevenin's and Norton's Theorems; Natural Frequencies; Circuit Partitioning; Nodal Analysis; Fourier series representation of periodic signals and frequency domain analysis. This course will cover these principles thoroughly in the context of the transient and sinusoidal steady state analysis of RLC circuits. Theoretical investigations presented in the class will be reinforced with laboratory experiments. A recurring motivational theme throughout the course is the study of high performance digital system switching speed limitations imposed by electronic circuit interconnects. 3 hrs. lec., 1 hr. rec., 3 hrs. lab. (every other week). Prerequisite: 18-100. Corequisite: 21-241.

18-231 — **Fall: Variable units**
18-232 — **Spring: Variable units**
Sophomore Projects
Experience in independent planning and conduct of 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.

Course Descriptions

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 abstractions of digital systems, basic machine organization and instruction set issues, assembly language programming and debugging, and microprogramming. Emphasis is on the fundamentals, the levels of abstraction that allow designers to cope with hugely complex systems, and connections to practical hardware implementation problems. Students will use computer-aided digital design software and actual hardware implementation laboratories to learn about real digital systems. 3 hrs. lec., 1 hr. rec., 3 hrs. lab. Prerequisite: 18-100, Corequisite: 21-127.

18-303
Engineering Electromagnetics I — **Fall: 12 units**
The objective of this and the subsequent course is to develop an understanding of fundamental electromagnetic principles and of electromagnetic field analysis methods. Maxwell's Equations in integral and differential forms, boundary conditions; Electroquasistatics, potential and voltage, Poisson's equation; Method of images; Capacitance; Laplace's equation, solutions in Cartesian, polar and spherical coordinates, numerical methods; Conduction; Polarization; Magnetoquasistatics, vector potential, Biot-Savart Law; Induced voltages as described by Faraday's Law, inductance; Magnetization, magnetic circuits; Numerical simulation laboratory and projects. 3 hrs. lec., 2 hr. rec., lab additional. Prerequisites: 21-259, 18-220.

18-304
Engineering Electromagnetics II — **Spring: 12 units**
Maxwell's equations, differential and integral forms; Energy conservation, Poynting Theorem; Plane waves; TEM waves on 2-conductor transmission lines, sinusoidal steady state, Smith Chart, reflection and transmission of transients at discontinuities; Modal description of waveguides and cavities; Radiation, antennas; Numerical simulation laboratory and projects. 3 hrs. lect., 2 hr. rec., lab additional. Prerequisite: 18-303.

18-311
Semiconductor Devices I — **Spring: 12 units**
In this course students will build a fiber optic communication system, capable of transmitting and receiving amplitude-modulated audio information over a glass optical link. The fundamental concepts central to understanding, applying, and modeling electronic devices are introduced and studied in the laboratory using this system. The goal is to develop an understanding of the operation of semiconductor devices, both electronic and optical, in terms of relevant physical concepts, and to apply these devices in practical circuits.
Devices studied in this course include bipolar junction transistors, PN diodes, zener diodes, photodetectors, light emitting diodes, glass optical fibers, and Schottky diodes. The fundamental physical principles governing their operation, how to use them in circuits by applying the appropriate DC and AC voltages, and how to predict the performance of the circuit using simple models and approximations, will be covered.
The description of the fundamental principles will make use of energy band theory, and will include the following topics: electron and hole generation in solids; carrier transport (drift and diffusion); carrier mobility; doping and conductivity; band diagrams; Fermi level and energy distribution functions; carrier recombination; generation, transmission, and absorption of light in solids as a function of wavelength; minority carrier diffusion equation; PN junction electrostatics and carrier transport. 3 hrs. lect., 1 hr. rec., 3 hrs. lab. Prerequisite: 18-220.

18-312
Semiconductor Devices II — **Fall: 12 units**
This course, a continuation of Semiconductor Devices I, will focus on the physics and operation of field effect devices, including MOS capacitors, MOSFET's JFET's, and MESFET's, as well as more advanced devices, such as charge coupled devices (CCD's), metal-semiconductor junctions, and heterostructure transistors. The course will begin with a thorough description of the MOS capacitor: electron affinity and metal work functions; accumulation, depletion, weak and strong inversion regimes; flatband and threshold voltage; ionic, fixed, oxide trapped, and interface trapped charges and their effects; high and low frequency capacitance-voltage measurements. We will then develop and solve the charge transport equations for the MOSFET to obtain terminal I-V curves. Nonidealities encountered in modern field effect devices, such as the narrow width effect, drain induced barrier lowering, hot carrier generation, etc., will be investigated in detail. The course will conclude with similar treatments of other technologically important semiconductor electronic devices. 3 hrs. lect., 1 hr. rec., Prerequisite: 18-311.

18-316
Introduction to Data Storage Systems Technology — **Spring: 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 description of the fundamental properties of magnetic materials. The origins of magnetism, demagnetizing fields, anisotropy, magnetostriction, domains and coercivity are explained. With this as a basis, the operation of magnetic and magneto-optical recording devices such as rigid and floppy disk drives, tape recorders, compact disk players and optical disk drives is explained. 4 hrs. rec. Prerequisites: 21-259 and 33-107.

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: DC bias calculations and circuits, MOSFET and BJT large- and small-signal device models, small-signal gain and frequency response characteristics of single-stage amplifiers, operational amplifier design, basic theory of feedback amplifiers, frequency stability and compensation techniques, large-signal characteristics and nonidealities. In the hardware laboratory, the student will gain experience designing and implementing analog circuits, and comparing actual to simulated performance using the SPICE circuit simulation program. 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. Prerequisite: 18-220.

18-322
Analysis and Design of Digital Circuits — **Fall: 12 units**
The purpose of this course is to introduce the student to the fundamentals of the analysis and design of basic digital circuits. Topics to be covered include: MOSFET and BJT large-signal device models, propagation delay calculations, MOS and BJT combinational and sequential gates, physical layout techniques, semiconductor memories, programmable logic arrays, pulse-generation techniques, and TTL and ECL technologies. The necessity of circuit simulation (SPICE), timing simulation (COSMOS) and physical layout (MAGIC) computer tools is stressed. The lab includes the design, analysis, layout and verification of a digital system such as a simple microprocessor. 3 hrs. lec., 1 hr. rec., 3 hrs. lab. Prerequisites: 18-220 and 18-240.

18-323
Analog Filter Design — **Offered Intermittently: 12 units**
Analog filtering is an indispensable aspect of signal processing. Passive filters for high frequency applications and active filters employing inexpensive operational amplifiers are emphasized in both the theory and laboratory/project portions of the course. Specific topics to be covered are the following: Overview of Analog Filter Design; Review of Resistor Operational Amplifier Circuits; Butterworth and Chebyshev Low Pass Filter Approximations; Frequency Scaling; Active Circuit Realizations of Low Pass Filters; High Pass Filter Specification; Low Pass to High Pass Transformation; Active Circuit Realizations of High Pass Filters; Inverse Chebyshev Approximation; Cauer Filters; Low Pass to Band Pass and Band Stop Transformations; Active Circuit Realization of Band Pass and Band Stop Filters; Passive Filter Design; Sensitivity; Active Circuit Equivalents for Passive Filter Elements; State Variable Forms of Filter Design; Delay Filters; Switched Capacitor Filters. This course will be conducted as a series of design exercises, each starting with a solution in theory and ending with a practical realization in the laboratory. 3 hrs. rec., 3 hrs. lab. Prerequisites: 18-220, 18-396, 18-321.

18-331 — **Fall: Variable units**
18-332 — **Spring: Variable units**
Junior Projects
Experience in independent planning and conduct of 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.

18-342
C/Unix Survival Skills — **Spring: 3 units**
This course provides a practical introduction to C programming in the Unix workstation environment for students who will not be exposed to it in advanced Computer Science courses. Lectures will focus on C itself, Unix, and Unix Utilities (csh, make, awk, grep, etc.) Example applications will be drawn from the breadth areas of the ECE curriculum. A secondary focus of the course will be software engineering (portability, reuse, etc.) for engineering/scientific programs. Particular attention will be paid to software engineering issues and how they complement/conflict with rapid software prototyping. Weekly programming labs will form the keystone of the work. Most labs will be short (1-2 hours) and will introduce a broad spectrum of tools. A few larger programs will be built over multiple weeks. Upon completion of the course students should be familiar with techniques and tools for engineering practical programs in C under Unix. Prerequisite: 15-127.

18-347/15-347
Introduction to Computer Architecture — **Fall: 12 units**
The goal of this course is to develop an understanding of the structure and operation of contemporary computer systems from the instruction set architecture level through the register transfer implementation level. We explore: theory of computation, levels of abstraction, instruction set design, assembly language programming, processor data paths, data path control, pipeline design, design of memory hierarchies, memory management, input/output. Several of the principles presented in lecture are reinforced through laboratory projects including assembly language programming, evaluation of instruction set architectures by benchmarks, behavioral simulation of an instruction set architecture, and design/simulation of a register transfer implementation of an instruction set architecture. A contemporary behavioral/functional/logical simulator will be used for the laboratory projects. 3 hrs. lec., 3 hrs. lab. Prerequisite: 18-240. Corequisite: 15-211.

Course Descriptions

18-349
Concurrency and Real-Time Systems **Spring: 12 units**
This course teaches the fundamentals of concurrency and time constrained computing both at the hardware and software levels. These notions are developed through the study and implementation of real-time systems. The fundamental problems and issues of timing correctness, synchronization, deadlock and contention are described. Solutions to these problems which have evolved in the software realm are presented along with the hardware required to implement these solutions. Topics include real-time interrupt driven systems; concurrency in digital systems; synchronous, asynchronous and self-timed systems; and hardware and software synchronization mechanisms. 3 hrs. rec., 3 hrs. lab. Prerequisites: 18-240 and 15-211.

18-370
Fundamentals of Control **Fall: 12 units**
An introduction to the fundamental principles and methodologies of classical feedback control and its application. Emphasis is on problem formulation and the analysis and synthesis of servomechanisms using frequency and time domain techniques. Topics include analytical, graphical, and computer-aided (MATLAB) techniques for analyzing and designing automatic control systems; analysis of performance, stability criteria, realizability, and speed of response; compensation methods in the frequency domain, root-locus and frequency response design, and pole-zero synthesis techniques; robust controller design; systems with delay and computer control systems; transfer function and state space modeling of linear dynamic systems; nonlinearities in control systems; and control engineering software (MATLAB). 3 hrs. lec., 1.5 hrs. rec., 3 hrs. MATLAB lab. Prerequisite: 18-396.

18-371
Design Optimization Techniques **Offered Intermittently: 12 units**
This course introduces the student to the concepts and techniques of design optimization by computers using various proven methods, both algorithmic and heuristic. The need to acquire each optimization tool is demonstrated through a design exercise of an actual device or system. The tools covered include modeling of engineering problems, matrix solution of linear equations, unconstrained quadratic optimization with and without constraints, nonlinear problems, mathematical programming techniques, Newton-Raphson methods, and nonlinear and geometric programming algorithms. Design exercises will include iron-core inductors, transformers, thermal power plants, servo systems, and economic dispatch of power plants. 4.5 hrs. rec. Prerequisite: 21-341.

18-373
Computer-Controlled Testing and Measurement System Design **Fall: 12 units**
The aim of this course is to familiarize the student with the fundamentals of measurements, data acquisition, control, and the role of a microcomputer in carrying out these activities. This course will consist of lectures and extensive laboratory experiments and a final project. Of special interest will be the following areas: sensors, measurement techniques, signal transmission methods, noise sources and noise suppression, signal conditioning techniques, fundamentals of computer control, A/D and D/A conversion techniques, sampling and data compression, and error analysis in experiments. In general, the course will concentrate on the use of a microcomputer in obtaining measurement data for the purposes of testing and control. The course has a practical slant and is intended to give the student a cohesive understanding of the relationships amongst different areas of Electrical and Computer Engineering and their application in practice. 3 hrs. rec., 3 hrs. lab. Prerequisite: 18-220 or 18-113 or permission of instructor.

18-384/15-384
Artificial Intelligence: Robotic Manipulation **Fall: 9 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: 21-122 or permission of the instructor.

18-396
Signals and Systems **Fall and Spring: 12 units**
This course is a breadth course that also is a prerequisite for most courses in communications, signal processing and control systems. The objective of this course is to provide students with an integrated understanding of the relationships between mathematical tools and properties of real signals and systems. This is accomplished by motivating lectures and recitation problems using demonstrations and laboratory assignments which cover such topics as radio transmission and reception, audio synthesizers, CDs, image processing, and prosthetic devices. In the course of the semester, students are introduced to industry-standard computing and simulation tools that will be used in subsequent courses. Continuous and discrete-time signals and systems are treated in a unified manner through the concept of sampling. The course covers the basic concepts and tools needed to perform time and transform domain analyses of signals and linear time-invariant systems, including: unit impulse response and convolution; Fourier transforms and filtering; Laplace transforms, feedback and stability; and a brief introduction to z-transforms in the context of digital filtering. Prerequisite: 18-220.

18-400
High Frequency System Design **Offered Intermittently: 12 units**
This course is intended to familiarize students with the characteristics of various radio frequency / microwave components and the design of representative systems. Waveguide components are available at X-band (8.20-12.40 GHz) and K-band (18.0-26.5 GHz). These include oscillators, attenuators, phase shifters, wavemeters, directional couplers, circulators, isolators, horns, detectors, etc. For example, an intruder alarm system (Doppler radar) can be designed, constructed and tested at both X- and K-bands. Various coaxial components enable operation down to several 100 MHz at least. An RF / microwave sweeper ranging up to 12 GHz is available. Planar transmission line circuitry (microstrip) can be fabricated. CAD programs are available for laying out and analyzing microstrip circuitry. At frequencies of 4 GHz or so, various resonators, filters and directional couplers can be designed, constructed, and tested. Microwave amplifiers can be designed and constructed at frequencies up to 4 GHz using drop-in components on wafers and PC boards. 2 hrs. rec., 3 hrs. lab. Prerequisite: 18-304 or equivalent or permission of the instructor.

18-405
Computer Aided Design of Electromagnetic Systems **Offered Intermittently: 12 units**
This course employs field theory based CAD tools to simulate the behavior of electromagnetic systems. Students learn to use finite element computer programs to determine the electric and magnetic fields in printed circuit boards and in other high-speed digital and microwave devices. Course topics include: Electromagnetics CAD; finite element methods; finite element mesh generation; electrostatics and magnetostatics of PCB and IC interconnects; capacitance and inductance matrices; cross-talk, insertion loss and return loss; dispersion; eddy currents and skin effect; use of CAD packages for computing signal characteristics; microwave CAD; S matrices; use of the Hewlett-Packard High-Frequency Structure Simulator; hybrid and MMIC microwave design; propagation of optical signals; modal characteristics of optical ICs. 2 hrs. rec., 3 hrs. lab. Prerequisite: 18-304.

18-431 **Fall: Variable units**
18-432 **Spring: Variable units**
Senior Projects
Experience in independent planning and conduct of 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.

18-439
Special Topics in Electrical and Computer Engineering **Fall or Spring: Variable units**
Offered from time to time on topics of current interest. Specific details will be announced prior to registration.

18-474
Computer Control Systems Design Laboratory **Spring: 12 units**
A senior design elective in Electrical and Computer Engineering focusing on issues in the design of feedback control systems using digital computers. Lectures and laboratory experiments cover basic switching control methods, collection and analysis of data for modeling system dynamics, PID control, design methodologies for setpoint control and disturbance rejection, state variable feedback, dynamic state observers, and methods for adaptive control. Major emphasis is placed on a project involving the analysis, design and implementation of a computer control system developed by each lab group. 2 hrs. rec., 3 hrs. lab. Prerequisite: Senior standing in Electrical or Computer Engineering.

18-480
Senior Seminar **Fall: 0 units**
The senior seminar provides students with information which should be of use in making the transition from undergraduate studies to graduate life. The seminar features discussions led by faculty members and invited guests, with student participation in the discussions. 1 hr. lec./rec. Prerequisite: Senior standing in Electrical or Computer Engineering.

18-481
Analysis, Synthesis and Evaluation **Offered Intermittently: 12 units**
Analysis, synthesis and evaluation in the context of realistic engineering situations. The student learns through practice to formulate and solve problems which require the application of skills that include modeling, analyses that range from mathematical to heuristic, experimental methods, inventing, making judgments of value and need, making decisions and recommendations, and producing an engineering report containing an analysis of the problem and an evaluation of the solution. 3 hrs. lec., 3 hrs. lab. Prerequisite: Senior standing in Electrical or Computer Engineering.

18-482/19-402
Telecommunications: Technology, Policy and Management **Fall: 12 units**
This course provides a comprehensive introduction to basic principles of telecommunications technology and the telephone network, and the legal, economic, and regulatory environment of the telecommunications industry. Role of new technologies such as fiber, integrated digital networks, computer communications, and information services. Common carrier law and the economics of natural monopoly as the basis for regulation of the telecommunications industry. Issues of competition, monopoly and technical standards. Spectrum allocation and management. International communications and transborder data flow. Special emphasis on how the new technologies have altered and are altered by regulation. Prerequisites: 73-100, Junior or Senior standing.

Course Descriptions

18-483/19-430
Civilian and Military Applications of Space **Spring: 12 units**
Space is an arena of growing activity and importance. The use in space puts specific requirements on the technology of remote sensing and communication. Furthermore, the access to space requires rocket engines. Operation in space supposes the ability of controlling automatically the attitude of spacecraft. Navigation and guidance requires a very large and powerful infrastructure. Most space endeavors are very ambitious and long term projects. The cost of space projects are often easier to estimate than the benefit. The goal of this course is to penetrate somewhat in the world of space policy dilemmas by studying the interface between the technology and what space programs could or try to accomplish. 3 hrs. lec. Prerequisites: Junior standing in engineering or science.

18-489
Basic Trends in the Evolution of Modern Microelectronics **Fall (alternate years): 12 units**
Recent rapid changes and future trends in the evolution of the microelectronics are determined by three factors: market needs, manufacturing capabilities and efficiency of design. Each of them has its own dynamics and limitations. Understanding all of them is necessary to explain the current structure of the microelectronics industry and to predict future developments in the areas of IC technology, design and CAD tools. The goal of this lecture is to introduce technical aspects related to the above mentioned three areas. Prerequisite: 18-322

18-501
Electromechanics **Spring: 12 units**
This course provides a broadly based introduction to interactions between mechanical media and electromagnetic fields. Attention is focused on the electromechanical dynamics of lumped-parameter systems, wherein electrical and mechanical subsystems may be modeled in terms of discrete elements. Interactions of quasistatic electric and magnetic fields with moving media are described and exemplified. Unifying examples are drawn from a wide range of technological applications, including energy conversion in synchronous, induction, and commutator rotating machines, electromechanical relays, a capacitor microphone and speaker, and a feedback-controlled magnetic levitation system. 4.5 hrs. rec. Prerequisite: 18-303

18-517
Data Storage Systems Measurement and Design Laboratory **Fall: 12 units**
This course is designed to provide students with an opportunity to gain hands-on experience in designing and carrying out a small research project on storage devices such as a disk drive, or an optical recording device. The students will be taught the principles of operation of a variety of magnetic measurement devices including magnetometers, hysteresis loop tracers and magnetic and magneto-optic recording device testers. Having learned the use of these instruments, students will select, design and carry out a research project related to storage technology in the research labs of the Data Storage Systems Center. 1.5 hr. rec., 10.5 hrs. lab scheduled at student's convenience. Prerequisites: 21-259 and 33-107

18-523
Analog Integrated Circuit Design **Fall: 12 units**
Advanced techniques for the design of analog integrated circuits. Emphasis will be placed on the design process. Design issues associated with both MOS and BJTs devices will be explored. Students will be expected to design and simulate several projects. Topics will be selected from the following: modeling of basic IC components (in MOS & BJT processes), wideband amplifier design, operational amplifier design, the design of switched-capacitor circuits, the design and analysis of phase locked loops, analog-to-digital conversion techniques (including the design of sample-and-hold amplifiers), and digital-to-analog conversion techniques. 4 hrs. lec., 3 hrs. lab. Prerequisites: 18-321 and 18-322 or equivalent with permission of instructor.

18-525
Integrated Circuit Design Project **Spring: 12 units**
The purpose of this course is to study the design process of VLSI circuits. The first part of the course will be devoted to the standard cell design methodologies. Major emphasis will be put on layout design, circuit and parasitic element extraction and verification of circuit performance via simulation tools. In the second part of the course, students will design functional blocks of digital ICs and verify their performance using such simulators as COSMOS and SPICE. The collection of these functional blocks will constitute a multiproject chip which will be submitted for fabrication to MOSIS. 4 hrs. rec., 3 hrs. lab. Prerequisite: 18-322

18-545
Advanced Digital Design Project **Fall: 12 units**
This is a project oriented course on advanced digital design. It provides the background needed for developing design skills of large digital systems at a professional level. The course covers fundamental design principles and extensive pragmatic implementation considerations. A substantial project will be designed and built by each project group of three students. A typical project is a single-board microprocessor that is implemented for a specified general purpose instruction set or special purpose embedded application, such as a network controller. Contemporary building blocks and design tools will be used, including programmable logic devices (PLDs), advanced field programmable gate arrays (FPGAs), schematic capture, Verilog simulation and PLD design tools. Industry standard practices of interim design reviews and final project presentations are followed. 3 hrs. lec., 3 hrs. lab. Prerequisites: 18-347 or 18-349, 15-212.

18-547
Superscalar Processor Design **Fall: 12 units**
This course presents the fundamental principles, critical issues and latest techniques involved in the design of advanced modern processors. The course emphasizes the design of processors capable of extracting and exploiting instruction level parallelism (ILP). The topics covered include: arithmetic (floating-point) unit design; design space exploration via profiling and trace-driven simulation; microcoded CISC and pipelined RISC processors; instruction level parallel processing (ILPP) principles; superpiplined, superscalar, and VLIW (very long instruction word) processors; dynamic (run-time hardware) and static (compile-time software) techniques for achieving ILPP; aggressive instruction scheduling, and machine-dependent code optimization. This course also incorporates case studies of a number of ILP processors e.g. IBM RS/6000, Motorola PowerPC, and DEC Alpha, and the use of software tools in experimenting with performance evaluation, machine simulation, and code transformation. 3 hrs. lec. Prerequisites: 18-347 and 15-212.

18-549
Time Critical Computing Systems **Spring: 12 units**
The analysis and design of time critical computing systems is emphasized in this course. Engineering skills necessary to build embedded/multimedia systems are presented. This course includes a significant project where students will build/analyze a system. Typical systems include control systems, signal processing systems, and multimedia systems. A real-time scheduling theoretic approach will be used to quantitatively explore the design space. Performance models will be developed to explore the hardware/software boundary issues for the following subsystems: CPU's, buses, disks arrays, LANs, switching networks, and video/graphics/rendering subsystems. 4 hrs. rec. Prerequisites: 18-240, 15-212 and (18-349 or 15-412).

18-550
Fundamentals of Communication Systems **Spring: 12 units**
A general introduction to analog and digital communications. Review of relevant aspects of linear systems and probability theories. Fourier analysis. Analog modulation systems: amplitude modulation (AM), frequency and phase modulation (FM and PM), and pulse amplitude modulation (PAM). Digital modulation systems: pulse code modulation (PCM), delta and differential PCM.

For each modulation system, the course covers the basic structure of the transmitter and receiver, the tradeoffs between bandwidth/data rates requirements and signal to noise ratio for desired levels of performance, and waveform design. Applications are drawn from broadcasting (radio and TV), telephone networks (multiplexing), satellite communications, radar, digital communications (matched filter and optimal detection). Time permitting, the course will cover error detection and correction and elements of information theory. 3 hrs. lec., 1.5 hrs. rec. Prerequisites: 18-396, 36-217.

18-575
Control System Design **Spring: 12 units**
A senior 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. The perspective spans the dynamic modeling of physical systems and the analysis and computer-aided design (utilizing MATLAB) of linear and nonlinear, continuous-time and discrete-time, robust multivariable feedback systems. In illustrating the centrality of numerical linear algebra in control engineering, case studies are selected from pole placement, linear-quadratic design and Kalman filtering. A significant emphasis is placed upon student selected design projects. 4 hrs. lec., 3 hrs. MATLAB lab. Prerequisite: 18-370 or equivalent.

Graduate Courses

The following graduate courses are available to undergraduate students who have appropriate prerequisites. Descriptions of these graduate courses may be found in the graduate catalog of the Department of Electrical and Computer Engineering.

18-701	Electromagnetic Field Theory
18-702	Numerical Methods in Electromagnetics
18-708	High Frequency Engineering
18-711	Solid State Electronics
18-712	Microwave and Optical Magnetics
18-714	Introduction to Superconducting Devices
18-715	Physics of Applied Magnetism
18-716	Advanced Applied Magnetism
18-723	Advanced Analog Integrated Circuit Design
18-725	Digital Integrated Circuit Design
18-728	Applications of Analog Integrated Circuits
18-742	Advanced Computer Architecture
18-746	Parallel Processing
18-748	Dependable System Design
18-751	Applied Stochastic Processes
18-752	Estimation, Detection and Identification
18-754	Error Control Coding: Theory and Applications
18-756	Packet Switching and Computer Networks
18-757	Principles of Broadband Networks
18-760	VLSI CAD: Logic to Layout
18-761	VLSI CAD: Layout to Manufacturing
18-762	Circuit Simulation: Theory and Practice
18-763	Physical CAD for VLSI

18-771	Linear Systems
18-772	Multivariable Control Systems
18-773	Adaptive Control
18-775	Optimal and Stochastic Control
18-791	Digital Signal Processing I
18-792	Digital Signal Processing II
18-793	Optical Image and Radar Processing
18-794	Pattern Recognition Theory
18-795	Sensory Processes: Perception & Psychophysics
18-796	Numerical Optimization Methods
18-809	Special Topics in Electromagnetics
18-813	Optical Electronics
18-815	Integrated Circuit Fabrication Processes
18-816	Magnetic and Optical Data Storage
18-819	Special topics in Solid State Devices
18-828	Design and Testing of Analog Integrated Circuits
18-829	Special Topics in Circuits
18-845	Computer Engineering Applied Graph Theory
18-849	Special Topics in Computer Engineering
18-859	Special Topics in Communications
18-869	Special Topics in Computer Aided Design
18-879	Special Topics in Systems and Control
18-899	Special Topics in Signal Processing

Engineering and Public Policy

Undergraduate Courses

19-101
Introduction to Engineering and Public Policy **Fall and Spring : 12 units**
This course examines the processes of public and private desisionmaking and of policy formation which shape the evolution of a technology and its impact on our soceity. Technology plays an important role in shaping our worls. At the same time, social forces often play a central role in the evolution of a technology. A particular technology such as an automobile is chosen to study technology and policy in context. Specific topics covered in the case of the automobile includes automotive design and manufacture, safety, pollution, fuel economy and their interactions. In each area, we discuss the technological and institutional issues, their interaction, the possible need for public policy and the factors that govern the policy. The course will involve several group problem solving sessions. Corequisites: Calculus I, Physics I.

19-102
EPP Sophomore Seminar **Fall: 3 units**
The Sophomore Seminar has the objective of introducing the student to the interdisciplinary nature of Engineering and Public Policy problems. This is achieved through the use of three or four case studies dealing with aspects of decision-making in policy issues which have a technological basis. Cases used include: "Is the Odyssey worth the risk? : Nuclera Power in Space " , "PCB Disposal in Wilsonvile, Illinois", "B-2 or not B-2?", and " Fiber-to-the-Home: Management of an integrated cservices network". Students are introduced to the technical and policy dimensions of these problems as well as to skills such as data collection and analysis, group work, and oral and written presentations. A few seminars by EPP graduates and faculty are also included to give the student an idea of careers and

19-269, 24-269
Quality Assurance **Spring: 9 units**
This Course is intended as a course in the Quality Engineering area. Several methods employing probability and statistical techniques to quality control assurance issues will be addressed. These issues are linked to advanced topics such as the Taguchi methods, statistical process and quality control (SPC & SQC), and queueing theory. Management and economic issues involved in today's international market will be discussed. Examples from a wide range of industries such as the automotive, computer, aerospace, and marine industries will be analyzed. Data analysis will be conducted using some state of the art techniques and tools. Prerequisite: 21-259
research in the field. Prerequisite: sophomore standing in CIT or MCS.

19-297, 24-297
Energy-Environmental Systems **Spring: 9 units**
Fuel cycles for conventional and non-conventional energy-resources; relationships between environmental impacts and the conversion or utilization of energy; measures of system and process efficiency; detailed study and analysis of coal-based energy systems including conventional and advanced power generation, synthetic fuels production, and industrial processes; technological options for multi-media (air, water, land) pollution control; mathematical modeling of energy-environmental interactions and tradeoffs and their dependency on technical and policy parameters, methodologies for energy and environmental forecasting; applications to issues of current interest. 3 hrs. rec. Prerequisite: 24-121 or equivalent.

19-319
Law and the Engineer **Fall and Spring: 9 units**
Basic legal concepts of interest to the general business/industrial setting are examined for their relevance to the engineering profession. From this foundation, the specific areas of consumer, commercial and environmental law will be studied from the viewpoint of their effect on the practicing engineer, both as a corporate employee and as a professional in private practice. The case study method will be utilized and students will engage in supervised research projects dealing with current legal issues in specific areas of interest. Prerequisite: junior standing or permission of instructor.

19-321
Law and Technology **Fall: 9 units**
The interaction of law and technology is considered in several areas: the environment, safety and health, product liability and patents and trade secrets. The public policy which emerges as law in these areas arises from forums such as public hearings or courts of law. The focus of the course is twofold: (1) understanding present law in these areas, and (2) using the data from prior public hearings in at least two of these areas to evaluate critically the nature and validity of the technological input used in reaching the public policy decision. Prerequisite: 19-319 or 70-361.

19-323
Products Liability **Spring: 9 units**
Taught in conjunction with faculty members from the Duquesne School of Law and local practicing attorneys. The role and effectiveness of the technical expert, the pivotal figure in a product liability suit, are examined. This is accomplished by examining defective products from cases currently in litigation and by critically analyzing the tactics and approaches used in product liability suits. Each student prepares one sample case, working in conjunction with a law student. The course culminates in moot court proceedings. Prerequisite: 19-319 or permission of instructor.

19-402/ 18-482
Telecommunications :
Technology, Policy and Management **Fall: 12 units**
This course provides a comprehensive introduction to basic principles of telecommunications technology and the telephone network, and the legal, economic, and regulatory environment of the telecommunications industry. Role of new technologies such as fiber, integrated digital networks, computer communications, and information services. Common carrier law and the economics of natuaral monopoly as the basis for regulation of the telecommunications industry. Issues of competition, monopoly and technical standards. Spectrum allocation and management. International communications and transborder daata flow. Special emphasis on how the new technologies have altered and are altered by regulation. Prerequisites: 73-100, junior standing in CIT.

19-420
Chemical Technologies,
the Environment and Society **Fall or Spring: 9 units**
Study of interactions of chemical products of industry with the environment and society. Natural resource requirements, the material/energy flows in the industrial technologies, and the uses of chemicals are outlined. Issues to be examined include: construction and operation of chemical facilities, their products, regulation of toxic and hazardous materials, and the analytical problems in assessing the social costs and benefits. Prerequisites: junior standing or permission of instructor.

19-422
Radiation, Health, and Policy **Fall: or Spring 9 units**
This course is concerned with the impact of radiation on public health, and the regulatory and social framework that controls radiation exposure to the public. After an overview of radiation physics and biology, the origin and magnitudes of the exposure to the public to ionizing and nonionizing radiation, and problems with measurement of radiation exposure and the determination of the effects of low level radiation are discussed. This is followed by an examination of the principles of health risk assessments and of the two major areas of radiation exposure: energy technologies and medical radiation. In each case the role of the government and of the citizen in the decision-making process that affects population exposure and strategies to optimize these roles will be examined. Prerequisites: junior or senior standing in CIT or MCS.

19-430/18-483
Civilian and Military Applications of Space **Spring: 9 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 assessemnt of the impact of technological advancement on the military capability, space policy and arms control issues is proposed. As the exploitation of high technology has a lot of ramifications, the course focuses on some areas carefully chosen, based on the recent events, to illustrate the extent of the impact and to permit as wide-ranging a discussion as possible. Those issues cover areas of advanced imaging and target recognition capabilittes; the military exploitation of new physical principles; the development of new capabilities in space for military or civilian exploitation, and the convolution of these new capabilities with the incresing technological demands of arms control. In all examples, the interaction between technological progerss and needs for policy changes (or emergence of policy dilemmas) are emphasized. Prerequisites: junior standing in Engineering or permission of instructor.

19-431
Technology and International Security **Fall : 9 units**
The course examines the impact of high technology on national and international security from three different perspectives: Military impact, the relevance of technology in various regional conflicts; impact of defense policy ; and , the proliferation of high technbology in the third world, the spread and edlffusion processes of military high-technology in the third world and its impact on security and llnmational relations. As the course is intended to be useful to stundels in international relations and security , it is not taught as a hevavily t echniclalcourse. The emphasis is on policy. Prerequisites: junior standing or permission of instructor.

19-448
Science, Technology and Ethics **Fall or Spring : 9 units**
Technology has always been a pervasive force in society. But the past 50 years have seen an unprecedented acceleration of the growth and permeation of technology. The central role of technology and engineering in the modem world requires an examination of the responsibility that must guide the action of those who develop, deploy and spread technologies. This course examines the meaning and significance of technology in society through general paradigms and through specific examples. It first traces the stages of technology as described by Bright and Mansfield . It reviews the philosophers with special reference to those whose work has significance for the development of an "Ethics for the Technological Age". The course then applies these principles of ethics to the different stages of a technology from sceintific discovery and invention through societal impact. Finally, it explores in detail the field of engineering ethics. Prerequisite: Junior standing in engineering or science or permission of instructor.

19-451
Engineering and Public Policy Projects **Fall or 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. Prerequisite: junior or senior standing as EPP student or permission of instructor.

19-501
Special Topics in Engineering and Public Policy **Fall or Spring: 9 units**
Special topics dealing with the relationship between technology and public policy in interest areas such as: environmental systems and resources, application of technology to urban problems, energy and fuel utilization, interaction of law and technology, problems in communication technology. Prerequisite: permission of instructor.

19-600, 610, 620
Undergraduate Research **Fall or Spring : 6-12 units**
Students may do undergradaute 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.

Mathematics

Undergraduate Courses

21-105 **(For H&SS students only)**
Pre Calculus Fall: 9 units
Review of algebra, inequalities, analytic geometry, functions including logarithmic, exponential and trigonometric. 3 hrs. lec.

21-110 **(For H&SS students only)**
Problem Solving in Recreational Mathematics Offered intermittently: 9 units
The emphasis is on learning to solve problems in elementary mathematics. Topics may vary among offerings of the course, but typically include puzzles, algebraic problems, number theory, and graph theory. 3 hrs. lec.

21-111 **(For H&SS students only)**
Calculus I **Fall or Spring: 10 units**
Functions, limits, derivatives of algebraic, exponential and logarithmic functions, curve sketching, applications, indefinite and definite integrals. 3 hrs. lec., 2 hrs. rec.

21-112 **(For H&SS students only)**
Calculus II **Fall or Spring: 10 units**
Techniques of integration, trigonometric functions, functions of several variables, partial derivatives, maximum-minimum problems, Lagrange multipliers, infinite series, applications. 3 hrs. lec., 2 hrs. rec.

21-121
Calculus 1 **Fall or Spring: 10 units**
Functions, limits, derivatives, curve sketching, related rates, trigonometric functions, maximum-minimum problems, inverse functions, definite and indefinite integrals; logarithmic, exponential, and hyperbolic functions; applications of integration, numerical integration, integration by substitution and by parts. 3 hrs. lec., 2 hrs. rec.

Course Descriptions

21-122
Calculus 2 **Fall or Spring: 10 units**
Methods of integration, indeterminate forms, improper integrals; sequences, series, Taylor's Theorem, power series; Newton's method; homogeneous linear differential equations with constant coefficients; 3 hrs. lec., 2 hrs. rec. Prerequisite: 21-121.

21-125
Maple Lab **Fall and Spring: 3 units**
An introduction to the symbolic programming package Maple using mathematical topics chosen from calculus and linear algebra. 1.5 hrs. lec.

21-127
Introduction to Modern Mathematics **Fall or Spring: 9 units**
This course serves to introduce 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, but these subjects are closely related to the application of mathematics in many areas, particularly computer science. The course contents include an introduction to the algebra of sets, relations, functions, and partitions, and a basic introduction to elementary number theory. The techniques of proof introduced include proof by specialization and division into cases, indirect proof, existence and uniqueness proofs, non-constructive methods, and induction. 3 hours lecture. No prerequisites. A prerequisite for 15-211.

21-131
Analysis I **Fall: 10 units**
An enriched first course in calculus which includes a greater concentration on the foundations of the subject. Recommended for students with some prior background in calculus and who seek a deeper calculus course. Functions, limits, continuity; the Intermediate Value Theorem; the Riemann integral; the Fundamental Theorem of Calculus; integrability of continuous functions; the derivative and its significance; product rule, quotient rule, chain rule; Mean Value Theorem; inverse functions. 3 hrs. lec., 2 hrs. rec.

21-132
Analysis II **Spring: 10 units**
A continuation of Analysis I. 'Hopital'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. Prerequisite: 21-131, or consent of the instructor

21-228
Discrete Mathematics **Fall or Spring: 9 units**
The techniques of discrete mathematics arise in every application of mathematics which is not purely continuous, for example in computer science, economics, and general problems of optimization. This course presents two of the fundamental areas of discrete mathematics, namely enumeration and graph theory. The contents of this course include: An introduction to enumeration: permutations, combinations, recurrence relations, and generating functions. Ramsey's Theorem. Graph theory: planar graphs, Euler's Theorem, graph coloring, matchings, networks, and trees. 3 hours lecture, 1 hour recitation. Prerequisite: 21-127.

21-229
Set Theory **Fall: 9 units**
Set theory was invented about 110 years ago by George Cantor as an instrument to understand infinite objects and to compare different sizes of infinite sets. Since then set theory has come to play an important role in several branches of modern mathematics, and serves as a foundation of mathematics. Contents: Basic properties of natural numbers, countable and uncountable sets, construction of the real numbers, some basic facts about the topology of the real line, cardinal numbers and cardinal arithmetic, the continuum hypothesis, well ordered sets, ordinal numbers and transfinite induction, the axiom of choice, Zorn's lemma. Optional topics if time permits: infinitary combinatorics, filters and large cardinals, Borel and analytic sets of reals. Prerequisite: 21-127.

21-235/6
Mathematical Studies I & II **Fall and Spring: 20 units each**
A unified and intensive presentation of algebra, analysis, and geometry by a team of instructors. For capable and dedicated students who can allot a substantial amount of time to the study of mathematics. Aims at providing a modern background in mathematics for a career in pure or applied mathematics, science, or engineering. Topics covered include analysis in IR, analysis in Euclidean spaces, linear algebra, geometry, algebraic theories, multi-linear algebra, ordinary differential equations. Covers and extends the material taken up in the courses Calculus in Three Dimensions, Advanced Calculus I, Algebraic Structures, Linear Algebra I and II. Normally taken by students in the third and fourth semesters. On completion a number of options are open, among them the Honors Degree Program. Participation by invitation. Interested Freshmen should contact the Department in March. Prerequisites: 21-131 and 21-132 or the equivalent. 6 hrs. lec., 2 hrs. rec.

Course Descriptions

21-241
Linear Algebra I — **Fall or Spring: 9 units**
Linear spaces, linear transformations, matrices, determinants, eigenvalues and eigenvectors, inner product spaces, adjoint spaces, self-adjoint transformations, quadratic forms, principal axis transformation, spectral decomposition. 3 hrs. lec. Prerequisite: 21-127 recommended.

21-257
Optimization for the Social Sciences — **Fall or Spring: 9 units**
This course introduces basic methods of operations research and is intended primarily for social science majors and Industrial Management majors. Linear algebra; linear programming, including the simplex algorithm, duality, and sensitivity analysis; the transportation problem; other structured optimization problems; introduction to non-linear optimization. Prerequisite: 21-112. 3 hrs. lec., 1 hr. rec.

21-259
Calculus in Three Dimensions — **Fall or Spring: 9 units**
Vectors, lines, planes, quadratic surfaces, polar, cylindrical and spherical coordinates, partial derivatives, directional derivatives, gradient, divergence, curl, chain rule, maximum-minimum problems, multiple integrals, parametric surfaces and curves, line integrals, surface integrals, Green-Gauss theorems. 3 hrs. lec. 2 hrs. rec. Prerequisite: 21-121.

21-260
Differential Equations — **Fall or Spring: 9 units**
Ordinary differential equations: first and second order equations, applications, Laplace transforms; partial differential equations: partial derivatives, separation of variables, Fourier series, applications; further topics (as time permits): numerical techniques, method of characteristics, power series solutions, systems of ordinary differential equations. 3 hrs. lec., 1 hr. rec. Prerequisite: 21-122.

21-292
Operations Research I — **Spring: 9 units**
Operations research offers a scientific approach to decision making, most commonly involving the allocation of scarce resources. This course develops some of the fundamental methods used. Linear programming: the simplex method and its linear algebra foundations, duality, post-optimality and sensitivity analysis; the transportation problem; the critical path method; non-linear programming methods. 3 hrs. lec. 1 hr. rec. Prerequisite: 21-122.

21-300
Problem Seminar — **Fall or Spring: Variable units**
Students present solutions to problems of varying difficulty. 2-3 hrs. rec. Prerequisite: Permission of the instructor.

21-301
Combinatorial Analysis — **Fall or Spring: 9 units**
This course continues the study of combinatorics begun in 21-228. 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, the principle of inclusion and exclusion, the Fibonacci sequence, and the harmonic series. Topics surveyed include existence proofs, partitions, finite calculus, generating combinatorial objects. 3 hrs. lec. Prerequisites: 21-122 and 21-228 or permission of the instructor.

21-320
Symbolic Programming Methods — **Fall or Spring: 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.

21-342
Linear Algebra II — **Spring: 9 units**
A second linear algebra course concentrating more on the algebraic content of the subject. Linear transformations, change of basis, invariant subspaces, decompositions; inner product spaces: general properties, Gram-Schmidt orthogonalization, orthogonal subspaces, inequalities; determinants: significance, existence and formal properties, characteristic polynomials and their relationship to eigenvalues, the Cayley-Hamilton theorem; dual spaces; similarity: diagonalization of normal matrices, Jordan block decomposition. Advanced topics such as Hilbert spaces, infinite dimensional spaces in general, or tensor and exterior products as time permits. 3 hrs. lec. Pre-requisites: 21-241.

21-355
Advanced Calculus I — **Fall or Spring: 9 units**
This course expands on topics introduced in the calculus sequence and considers them at a higher mathematical level. Infinite series and sequences, completeness of the real numbers, continuous and differentiable functions, Riemann integral, sequences of functions, uniform convergence. 3 hrs. lec. Prerequisites: 21-259, 21-241.

21-356
Advanced Calculus II — **Spring: 9 units**
The purpose is to provide a successor to part I, presenting the fundamental ideas and methods of analysis. This course supplements the contents of the first course, and contains much of the theory of functions of several variables. 3 hrs. lec. Prerequisites: 21-241, 21-355.

21-369
Numerical Methods — **Fall or 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. Prerequisite: 21-259.

21-371
Functions of a Complex Variable — **Fall or Spring: 9 units**
This course provides an introduction to one of the basic topics of both pure and applied mathematics and is suitable for those with both practical and theoretical interests. Algebra and geometry of complex numbers; complex differentiation and integration. Cauchy's theorem and applications; conformal mapping; applications. 3 hrs. lec. Prerequisites: 21-259 and 21-260.

21-372
Partial Differential Equations — **Spring: 9 units**
This course provides an introduction to partial differential equations and is recommended for majors in mathematics, physical science, or engineering. Boundary value problems on an interval, Fourier series, uniform convergence, the heat, wave, and potential equations on bounded domains, general theory of eigenfunction expansion, the Fourier integral applied to problems on unbounded domains, introduction to numerical methods. 3 hrs. lec. Prerequisites: 21-259 and 21-260.

21-373
Algebraic Structures — **Fall or Spring: 9 units**
This course introduces the basic concepts of algebra, preparing the student to understand abstract concepts, and thus to go on to other courses. Algebraic systems, groups, rings, fields, integral domains, fields, polynomials, unique factorization domains, rings and ideals, applications to computer science and coding theory. 3 hrs. lec. Prerequisite:
21-241.

21-374
Field Theory — **Spring: 9 units**
The purpose of this course is to provide a successor to Algebraic Structures, with an emphasis on applications of groups and rings within algebra to some major classical problems. These include constructions with a ruler and compass, and the solvability or unsolvability of equations by radicals. It also offers an opportunity to see group theory and basic ring theory "in action", and introduces several powerful number theoretic techniques. The basic ideas and methods required to study finite fields will also be introduced. These ideas have recently been applied in a number of areas of theoretical computer science including primality testing and cryptography. 3 hrs. lec. Prerequisite: 21-241, 21-373.

21-393
Operations Research II — **Fall: 9 units**
An important goal of this course is for the student to gain experience with the process of working in a group to solve a problem. Much of the course is devoted to a group project based upon case studies and methods presented. Topics may include combinatorial optimization, game theory, integer programming, heuristic methods. Prerequisite: 21-292. 21-228 and 36-410 recommended. 3 hrs. lec.

21-440
Selected Topics in Algebra — **Fall or Spring: 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. Prerequisites: Variable.

21-441
Number Theory — **Fall: 9 units**
Number theory deals with the most basic structures of mathematics, specifically the integers. 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. Prerequisite: 21-127. 3 hrs. lec.

21-450
Selected Topics in Geometry — **Fall or Spring: 9 units**
Typical of courses which are offered from time to time are convex sets, differential geometry, projective geometry, and classical geometry. Prerequisites: Variable.

21-460
Topology **Spring: 9 units**
This course introduces the topological concepts that underlie analysis. Included are metric spaces, topological spaces, separation, compactness, convergence, and connectedness. Also included are constructions and concepts in topological spaces that parallel those found elsewhere in mathematics such as quotients, products, sums, factorization of mappings, and isomorphisms. Other topics included as time permits according to the interests of the instructor. 3 hrs. lec. Prerequisite: 21-355.

21-470
Selected Topics in Analysis **Fall or Spring: 9 units**
Typical of courses which are offered from time to time are finite difference equations, calculus of variations, and applied control theory. Prerequisites: Variable.

21-471
Numerical Analysis of Differential Equations **Fall or Spring: 9 units**
Runga-Kutta methods, Adams methods, predictor-corrector methods, Milne's method for second order equations, Newton's method in boundary-value problems, questions of stability of numerical methods, other topics such as stiff systems as time permits. Prerequisite 21-260.

21-476
Ordinary Differential Equations **Fall or Spring: 9 units**
Review of solution techniques, modeling techniques, existence and uniqueness, numerical procedures, linear equations and systems, special functions, autonomous non-linear systems, qualitative techniques. 3 hrs. lec. Prerequisites: 21-241 and 21-260.

21-484
Applied Graph Theory **Fall or Spring: 9 units**
Continued study of the methods of graph theory with a view toward applications to mathematical modeling in operations research, computer science and other disciplines. Topics include cycles, trees, connectivity, planarity, coloring, matching, directed graphs, network flows, path problems, counting arguments, graph algorithms. 3 hrs. lec. Prerequisite: 21-228 or permission of instructor.

21-599
Undergraduate Reading and Research **Fall or Spring**
Individual reading courses or projects in mathematics and its applications. Prerequisites and units to be negotiated with individual instructors.

Graduate courses

Courses numbered 21-6xx are considered transitional between undergraduate and graduate study. Advanced undergraduates are encouraged to elect these courses.

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. Prerequisites: 21-373 or 21-484 recommended.

21-602
Introduction to Set Theory **Fall: 12 units**
First order definability and the Zermelo-Fraenkel axioms; cardinal arithmetic, ordered sets, well-ordered sets (axiom of choice), transfinite induction, the filter of closed unbounded sets (Fodor, Ulm and Solovay's theorems), Delta systems, basic results in partition calculus (e.g., Ramsey's Theorem and the Erdos-Rado Theorem); small to medium large cardinals; applications to general topology (e.g., Alexandroff's conjecture), and the basic ideas of descriptive set theory. The independence of Suslin conjecture from the usual axioms. Godel's axiom of constructibility. Time permitting, the Galvin-Hajnal-Shelah inequality will be proved.

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 Neilsen-Schreier theorem. Vector spaces over division rings, field extensions, the fundamental Galois correspondence, algebraic closure. The Jacobson radical and the structure of semisimple rings. Time permitting, one of the following topics will be included: Wedderburn's theorem on finite division rings, Frobenius' Theorem. Prerequisite: Familiarity with the content of an undergraduate course on groups and rings.

21-620
Real Analysis **Fall: 6 units**
A review of one-dimensional, undergraduate analysis, including a rigorous treatment of the following topics in the context of real numbers: sequences, compactness, continuity, differentiation, Riemann integration. (Mini-course. Normally combined with 21-621.)

Course Descriptions

21-621
Introduction to Lebesgue Integration **Fall: 6 units**
Construction of Lebesgue measure and the Lebesgue integral on the real line. FatouV{U}s Lemma, the monotone convergence theorem, the dominated convergence theorem. (Mini-course. Normally combined with 21-620.)

21-622
Finite-Dimensional Analysis **Fall or Spring: 12 units**
Linear spaces, linear transformations, duality, bilinearity, inner-product spaces. Convexity. Norms, limits, compactness. Gradients of mappings, divergence and curl. Implicit Function Theorem. Constrainted extrema. Spectral theory. Volume and surface integrals, Divergence Theorem.

21-651
General Topology **Fall: 12 units**
Metric spaces: continuity, compactness, Arzela-Ascoli Theorem, completeness and completion, Baire Category Theorem. General topological spaces: bases and subbases, products, quotients, subspaces, continuity, topologies generated by sets of functions, homeomorphisms. Convergence: nets, filters, and the inadequacy of sequences. Separation: Hausdorff spaces, regular spaces, completely regular spaces, normal spaces, Urysohn's Lemma, Tietze's Extension Theorem. Connectedness. Countability conditions: first and second countability, separability, Lindelof property. Compactness: Tychonoff's Theorem, local compactness, one-point compactification.

21-660
Introduction to Numerical Analysis I **Fall: 12 units**
Finite precision arithmetic, interpolation, spline approximation, numerical integration, numerical solution of linear and nonlinear systems of equations, optimization in finite dimensional spaces.

21-700
Mathematical Logic II **Spring: 12 units**
Introduction to higher-order logic (type theory) with primary emphasison the typed lambda-calculus. Syntax and semantics, lambda-notation, axiomatic treatment, axioms of Descriptions, Choice, and Infinity, weak completeness, weak compactness, standard and non-standard models. Computer-assisted formal proofs. Formalization of mathematics, definability of natural numbers, representability of recursive functions, Church's Thesis. Godel's Incompleteness Theorems, undecidability, undefinability. Prerequisite: 21-600 or permission of the instructor.

Course Descriptions

Mechanical Engineering

Undergraduate Courses

24-101
Fundamentals of Mechanical Engineering — **Fall and Spring: 12 units**
The purpose of this course is to introduce the student to the field of mechanical engineering through an exposition of its disciplines, including structural analysis, mechanism design, fluid flows, and thermal systems. By using principles and methods of analysis developed in lectures, students will complete two major projects. These projects will begin with conceptualization, proceed with the analysis of candidate designs, and culminate in the construction and testing of a prototype. The creative process will be encouraged throughout. The course is intended primarily for CIT freshmen. 3 hrs. lec., 2 hrs. rec./lab. Co-requisites: 21-121, 33-106.

24-112
Fluid Mechanics — **Spring: 9 units**
Hydrostatics. Control volume concepts of mass, momentum, and energy conservation. Euler's and Bernoulli's equations. Viscous flow equations. Head losses in ducts. Dimensional analysis as an engineering tool. 2 hrs. lec., 1 hr.rec. Prerequisites: 21-122, 33-106.

24-121
Thermodynamics I — **Fall : 9 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. Applications to a wide range of processes and devices. 3 hrs. rec. Prerequisites: 21-122, 33-106.

24-141
Statics and Dynamics — **Fall: 12 units**
The force and moment static equilibrium relations for two- and three-dimensional rigid systems are developed. Dynamic topics include kinematical relations for particles and rigid bodies in three-dimensional motion. The equations of motion for particles and rigid bodies are developed with emphasis on planar motion. The concepts of kinetic and potential energy for rigid bodies is introduced. The course will be equally divided between the study of statics and dynamics. 3 hrs. lec., 1 hr. rec. Prerequisites: 33-106, 21-259 (concurrently).

24-160
Engineering Graphics — **Fall and Spring: 9 units**
Introduction to the use and preparation of engineering drawings, including the following topics: basic drawing techniques; dimensioning of orthographic drawings; auxiliary and oblique views; sectional drawings; working drawings; blueprint reading; freehand sketching; production standards, methods, and symbols; simplified drawing techniques; intersection and development; basic applied descriptive geometry. 3 hrs. rec., 3 hrs. lab.

24-202
Mechanics of Deformable Solids — **Spring: 10 units**
Conditions of static equilibrium are reviewed and stress-strain relations for biaxial stress are developed. Problems include thin-walled pressure vessels, stresses and deformations in statically determinate and indeterminate bars in tension or compression, shafts in torsion, and beams in bending. 3hrs. lec., 1 hr. rec., 1 hr. lab. Prerequisites: 21-259, 33-106, 24-141, or permission of the instructor.

24-203
Stress Analysis — **Spring: 10 units**
This course will first review important solutions from strength of materials. The students will then be introduced to the theory of elasticity with emphasis on developing an understanding of stress concentrations. Additional types of deformation processes that may be discussed are: buckling, simple plasticity, and creep. An important aspect of the course will be in showing how each type of process can cause failures in actual engineering applications. 3 hrs. lec., 1 hr. lab. Prerequisites: 24-202, 21-259.

24-208
Manufacturing Sciences — **Fall: 9 units**
This course has two broad concerns: an introductory review of manufacturing systems organization and a review of common manufacturing processes from the point of view of design for manufacturability. The features of mass and batch production are quantitatively considered. The basic principles of group technology and production planning are outlined. The use of computers in manufacturing is described, together with a review of the current capabilities of industrial robots. Students will be involved in weekly seminars which will describe the basic features of common manufacturing processes, including metal machining, metal forming, polymer processing, casting techniques, joining techniques, ceramic processing, and powder processing. Case studies from industry and films may be used. 3 hrs. rec. Prerequisites: 24-202 or permission of the instructor.

24-213
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: 24-112, 24-121, 21-259, 21-260.

24-215
Potential Flow and Aerodynamics — **Spring: 9 units**
Development of the fundamental equations of incompressible frictionless flow. Concepts of circulation, vorticity, irrotationality, stream function, and velocity potential. Two-dimensional low speed airfoil theory; lift and moment calculations for the infinite span wing; empirical airfoil data for real airfoils; thin airfoil theory. Three-dimensional effects; flow distribution; Prandtl's wing theory; induced drag; the elliptic lift distribution; the general lift distribution. 3 hrs. rec. Prerequisites: 24-112, 21-259, 21-260.

24-216
Gas Dynamics — **Spring: 9 units**
Development of the foundations of frictionless compressible flow. Internal flow with friction and heat transfer. Acoustics and wave motion. Oblique shocks and expansion waves. Two-dimensional subsonic and supersonic flow including hodograph transformations, linearized theory of thin airfoils, and the method of characteristics. Introduction to transonic and hypersonic flow and reentry problems. 3 hrs. rec. Prerequisites: 21-259, 21-260, 24-223.

24-223
Thermodynamics II — **Fall: 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 liquifiers. One-dimensional compressible flow in nozzles; normal shock waves. Mixtures of gases; application to hygrometry and air conditioning. Thermodynamics of reactive systems, including equilibrium criteria, the phase rule, heats of reaction, combustion and dissociation. 3 hrs. rec., 3 hrs. lab. Prerequisites: 24-112, 24-121.

24-224
Thermal Systems Analysis — **Spring: 9 units**
Performance studies of various thermal processes and devices with emphasis on energy utilization and environmental impact. Examples may be drawn from nuclear power plant processes, jet propulsion, energy conversion, internal and external combustion engines, desalination, and other areas of current interest. 3 hrs. rec. Prerequisite: 24-223.

24-225
Direct Energy Conversion — **Spring: 9 units**
Principles of energy conversion between various forms of energy such as heat, electricity, and light with applications. Theory of thermoelectric, thermionic, magnetohydrodynamic, and photovoltaic direct conversion devices. Principles of chemical and mechanical energy storage. 3 hrs. rec. Prerequisites: 24-112, 24-121, 33-107.

24-227
Internal Combustion Engines — **Fall: 10 units**
Basic principles and fundamentals of internal combustion engines; gas turbine, spark ignition and diesel compression ignition engines. Combustion chamber design. Monitoring and control of fuel efficiency and emission of pollutants in exhaust gases. Developments in direct injection, rotary, prechamber and stratified charge engines. Ignition, fuel injection, mixing and combustion processes, heat release, and energy balances. Engine laboratory projects include: air and fuel controls, measurement of particulate and species concentrations in exhaust gases. 3 hrs. rec., 1 hr. lab. Prerequisite: 24-223.

24-233
Heat Transfer — **Spring: 9 units**
Introduction to basic concepts of engineering heat transfer. Steady and transient heat conduction in solids, including the effect of heat generation. Finned surfaces. Heat and momentum transfer in forced and free laminar and turbulent convection for both confined fully developed flows and boundary layer flows. Condensation and boiling. Design of heat exchangers. Radiation heat transfer. Problems in combined convection and radiation. 3 hrs. rec. Prerequisites: 24-112, 24-121, 21-259, 21-260.

24-242
Engineering Vibrations — **Fall or Spring: 11 units**
Frequency response of linear mechanical systems, with and without damping. Use of computational methods for simulating system response and the use of modal analysis for understanding the vibratory response of complex systems. Lumped and distributed mass systems. Applications include isolation, stability, and balancing. 3 hrs. lec., 1 hr.rec., 2 hrs. lab. Prerequisite: 24-245.

24-243
Engineering Dynamics — **Spring: 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. Prerequisites: 24-141, 24-245, 24-258.

Course Descriptions

24-245
Dynamics of Physical Systems — **Fall: 11 units**
Unified treatment covers modeling, solution forms, and physical understanding of dynamic systems which involve the storage and transfer of matter and energy. Mathematical lumped models for mechanical, electrical, fluid, and thermal systems are emphasized. Time domain analysis methods, block diagrams, linear graphs, and stability and their relationship to dynamic engineering systems are introduced. Laboratory evaluations and demonstrations compare real systems and the behavior of their associated mathematical models. 3 hrs. rec., 2 hrs. lab. Prerequisites: 21-259, 21-260, 24-141, 33-107.

24-246
Feedback Control Systems — **Spring: 9 units**
An introduction to the fundamental principles of classical feedback control and its application. Emphasis is on the analysis and control of dynamic systems using classical techniques. Topics include the following. Overview of dynamic systems modeling. Feedback control system concepts: plant, controller, actuator, and sensor. Performance specifications and design requirements: robustness, speed of response, stability, and accuracy. Analytical and graphical methods for treating linear control systems: root-locus, Bode diagrams, Nyquist criterion. Introduction to time domain analysis of linear systems, control system instrumentation and design, and digital control. 3 hrs. rec. Prerequisites: 24-245, 15-127.

24-247
Instrumentation and Design of Control Systems — **Fall: 9 units**
Open-loop and closed-loop structure of control systems. Analog and digital control systems. Identification of basic components (plant, drive system, controller, measurement system, and signal modification devices) in a control system with respect to their functions, operation, and interaction with each other. Selection of structure and parameter values for various components, and component matching, in order to meet a set of design specifications. Design in the time domain. Design in the frequency domain. Optimal design of control systems. Applications to mechanical systems. 3 hrs. rec. Prerequisite: 24-246, or concurrent with 18-301.

24-248
Kinematics and Dynamics of Mechanisms — **Spring: 9 units**
This design-oriented course addresses the kinematics and dynamics of mechanisms with applications to linkage systems, reciprocating engines, and industrial machinery. Conventional as well as innovative rigid-body dynamic systems are studied. Problems of kinematics and dynamics are framed in a form suited for computer analysis. The course bridges analysis and design by emphasizing the synthesis of mechanisms. To stimulate a creative approach, homework and project work draw upon actual engineering design problems. 3 hrs. rec. Prerequisites: 24-141, 24-245.

24-249
Dynamics and Vibrations — **Fall: 10 units**
Equations of motion for dynamic systems are formulated, utilizing Newtonian and energy methods of mechanics. Three-dimensional vector kinematics and the dynamics of particles and rigid bodies, including inertia properties, are presented. The frequency response of linear mechanical systems, with and without damping, is considered. Matrix methods, using stiffness and flexibility concepts, and the use of the digital computer for the solution of problems are included. Lumped and distributed mass systems are studied. 3 hrs. rec., 1 hr. lab. Prerequisite: 24-245.

24-251
Engineering Analysis — **Fall and Spring: 12 units**
The purpose of this course is to develop in the student the professional method of solving engineering problems in analysis and design, through application of the fundamental principles of physics, mathematics, thermodynamics, and electricity. Because the course is built around actual engineering problems, it leans heavily on problem definition and modeling, for which assumptions based on engineering judgment must be made. Checking analytical results is emphasized, by use of dimensions, limiting cases, and reasonableness, since solutions are generally open-ended or not unique, and therefore must be technically defensible. Particular attention is paid to the interpretation, evaluation, and generalization of results, with dimensionless variables being used where appropriate. 3 hrs. rec., 2 hrs. lab. Prerequisite: Senior standing.

24-258
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: 21-259, 21-260.

24-266
Engineering Design — **Fall and Spring: 12 units**
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. Prerequisite: Senior standing in Mechanical Engineering.

24-267
Engineering Design — **Fall and Spring: 12 units**
A design course similar to 24-266. For Mechanical Engineering students who are taking a double major with Engineering and Public Policy. 3 hrs. rec., 3 hrs. lab. Prerequisite: Senior standing in Mechanical Engineering and double major with EPP.

24-268
Design for Manufacture — **Spring: 9 units**
Introduces methods for concurrent design and manufacturing. Course topics will include methods of value engineering, function logic, design review process, Taguchi analysis, design of experiments, design for assembly, process selection, statistical process control, and discussion of such topics as net shape processes, zero quality control, 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. Prerequisite: Open to engineering seniors who have taken 24-208, or permission of instructor.

24-269 (19-269)
Quality Assurance — **Spring: 9 units**
This course is intended as a course in the Quality Engineering area. Several methods employing probability and statistical techniques to quality control assurance issues will be addressed. These issues are linked to advanced topics such as the Taguchi methods, statistical process and quality control (SPC & SQC), and queueing theory. Management and economic issues involved in today's international market will be discussed. Examples from a wide range of industries such as the automotive, computer, aerospace, and marine industries will be analyzed. Data analysis will be conducted using some state of the art techniques and tools. Prerequisite: 21-259.

24-271, 24-272
Mechanical Engineering Project — **Fall and Spring: 9 units**
Practice in the organization, planning, and execution of appropriate engineering projects. These investigations may be assigned on an individual or a team basis and in most cases will involve experimental work. 9 hrs. lab.

24-273, 24-274
Departmental Research Honors — **Fall, Spring and Summer: 9 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, writing a thesis describing that project, and presenting the thesis orally to the College/Department at the end of the Senior year. 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.

24-281
Mechanical Engineering Seminar I — **Fall: 1 unit**
Practice in making an oral presentation on a technical topic. Each student prepares and delivers a talk on an engineering subject. This course is designed to improve the ability of the student to present a formal talk and to establish confidence in speaking before a group. 1 hr. rec.

24-282
Mechanical Engineering Seminar II — **Spring: 1 unit**
Continuation of 24-281. Further practice in speaking to a group on a subject of interest to engineers. Each student will give at least one talk during the term. 1 hr. rec.

24-295
Air Pollution — **Fall: 9 units**
Sources of atmospheric contaminants and their effects on visibility, health, vegetation, and materials. Particulate and gaseous emissions and their classification. Chemistry and fluid mechanics of atmospheric pollutants. Combustion processes and formation of photochemical smog. Meteorological effects and dispersion of pollutants from stationary and moving sources. Measurements of air pollutants. Detection devices and techniques of sampling and analysis. Principles and design of air pollution control equipment. Economic aspects of air pollution control. Control legislation and public policy issues. 3 hrs. rec. Prerequisite: junior or senior standing.

24-297 (19-297)
Energy-Environmental Systems — **Spring: 9 units**
Fuel cycles for conventional and non-conventional energy resources; relationships between environmental impacts and the conversion or utilization of energy; measures of system and process efficiency; detailed study and analysis of coal-based energy systems including conventional and advanced power generation, synthetic fuels production, and industrial processes; technological options for multi-media (air, water, land) pollution control; mathematical modeling of energy-environmental interactions and tradeoffs and their dependency on technical and policy parameters; methodologies for energy and environmental forecasting; applications to issues of current interest. 3 hrs. rec. Prerequisite: 24-121 or equivalent, junior or senior standing.

24-301
Nuclear Power Generation **Spring: 9 units**
An introduction to nuclear physics. Neutrons and their interaction with matter. Elementary fission reactor theory. Critical size calculations. Heat transfer and fluid flow in nuclear reactors. Thermodynamic aspects of nuclear power plants. Breeder reactors and nuclear fuel cycles. Fusion reactors. Operating characteristics of nuclear reactors. 3 hrs. rec. Prerequisite: 24-223 or permission of the instructor.

Graduate Courses

The following graduate courses may be scheduled as technical electives by undergraduates provided that the student has (a) completed the necessary prerequisites, (b) obtained approval from a faculty advisor, and (c) obtained permission from the instructor for the course. Descriptions of these and other graduate courses may be found in the Carnegie Institute of Technology Graduate Catalog.

24-701	Mathematical Techniques in Mechanical Engineering I
24-702	Mathematical Techniques in Mechanical Engineering II
24-703	Numerical Methods in Mechanical Engineering
24-704	Advanced Engineering Analysis
24-711	Fluid Mechanics
24-712	Turbulent Flow
24-713	Plasma Dynamics and Magnetohydrodynamics I
24-714	Plasma Dynamics and Magnetohydrodynamics II
24-716	Nonequilibrium Gas Dynamics
24-718	Computational Fluid Mechanics
24-719	Advanced Topics in Fluid Mechanics
24-721	Thermodynamics I
24-722	Thermodynamics II
24-729	Advanced Topics in Thermodynamics
24-731	Conductive and Radiative Heat Transfer
24-732	Convective Heat Transfer
24-739	Advanced Topics in Heat Transfer
24-744	Combustion
24-749	Advanced Topics in Combustion
24-751	Introduction to Solid Mechanics I
24-752	Introduction to Solid Mechanics II
24-753	Theoretical Solid Mechanics I
24-754	Theoretical Solid Mechanics II
24-755	Theories of Beams, Plates, and Shells
24-756	Stability Phenomena in Mechanics
24-757	Vibrations of Elastic Systems
24-759	Advanced Topics in Solid Mechanics
24-760	Computer Methods in Solid Mechanics
24-765	Dynamics
24-767	Mechanics of Fracture and Fatigue
24-768	The Finite Element Method in Structural Mechanics
24-769	Finite Element Program Development
24-771	Modern Control Engineering
24-772	Multivariable Process and Nonlinear Control
24-774	Robotic Systems
24-775	Optimal and Stochastic Control
24-779	Special Topics in Control Engineering
24-781	Design Procedures
24-782	Design and Entrepreneurship
24-788	Expert Systems and the Mechanics of Manufacturing
24-789	Advanced Topics in Manufacturing

Materials Science and Engineering

Undergraduate Courses

27-100
Materials in Engineering **Fall and Spring: 12 units**
The objective of this course is to provide an introduction to several important classes of materials and to the use and selection of materials for engineering applications. Polymers, ceramics, semiconductors, metals, glasses and composites are discussed in the context of six specific engineering applications. The physical, optical, electrical and/or mechanical properties critical to the design of the engineered component are discussed. Considerations involved in materials selection for the particular application are discussed with emphasis on the balance between performance and cost. Processing methods used for improvement of material properties are presented and practiced through a series of laboratory experiments which illustrate the connection between microstructure, properties and processing. The engineered items which are discussed vary, but a typical list may include applications such as optical fibers, jet engine blades, running shoes, LEDs, and superconductors. 3 hrs. lecture, 3 hrs. laboratory on alternate weeks. Corequisites: 21-121 and 33-121, or permission of the instructor.

27-131
Introduction to Materials Science **Spring: 9 units**
This course covers the same material as 27-100 but is taught without lab. 3 hrs. lecture. (Discontinued after Spring 1994)

27-201
Structure of Materials **Fall: 9 units**
Electronic structure of the elements and the periodic table. Bonding in different classes of materials, and the relation to crystal structure and amorphous materials. Fundamentals of symmetry and crystallography. Diffraction of various electromagnetic waves. Crystal imperfections of 1, 2 and 3 dimensions. Pre- or co-requisites 21-122, 09-105, 33-107.

27-215
Thermodynamics of Materials **Spring: 12 units**
The fundamental thermodynamic laws will be presented and the concepts of work, heat, enthalpy, entropy, free energy and chemical equilibrium discussed in detail. Problems in thermochemistry, electrochemistry, phase equilibria, and solution chemistry will be used to illustrate the role of thermodynamics in materials science and to instruct the student in the application of thermodynamics to real materials and environmental problems. Pre- or co- requisites: 09-105, 33-107, 09-106.

27-250
Sophomore Seminar **Spring: 3 units**
This seminar course will stress the development of communication skills in the context of technical interchange. 1 hr. lecture.

27-303
Materials Science and Engineering Laboratory I **Fall: 9 units**
The objective of this laboratory course is not only to develop a range of basic experimental skills, but also to reinforce some of the most important fundamental concepts introduced in previous courses. These principles include crystal structures, X-ray diffraction, phase diagrams and defects. Basic skills to be developed include standard laboratory procedures, recording of results, written and oral communication of results, experimental design, materials synthesis, practical aspects of X-ray diffraction, electrical measurements, and the use of computers for data analysis. 1 hr. lecture, 3 hrs. lab. Pre- or co-requisite: 27-100, 27-131 or permission of the instructor.

27-304
Materials Science and Engineering Laboratory II **Spring and Summer: 9 units**
This course is a continuation of 27-303. Four sets of laboratory experiments are conducted in the areas of (1) mechanical properties including behavior of polymeric materials (2) recrystallisation and grain growth (3) hardening mechanisms in metals and alloys and (4) processing and properties of ceramics. Technical report writing receives major emphasis. 1 hr. lecture, 3 hrs. lab. Prerequisite 27-303

27-311
Phase Relations **Spring and Summer: 12 units**
Stability of structures. Hume-Rothery rules. Free energy-composition curves with applications to binary and ternary phase diagrams. Quantitative concepts of nucleation and growth with examples from solidification. Development of microstructures in various classes of phase diagram under near-equilibrium conditions. Atomic mechanisms of solid state diffusion and approach to equilibrium through diffusion. 4 hrs. lecture. Pre- or co- requisites 27-215, 27-321.

27-321
Transport and Kinetics **Fall: 12 units**
This course is designed to allow the student to become familiar with the fundamental principles of heat flow, fluid flow, mass transport and reaction kinetics. In addition, the student will develop the skills and methodologies necessary to apply these principles to problems related to materials manufacture

Course Descriptions

and processing. Topics will include thermal conductivity, convection, heat transfer equations, an introduction to fluid phenomena viscosity, etc., Newtons and Stokes Laws, mass momentum balances in fluids, boundary layer theory, diffusion and absolute reaction rate theory. Where appropriate, examples will be taken from problems related to the design of components and the processing of materials.

27-322
Processing Methods **Spring: 9 units**
This course deals with the principles of processing materials and the application of those principles to process design optimization. Topics include chemical thermodynamics, reaction kinetics, surfaces, colloids and dispersions, process engineering, fundamentals of heat treatment, compaction of powders, densification and sintering. These principles will be applied to processing of metals (hydrometallurgy, electrometallurgy and steel making) and ceramics (high and low temperature processing) and specifically to their effects on the environment. 4 hrs. lecture. Pre- or co- requisite: 27-215, 27-321

27-350
Industrial Projects Seminar **Summer: 9 units**
This course is offered only to students in the Industrial Internship Option who have completed two terms in industry. Its purpose is to consolidate learning gained from industrial experiences and to sharpen communication skills. Reports are presented by the students describing and interpreting their industrial project assignments. These reports draw upon the technical literature as well as on previous courses and work experience, and they focus on operating and/or marketing problems of the company or industry involved. Interspersed with the seminars are plant visits and talks from representatives of industry.

27-357
Issues in Materials Selection **Fall: 9 units**
This course covers many of the same issues as 27-557 but is intended for non-MSE majors and will not require the background assumed for that course. 3 hr. lecture. Prerequisite 27-131 or equivalent, or permission of instructor.

27-412
Phase Transformations **Fall: 9 units**
Structural issues in non-equilibrium transformations of various types. Energies and structures in homophase and heterophase boundaries, and effects on nucleation and growth. Applications to recovery, recrystallization, and grain growth in single phase materials. Kinetics of diffusional phase transformations - classical nucleation and growth (including strain energy), spinodals, massive transformations, ordering and Ostwald ripening. Diffusionless transformations. Structural aspects of solidification in alloys and examples from crystal growth, casting and joining. 3 hrs. lecture. Prerequisites: 27-311, 27-321.

27-421 and 27-721
Processing Design **Fall: 9 units**
In this course the concepts of materials and process design are developed, integrating the relevant fundamental phenomena. The relationship between processing, structure and materials properties are discussed. The course consists of a number of case studies, such as chemical vapor deposition, strip casting, powder compaction, direct ironmaking, and the forming of clad and coated materials. The graduate version of this course includes a major project. 3 hrs. lecture. Pre- or co-requisites: 27-215, 27-321

27-432
Electrical, Magnetic, and Optical Properties of Materials **Fall: 9 units**
Students will develop a basic understanding of the electrical, optical, and magnetic properties of materials using the principles of modern solid state physics. The course will include such topics as electrical conduction in metals and alloys, ionic conduction in ceramics, optical properties of pure and doped semiconductors, and magnetic recording media. Wherever possible, examples will emphasize applications involving materials which were selected, designed, or processed to accentuate a particularly interesting electrical, optical, or magnetic property. 3 hrs. lecture. Prerequisites: 33-225 or equivalent introductory quantum mechanics course; permission of the instructor.

27-441
Deformation and Fracture of Materials **Fall: 9 units**
This course covers fundamentals of stress and strain and their transformation; stress-strain relations in tension, compression, shear, torsion and bending; elastic and plastic properties of single crystals and polycrystalline aggregates; elementary dislocation theory and its application to strengthening mechanisms; ductile and brittle fracture; applications to metals, ceramics, polymers and composites. 3 hrs. lecture. Prerequisites: 33-106, 27-201.

27-442
Deformation Processing **Spring: 9 units**
A continuum analysis of plastic flow of isotropic and anisotropic (textured) materials will be applied to deformation processing. Crystallographic models of yielding and plastic flow will also be developed and used to characterize various industrial deformation processing techniques. 3 hrs. lecture. Prerequisite 27-441.

27-454
Advanced Reading **Fall, Spring or Summer**
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 Senior Project, 27-555. Prerequisite: junior standing with consent of faculty supervisor.

27-512
Diffraction Methods in Materials Science **Fall: 9 units**
This is a specialized course in x-ray diffraction intended for advanced undergraduate students or graduate students. The theory and experimental techniques of diffraction in crystalline solids are introduced. Attention is given to the physical concepts behind crystal structure and diffraction, including the direct and reciprocal lattices, Bragg and Laue diffraction theories and structure-factor calculations. The experimental methods of x-ray and electron diffraction are presented, with emphasis on x-ray diffraction. Topics include the production and scattering of x-rays, factors affecting the scattered intensity, and techniques for obtaining and interpreting diffraction patterns. 3 hrs. lecture. Prerequisites: junior standing.

27-530
Advanced Physical Metallurgy **Fall: 9 units**
The purpose of this course is to develop a fundamental understanding of the evolution of microstructure in engineering alloys and how desired mechanical and physical properties can be obtained by control of microstructure. The first part of the course considers phase stability, phase diagrams and the thermodynamics, mechanisms and kinetics of phase transformations. The second part of the course concerns property/microstructure relationships in engineering alloys and how the concepts covered in the first part of the course can be used to obtain the desired microstructures. 3 hrs. lecture. Prerequisite: Permission of the instructor.

27-533
Principles of Growth and Processing of Semiconductors **Spring: 9 units**
Development of a fundamental understanding of material principles governing the growth and processing of semiconductors. Techniques to grow and characterize bulk crystals and epitaxial layers are considered. The processing of semiconductors into devices and the defects introduced thereby are discussed. The roles of growth- and processing-induced defects in determining long term reliability of devices are examined. Prerequisite: Permission of the instructor.

27-542
Structure and Properties of Thin Films **Spring: 9 units**
This course is designed to provide an introduction to the science and technology of thin films, with special emphasis on relationships between microstructure and concomitant engineering properties. Topics include (1) various methods of thin film production, such as vapor, ion beam, and chemical deposition, (2) epitaxial growth and regrowth processes, (3) dimensional, chemical, and structural characterization of thin films, (4) degradation mechanisms, such as interdiffusion, interfacial reactions, and electromigration, and (5) mechanical, electrical, magnetic, and optical properties of thin films and related applications. Prerequisite: 27-131 or permission of the instructor.

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, such as strength, toughness and 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 ferrites in phased-array radar systems. Numerous examples are used throughout the course to illustrate the engineering relevance of fundamental phenomena. 3 hrs. of lecture. Prerequisite: Permission of the instructor.

27-555
MSE Senior Project I **Fall or Spring: 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
MSE Senior Project II **Fall or Spring: 9 units**
Optional second semester of Senior Project I, see 27-555.

27-557
Selection and Performance of Materials **Spring: 9 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. 3 hr. lecture. Prerequisite: 27-311

27-566
Special Topics in MSE **Fall or 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. 3 hrs. lecture. Prerequisite: junior or senior standing.

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.

Graduate Courses (27-7xx)

The following graduate courses are available to undergraduate students who have appropriate prerequisites and permission of the instructor. Descriptions of these and other graduate courses may be found in the graduate catalogue of CIT.

27-760	Advanced Metallurgical Reactions
27-763	Electron Optical Methods of Materials Characterization
27-765	Special Topics in Metallurgy and Materials Science
27-767	Solid Surfaces
27-770	Electrical, Magnetic and Optical Properties of Materials
27-778	Mathematical Methods in Materials Research
27-779	Bonding, Crystals and Defects
27-780	Thermodynamics
27-782	Phase Transformations
27-783	Phase Transformations in Solids II
27-784	Strengthening Mechanisms in Solids
27-785	Theory of Alloy Phases
27-786	Deformation Behavior of Materials
27-787	Fracture Behavior of Materials
27-788	Defects in Materials
27-791	Relation Between Structure and Mechanical Behavior
27-792	Solidification Processing

Military Science - Army ROTC

Undergraduate Courses

30-101
Self Development and Military Skills I **Fall: 5 Units**
An introductory course to the organization of the United States Army. Instruction includes basic military skills; map reading, rifle marksmanship, small unit tactics, drill and ceremonies, physical training and military history.

30-102
Self Development and Military Skills II **Spring: 5 Units**
A continuation of 30-101. Instruction includes advanced map reading and land navigation skills, physical training , first aid and tactics combined with practical exercises.

30-201
Challenges in Modern Leadership I **Fall: 5 units**
An introduction of basic leadership skills and the continuing study of basic military skills. Emphasis is placed on practical leadership in today's Army. Areas of concentration include personal communication development, small group interaction and individual counseling skills. A continuation of training in basic military skills, physical training, Army organization, customs and traditions is also included. 2 hr./wk.

30-202
Challenges in Modern Leadership II **Spring: 5 units**
A continuing study of the American Army today as related to the organization, branches, customs, traditions, doctrine, physical training , roles of related components and basic military skills. Further introduction to leadership/ management skills is also included. 2 hr./wk.

30-301
Tactics and Strategies I **Fall : 5 units**
This course is an introduction to small unit leadership, concentrating on the role of the small unit leader in a tactical military situation. Emphasis is on mastering the functions of common military equipment, normal duties encountered by small unit leaders and physical conditioning.(Junior Phase). 2 hr./wk. Note: this class is for contracted cadets only. Auditing permitted only with the permission of the Professor of Military Science.

30-302
Tactics and Strategies II **Spring: 5 units**
This course is a continuation of 30-301. Refinement in techniques of small unit leadership, situational problems, physical training and preparation for attendance at Advanced Camp comprise the course.(Junior Phase). 2 hr./wk. Note: this class is for contracted cadets only. Auditing permitted only with the permission of the Professor of Militiary Science.

30-401
Transition to Professional Leadership I **Fall: 5 units**
This course consists of Administration and Staff Operations. It is designed to prepare the student for leadership positions through proper utilization of management skills — decision making, counseling, planning and conducting meetings, conferences, briefings, and preparing, conducting and evaluating training. Also discussed are duties, responsibilities and authority of a leader, staff functions, physical training and personnel management. 2 hr./wk. Note: this class is for contracted cadets only. Auditing permitted only with the permission of the Professor of Military Science.

30-402
Transition to Professional Leadership II **Spring: 5 units**
This course is designed to prepare the student for the role of a newly commissioned officer. The student is introduced to Military Justice, the Law of Warfare, explores the ethics and professionalism of a leader, and prepares for the transition from student to military officer. A review of small unit leadership and physical conditioning is also conducted. 2 hr./wk. Note: this class is for contracted cadets only. Auditing permitted only with the permission of the Professor of Military Science.

Leadership Lab/Seminar **Fall/Spring: 0 units**
Leadership Lab is a required part of all Military Science classes. It provides a leadership laboratory for the junior and senior cadets to assist them in their development of leadership skills. This lab is cadet planned, organized and run. 1-1/2 hr./wk. Note: This class is for contracted cadets only.

Course Descriptions

Aerospace Studies - Air Force ROTC

Undergraduate Courses

31-101
Air Force Today — **Fall: 3 units**
Introductory course exploring the military as a profession, control of U.S. armed forces, the functions and organization of the U.S. Air Force, and communication methods in the Air Force.

31-102
Air Force Today — **Spring: 3 units**
Continues the study of the U.S. military forces, including the doctrine, missions and employment concepts. U.S. strategic defensive forces, general purpose forces, and aerospace support forces are each examined.

31-201
Development of Air Power — **Fall: 3 units**
An introductory course in the history of air power, from the beginnings of manned flight through the end of World War II, with emphasis on concepts governing the employment of air power.

31-202
Development of Air Power — **Spring: 3 units**
Continues the study of air power history from World War II through the present with emphasis on how air power has been used in military and non-military operations to support national objectives.

31-301
Management and Leadership — **Fall: 9 units**
A study of the management functions of planning, organizing, coordinating, directing and controlling. Within these functions, basic and advanced techniques, to include Total Quality Management, are explored. Communication skills are stressed through written and oral assignments.

31-302
Management and Leadership — **Spring: 9 units**
An interdisciplinary approach to leadership which includes the study of human behavior and relationships. Concepts of motivation, professional ethics, leadership styles, and discipline are explored. Communicative skills are stressed through written and oral assignments.

31-401
National Security Forces — **Fall: 9 units**
Discusses the major institutional participants of the U.S. National Security System, the evaluation of strategy, and civilian-military relationships. Examines the actions and processes of the national security establishment as well as issues of national strategy.

31-402
National Security Forces — **Spring: 9 units**
Discusses contemporary strategic thought, strategic options available to the U.S., and international and regional security issues which form the bases for current and projected security challenges. Examines key aspects of the military profession, such as Air Force doctrine and the military justice system.

31-105 (FR)
31-106 (SO)
31-107 (JR)
31-108 (SR)
Leadership Lab — **Fall/Spring: 0 units**
Student organized and conducted, designed for the purpose of practicing leadership and management techniques, and improving drill and ceremonies skills.

Naval Science - Navy ROTC

Undergraduate Courses

32-101
Naval Orientation — **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. Included is an overview of officer and enlisted ranks and rates, training and education, and career patterns. The course also covers naval courtesy and customs, military justice, leadership, and nomenclature. This course exposes the student to the professional competencies required to become a naval officer.

32-102
Naval Ships Systems I (Engineering) — **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.

32-201
Naval Ships Systems II (Weapons) — **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 weapons 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.

79-275
History of Modern Warfare — **Spring: 6 units**
Broadly conceived, this course examines the role of war in society and history. Central themes include the relationship of war to the state and its financial and material resources, to military technology, and to technological change in the means of production. Equally central are military leadership and the will to combat, military and civilian. The course concludes with a survey of U.S. naval history from the American Revolution to the present with emphasis on major developments. The course also treats present day concerns in seapower and maritime affairs including the economic and political issues of merchant marine commerce, the law of the sea, and the Russian navy and merchant marine.

32-301
Navigation and Naval Operations I — **Spring: 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, sextant theory and operation, and a step-by-step treatment of the sight reduction process. Students develop practical skills in both piloting and celestial navigation. Other topics discussed include tides, currents, effects of wind and weather, plotting, use of navigation instruments, types and characteristics of electronic navigation systems, and the typical day's work in navigation.

32-302
Navigation and Naval Operations II — **Fall: 9 units**
A study of the international and inland rules of the nautical road, relative motion vector analysis theory, relative motion problems, formation tactics, and ship employment. Also included is an introduction to naval operations and shipboard evolutions, vessel behavior and characteristics in maneuvering, applied aspects of ship handling, and afloat communications.

32-303
Evolution of Warfare — **Fall: 9 units**
This course traces historically the development of warfare from the dawn of recorded history to the present, focusing on the impact of major military theorists, strategists, tacticians, and technological developments. The student acquires a basic sense of strategy, develops an understanding of military alternatives, and sees the impact of historical precedent on military thought and actions.

32-401
Leadership and Management I — **Fall: 6 units**
A comprehensive advanced-level study of organizations. Topics include a survey of the management functions of planning, organizing, and controlling, an introduction to individual and group behavior in organizations, and extensive study of motivation and leadership. Major behavioral theories are explored in detail. Practical applications are explored by the use of experimental exercises, case studies, and laboratory discussions.

32-402
Leadership and Management II — **Spring: 6 units**
The study of naval junior officer responsibilities in naval administration. The course exposes the student to a study of counseling methods, military justice administration, naval human resources management, directives and correspondence, naval personnel administration, material management and maintenance, and supply systems. This capstone course in the NROTC curriculum builds on

and integrates the professional competencies developed in prior course work and professional training.

32-404
Amphibious Warfare **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 20th century, especially during World War II. Focus is applied to four main themes: political/strategic situation, sea-to-land transition, tactics ashore, and development of amphibious technology. Present day potential and limitations on amphibious operations, including the rapid deployment force concept, are explored.

32-100-400
Naval Laboratory **Fall/Spring: 3 units**
Military drill, physical fitness and leadership seminars.

Physics

Undergraduate Courses

33-102
Concepts of Modern Physics **Spring: 9 units**
This course is designed to provide MCS and CIT freshmen an opportunity to learn about some of the frontier areas of physics in which active research is now going on. Students from the College of H&SS and Fine Arts should obtain the consent of the instructor. Topics that may be covered include the physics of elementary particles, the fundamental forces, quantum physics, astrophysics and nuclear physics. Typically the course involves a small group of students and is run quite informally. Each student presents a report on some topic of personal choice. 3 hrs. rec.

33-104/105
Experimental Physics **Fall or Spring: 9 units**
These courses provide freshmen 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 communication of experimental procedures and results in the form of written and oral reports. 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. Exceptionally motivated students who have completed 33-104 may take 33-105 as an elective. This course provides the opportunity for talented students to design their own experiments in consultation with the instructor and/or to perform a set of experiments of a more elaborate nature than those in 33-104. 6 hrs. lab.

33-106
Physics for Engineering Students I **Fall or Spring: 12 units**
Basic principles of mechanics and thermodynamics; vectors, displacement, velocity, acceleration, force, equilibrium, mass, Newton's laws, gravitation, work, energy, momentum, impulse, temperature, heat, equations of state, thermodynamic processes, heat engines, refrigerators, first and second laws of thermodynamics, kinetic theory of gases. 3 hrs. lec., 2 hrs. rec. Prerequisite: 21-121, or concurrently.

33-107
Physics for Engineering Students II **Fall or Spring: 12 units**
This is the second half of a two-semester calculus-based introductory physics sequence for engineering students. One third of the course covers oscillations and waves, including standing and, travelling waves, superposition, normal modes boundary conditions, resonance, beats, reflection, refraction, interference and diffraction. Two thirds of the course covers electricity and magnetism, including electrostatics, Gauss' law, simple circuits, magnetostatics induction and an introduction to electromagnetic radiation. 3 hrs. lec., 2 hrs. rec. Prerequisites: 33-106, 21-121.

33-108
Physics for Building Science **Spring: 9 units**
This course is structured for first year architecture students. Topics discussed are a mathematics review, kinematics in one and two dimensions, Newton's Laws, objects in equilibrium, work and energy, momentum, density, pressure, buoyancy, fluid dynamics, thermal physics, ideal gas, conduction, convection, radiation, first and second laws of thermodynamics, vibrations, sound and light. Emphasis is on applications to architecture. The course is team taught by one physicist and one architect. 3 hrs. lec. Prerequisite: 21-121. This course is open to architecture majors only.

33-111
Physics for Science Students I **Fall or Spring: 10 units**
Basic principles of mechanics: vectors, displacement, velocity, acceleration, force, equilibrium, mass, Newton's laws, gravitation, work, energy, momentum and impulse, Thermal physics: temperature, heat and the first and second laws of thermodynamics. 3 hrs. lec., 2 hrs. rec. Prerequisite: 21-121, or concurrently.

33-112
Physics for Science Students II **Fall or Spring: 10 units**
Electricity and magnetism: Coulomb's law, polarization, electric field, electric potential, DC circuits, magnetic field and force and magnetic induction. Waves: Oscillations, propagation and interference. 3 hrs. lec., 2 hrs. rec. Prerequisites: 33-111, 21-122 concurrently.

33-114
Physics of Musical Sound **Spring: 9 units**
An introduction to the physics and psychophysics of musical sound. Elementary physics of vibrating systems: normal modes, resonance; propagation of sound: traveling waves; standing waves, reflection, diffraction, beats. Perception of sound: loudness, pitch, timbre, masking. Qualitative description of general periodic systems by Fourier analysis; The harmonic series. Percussion instruments, struck and plucked instruments; instruments exhibiting self-sustained oscillations: bowed strings, blown pipes, reed instruments, brasses, singing. Intervals and consonance, musical scales, tuning and temperament. Room and auditorium acoustics. Electronic synthesis and digital processing of musical sounds. There are no formal prerequisites, but a strong interest and some background in music are advised. 3 hrs. lec.

33-115 **Fall: 10 units**
33-116 **Spring: 10 units**
Introductory Physics
An introduction to the fundamental principles and methodology of physics. In 33-115, the laws of Newtonian mechanics are examined and applied. Heat and energy conversion are discussed. In 33-116, topics typically include electricity, magnetism and modern physics. The course is intended for students in the college of H&SS and does not require calculus. 3 hrs. lec., 1 hr. rec. Prerequisite: 33-115 or 33-111 or permission of instructor is needed for 33-116.

33-124
Introduction to Astronomy **Spring: 9 units**
An introductory course in astronomy intended for both liberal arts and science and engineering students. An introduction to the phenomena and observational techniques of astronomy. Emphasis on observations with naked eye, binoculars and telescopes. Each student does an observational project on a topic of his or her own choice. 2 hrs. lec., 1 hr. rec. and one field trip or laboratory session per week.

33-201 **Fall: 1 unit**
33-202 **Spring: 1 unit**
Undergraduate Colloquium I and II
All physics majors meet together for 1 hour a week to hear discussions on current physics research from faculty, undergraduate and graduate students, and outside speakers. Other topics of interest such as application to graduate school, possible areas of industrial research and job opportunities will also be presented.

33-211
Physics III **Fall: 10 units**
A follow-up to the two-semester physics for science students sequence, this course is intended primarily for physics majors. Various topics from classical and modern physics will be covered. 3 hrs. lec., 2 hrs. rec. Prerequisite: 33-112 or 33-107

33-225
Quantum Physics and Structure of Matter **Fall: 9 units**
Experimental evidence for the quantum nature of matter and radiation. The Bohr atom. Wave functions and application of Schrodinger's equation to the tunnel effect, to a particle in a well, and the ground state of hydrogen. Chemical bond in the hydrogen molecule. Electron spin, Maxwell-Boltzmann statistics. Probability and entropy. Application to Curie paramagnetism and to the specific heat of an ideal gas. The emphasis is on simple prototype cases rather than complete mathematical rigor. 3 hrs. lec. Prerequisite: 33-112 or 33-107.

33-228
Electronics I **Spring: 10 units**
An introductory laboratory and lecture course with emphasis on electrical circuit analysis as applied to RC filters, tuned circuits, DC power supplies, transistor amplifiers, amplifiers with feedback, and integrated circuit operational amplifiers. Multivibrators and other oscillators and waveform generators are covered if time allows. The simulation program MICRO-CAP III is used whenever possible to model the behavior of these circuits. 2 hrs. rec., 6 hrs. lab. Prerequisite: 33-112 or permission of the instructor.

33-232
Physical Analysis **Spring: 9 units**
The application of more advanced math topics to solve physical problems. The topics include: use of complex exponentials to solve ordinary differential equations; use of matrices to solve coupled oscillators; and the use of Fourier series to describe standing waves. The physical interpretation of mathematical results is emphasized by the use of plotting and examination of physical limits. The symbolic mathematics program, MAPLE, is used throughout the course. This course fulfills one of the mathematics electives and is a preparation for the upper level physical mechanics and electricity and magnetism sequences. 3 hrs. lec. Prerequisites: 33-112, 33-211, 21-122

Course Descriptions

33-234 **Spring: 10 units**
33-335 **Fall: 10 units**
Quantum Physics I, II
An introduction to the fundamental principles and applications of quantum physics. The first semester (33-234) begins with a discussion of the experimental evidence for the quantization of energy, the particle and wave properties of matter, and the early quantum picture of the atom. Wave mechanics is then developed in an elementary way, but in sufficient detail to provide a semiquantitative description of the structure and spectra of one-electron atoms and other single particle systems. In the second semester (33-335) these methods are extended to the description of many-electron atoms and molecules. Many-particle systems are described using both classical and quantum statistics. Other topics include the physics of condensed matter, elementary nuclear physics and the physics of elementary particles. 3 hrs. lec., 1 hr. rec. Prerequisite: for 33-234, 33-211.

33-241
Introduction to Computational Physics **Fall: 9 units**
The course emphasizes the formulation of physical problems for machine computation with exploration of alternative numerical methods. The FORTRAN programming language is used with some attention to code optimization. Work will be done on a range of computers from high function workstations to vector and massively parallel supercomputers. Examples are drawn from Physics I, II and Experimental Physics as well as concurrent physics courses. 3 hrs. lec. Prerequisites: 33-104, 33-112, 21-122, 15-125 or 15-127

33-301 **Fall: 1 unit**
33-302 **Spring: 1 unit**
Undergraduate Colloquium III and IV
A continuation of 33-201, 202 for juniors. All physics majors meet together 1 hour per week to discuss topics of interest.

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 and systems of particles. 3 hrs. lec., 1 hr. rec. Prerequisites: 33-112, 21-122, 21-259, 21-260.

33-332
Physical Mechanics II **Spring: 10 units**
Accelerated coordinate systems, general rigid body motion, coupled oscillators and normal modes. 3 hrs. lec., 1 hr. rec.. Prerequisite: 33-331

33-338
Intermediate Electricity and Magnetism I **Spring: 10 units**
Basic concepts of electrostatics, Gauss' Law, electrostatic potential. Techniques for calculating electric fields for typical configurations. Boundary-value problems including method of images and solution of Laplace's equation. Electrostatics in the presence of matter. Electrostatic energy. Electrical current in conducting media. The continuity equation. The Lorentz Force Law. Basic concepts of magnetostatics. Biot-Savart and Ampere's Laws. Introduction to Special Relativity: Lorentz transformation, four-vectors, invariants, application to particle mechanics. 3 hrs. lec., 1 hr. rec. Prerequisites: 33-107 or 33-111, 21-259, 21-260 or 33-232 or 33-345.

33-340
Modern Physics Laboratory **Spring: 10 units**
Experiments drawn from the areas of atomic, nuclear, solid state, chaos, and particle physics are available. The student usually performs three during the semester. Representative examples include: Compton scattering, Zeeman effect, x-ray and gamma ray spectroscopy, magnetic resonance, Mössbauer effect, magnetic susceptibility, muon lifetime and Brownian motion. The opportunity also exists for the development of new experiments. 1 hr. rec., 6 hrs. lab.

33-341
Thermal Physics I **Fall: 10 units**
The student is introduced to both macroscopic and microscopic descriptions of the thermal properties of matter. The fundamental laws of macroscopic thermodynamics are developed and then justified for a set of model microscopic systems. Several thermodynamic potential functions are defined in terms of the Legendre transformations between them. Derivatives of the energy functions are defined in terms of intensive parameters such as temperature and pressure. The calculational machinery of statistical mechanics is developed using the canonical and grand canonical ensembles. Physical systems covered include the binary magnet, ideal gases, harmonic oscillators, thermal radiation and lattice vibrations in crystals. 3 hrs. lec., 1 hr. rec. Prerequisite: 33-234.

33-342
Thermal Physics II **Spring: 10 units**
This course begins with a more systematic development of formal probability theory, with emphasis on generating functions, probability density functions and asymptotic approximations. Examples are taken from games of chance, geometric probabilities and radioactive decay. The connections between the ensembles of statistical mechanics (microcanonical, canonical and grand canonical) with the various thermodynamic potentials is developed for single component and multicomponent systems. Fermi-Dirac and Bose-Einstein statistics are reviewed. These principles are then applied to applications such as electronic specific heats, Einstein condensation, chemical reactions, phase transformations, mean field theories, binary phase diagrams, paramagnetism, ferromagnetism, defects, semiconductors and fluctuation phenomena. 3 hrs. lec., 1 hr. rec. Prerequisite: 33-341.

33-345
Mathematical Methods of Physics **Fall: 9 units**
This course is intended to provide mathematical tools needed in many upper-level physics courses and for advanced theoretical study in the physical sciences. Topics include: Fourier series and integrals, partial differential equations and boundary value problems, special functions, complex variables and functions, and integration in the complex plane. The material is developed using specific physical problems as illustrations. This course satisfies one of the mathematics electives. Prerequisites: 21-259, 21-260.

33-350
Undergraduate Research **Fall or Spring: Variable units**
Laboratory course in which the student undertakes an experimental project of interest in contemporary physics under the supervision of one of the members of the faculty.

33-401 **Fall: 2 units**
33-402 **Spring: 2 units**
Undergraduate Colloquium V and VI
A continuation of 33-201, 202 for seniors. In this course, the student not only hears discussions on topics of current interest, but also gives a presentation.

33-439
Intermediate Electricity and Magnetism II **Fall: 10 units**
Techniques for calculating magnetic fields for typical configurations. Faraday's Law of induction. Magnetostatics in the presence of matter. Properties of dia-, para- and ferromagnetic materials. Magnetic energy. Maxwell's equations. Electromagnetic waves: plane waves, waves in non-conducting and in conducting media, reflection and refraction of waves. Guided waves. Electromagnetic radiation: generation and characteristics of electric and magnetic dipole radiation. Application of Special Relativity to electrodynamics: electric and magnetic fields in different reference frames. 3 hrs. lec., 1 hr. rec. Prerequisite: 33-338.

33-444
Introduction to Nuclear & 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 the interactions of particles in matter leading to various types of instrumentation. In turn we discuss methods for measuring sub-atomic structure, symmetries and conservation laws, and the electromagnetic, weak and strong interactions. We develop the quark model of the mesons and baryons, as well as several models of the atomic nucleus. 3 hrs. lec. Prerequisites: 33-234 and 33-335 or permission of instructor. (Alternate years)

33-446
Advanced Quantum Physics **Spring: 9 units**
Review of Lagrangian and Hamiltonian classical mechanics and linear vector spaces; generalization to infinite dimensional and complex vector spaces; function spaces; Dirac notation. Foundations of quantum theory: the postulates; derivation and applications of the uncertainty relations. Multi-particle systems; identical particles. Symmetries and their consequences. Time-independent perturbation theory; time-dependent perturbation theory. The principles of quantum theory are illustrated by application to various physical systems. 3 hrs. lec. Prerequisites: 33-332, 33-335.

33-448
Introduction to Solid State Physics **Spring: 9 units**
The aims of this course are to describe the structure of solids and to develop a variety of models with which to explain some of their properties: thermal, electrical, magnetic. Topics covered are periodic lattices and crystal structure, crystal diffraction and the reciprocal lattice, binding, lattice vibrations, thermal properties, the free electron theory of metals, and electron energy bands. Other topics from which a selection may be made include disordered materials, semiconductors, point defects and dislocations, superconductivity, optical properties, magnetism. 3 hrs. lec., 1 hr. rec. Prerequisites: 33-335, 33-341, or permission of the instructor.

33-449
Electronics II **Fall: 10 units**
This laboratory course covers techniques associated with digital electronics, including relevant analog circuitry. An introduction is given to logic gates and Boolean algebra implementation. Also included is preparation of signals for analog-to-digital conversion and treatment of analog signals after digital to analog conversion. The latter part of the course deals with microprocessor fundamentals and computer interfacing. Simulation programs MICRO-CAP III and MICROLOGIC are used, whenever feasible, to model the behavior of the circuits discussed in the course. 6 hrs. lab., 1 hr. rec. Prerequisite: 33-228.

33-451
Senior Research **Fall: 9 units**
Open to all physics majors. May include research done in a research lab, extending the capabilities of a teaching lab, or on a theoretical or computational physics project. The student experiences the less structured atmosphere of a research program where there is much room for independent initiative. Modern Physics Laboratory, 33-340, should precede this course, though not required. A list of research projects will be available before preregistration in spring of the junior year so that student project pairings can be set. Ordinarily taken for one semester in fall of senior year. May be extended to spring with faculty consent. Written and oral reports on results are required at end of semester.

33-453
Intermediate Optics **Fall: 12 units**
Geometrical optics: reflection and refraction, mirrors, prisms, lenses, apertures and stops, simple optical instruments, fiber optics, matrix description of paraxial optics. Physical optics: wave properties of light, electromagnetic waves at dielectric interfaces, interference, coherence, Fraunhofer and Fresnel diffraction, Fourier optics, interferometry, resolution of optical instruments, polarized light. As time permits, additional topics may be chosen from the following: crystal optics, simple models of the optical properties of matter, lasers and holography. 3 hrs. lec., 3 hrs. lab. Prerequisite: 33-112 or 33-107.

33-454
Physics of Continua **Spring: 9 units**
This course provides an introduction to the kinematics and dynamics of fluids and solids. The equations of mass conservation, motion, and energy conservation are derived and applied to various problems of fluid flow, and static and dynamic deformations of elastic solids. Topics included are: stress, strain and rate of deformation tensors; constitutive equations for viscous fluids and elastic solids; incompressible fluid flow; sound propagation in fluids and solids; shear strength of solids; and various applications (which may differ from year to year) such as Reynolds number, drag coefficient, boundary layers, bending of beams, stress in rotating solids and in pressure vessels. 3 hrs. lec. Prerequisite: 33-331 or permission of instructor. (Alternate years)

33-456
Advanced Computational Physics **Spring: 9 units**
This course will emphasize application of practical numerical techniques to the types of problems which are encountered by practicing physicists. The student will be expected to understand the principles behind several numerical methods including several specialized methods, such as SVD decomposition, chi-squared minimization, and Monte Carlo simulation of experiments. 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 programming. A brief introduction to algebraic manipulation programs will also be given. Prerequisites: 33-332, 33-335, 33-241 or permission of instructor. (Alternate years)

33-458
Special Problems in Computational Physics **Fall or Spring: 9 units**
The student will work under the direction of a Department member on a computational physics problem of mutual interest. Prerequisite: 33-456.

33-463
Special Relativity **Fall: 9 units**
This course begins by considering the historical origins of relativity, and then develops the physical consequences which follow from the basic tenets of the theory: the Lorentz transformation, relativistic kinematics, the relationships among mass, energy and momentum, relativistic electromagnetism. The course introduces and uses the four-vector formulation of mechanics, tensors and the geometrical representation of space-time. 3 hrs. lec. Prerequisites: 33-338, concurrent enrollment in 33-439 or permission of instructor.

33-467
Introduction to Astrophysics **Fall: 9 units**
This course provides an introduction to the physics of stars. Distances, magnitudes and masses of stars, and the Herzspring-Russell diagram; the basic differential equations of stellar structure for a spherical star; nuclear reactions in stars; stellar evolution; white dwarfs and neutron stars. Additional topics which may be included: binary stars, x-ray sources, calculation of opacities, stellar atmospheres, black holes. 3 hrs. lec. Prerequisite: 33-234 or permission of instructor. (Alternate years)

33-466
Introduction to Cosmology **Spring: 9 units**
This course will discuss how physical principles can be applied to obtain information about the early universe. Both observational and theoretical issues will be studied in the framework of the Big Bang model. The topics covered will include expansion of the universe, cosmic microwave background radiation, thermal history of the early universe, production of the light elements. 3 hrs. lec. Prerequisite: 33-234. (Alternate years)

33-499
Supervised Reading **Fall or Spring: Variable units**
The student explores a certain area of advanced physics under the supervision of a faculty member.

33-515
Global Security and Science **Fall or Spring: 9 units**
This course deals with the impact of modern science and technology on society and international relations with an emphasis on the significance of nuclear weapons. The course provides a scientific and historical background leading into a discussion of topics of contemporary importance. The course is interdisciplinary with lecturers from physics and H&SS. Offered when there is sufficient demand. 3 hrs. lec.

33-650
General Relativity **Spring: 9 units**
Einstein's theory of relativity is discussed in some detail. The mathematical background (tensor analysis) will be introduced and used together with physical concepts such as the principle of equivalence to arrive at the Einstein equations. We will discuss the Schwarzschild, Kerr and Robertson-Walker metrics in detail. 3 hrs. lec. Prerequisites: 33-463 or some knowledge of special relativity. (Alternate years)

Graduate Courses

The following graduate courses are available to undergraduate students who have appropriate prerequisites and permission of the instructor. Descriptions of these and other graduate courses may be found in the graduate catalog of Physics.

33-755	Quantum Mechanics I
33-756	Quantum Mechanics II
33-757	Classical Mechanics
33-759	Introduction to Theoretical Physics
33-761	Classical Electrodynamics I
33-762	Classical Electrodynamics II
33-765	Statistical Mechanics

Statistics

Undergraduate Courses

36-198
Research Training: Statistics **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. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as "elective" units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. Prerequisites/restrictions: For H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question. Prerequisite: 36-201.

36-201
Statistical Reasoning **Fall: 9 units**
This course will introduce students to the basic concepts, logic, and issues involved in statistical reasoning. The major topics to be covered include methods for exploratory data analysis, an introduction to research methods, and methods for statistical inference. The objectives of this course are to help students develop a critical approach to the evaluation of study designs, data, and results. 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 two 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. No prerequisite.

36-202
Introduction to Statistical Methods **Spring: 9 units**
This course builds on the principles and methods of statistical reasoning developed in 36-201. It will cover elementary probability theory, statistical methods, and data analysis. Some specific topics covered include: conditional probability, regression analysis, analysis of variance, and the analysis of contingency tables. The objectives of this course are to introduce and to develop skills in the applications of the basic principles and methods that underlie the practice of statistics and empirical research. Examples will be drawn from areas of applications of particular interest to H&SS students. Prerequisite: 36-201.

36-203
Sampling, Surveys, and Society **Offered Intermittently: 9 units**
This course will revolve around the role of sampling and sample surveys in the context of U.S. society and its institutions. We will examine the evolution of survey taking in the United States in the context of its economic, social and political uses. This will eventually lead to discussions about the accuracy and relevance of survey responses, especially in light of various kinds of nonsampling error. Prerequisites: 36-201 and permission of the instructor or 36-202.

Course Descriptions

36-211,212
Probability and Applied Statistics for Physical Science and Engineers I/II — **Fall and Spring: 9 units**
This two-semester course is designed for students in science and engineering. It provides an introduction to probability and the elements of statistical methodology with an emphasis on engineering applications. Topics include basic elements of probability, parameter estimation, confidence intervals, and hypothesis testing with special emphasis on regression and analysis of variance. The use of quality control and designed experiments in industrial and related settings is highlighted. 3 hrs. rec. Prerequisite: 21-122.

36-217
Probability Theory and Random Processes — **Fall: 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. 3 hrs. rec. Prerequisite: 21-122.

36-220
Engineering Statistics and Quality Control — **Spring: 9 units**
This is a course in introductory statistics for engineers with emphasis on modern product improvement techniques. Besides basic probability, distribution theory and hypothesis testing, special topics include exploratory data analysis, experimental design (including fractional factorials and nested designs), response surface methods, control charts and acceptance sampling. The course also provides an introduction to a major statistical software package. 3 hrs. rec. Prerequisite: 21-111 or 21-121.

36-225, 36-226
Introduction to Probability and Statistics I, II — **Fall and Spring: 9 units**
This year-long course provides an introduction to probability and 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, central limit theorem, parameter estimation, confidence intervals, and hypothesis testing with special emphasis on regression and analysis of variance, and simulation. 3 hrs. rec. Prerequisite: 21-122.

36-253
Introduction to Biostatistics — **Spring: 9 units**
This course presents the basic concepts and methods of statistics for student with interests in the health and biomedical sciences. Topics to be covered include data reduction and summary, methods for exploratory data analysis, elementary probability theory, confidence intervals and hypothesis testing, regression and analysis of variance. Examples will be drawn from the health and biomedical sciences. The analysis of actual data sets will be performed using MINITAB, a statistical package requiring no previous computer experience. Students taking this course may not receive credit for 36-202, 36-212, 36-220, or 36-226. Prerequisite: 21-111 or 21-121.

36-295
Independent Research Project — **Fall and Spring: 9 units**
Statistics majors are given 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. Prerequisite: 36-201 and 36-202. Limited to Statistics majors.

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 and will stress the interpretation of results. 3 hrs. rec. Prerequisite: 36-202 or 36-212 or 36-226.

36-325
Probability and Mathematical Statistics I — **Fall: 9 units**
This course is a rigorous introduction to the mathematical theory of probability, and it provides the necessary background for the study of mathematical statistics and probability modeling. A good working knowledge of calculus is required. Topics include combinatorial analysis, conditional probability, generating functions, sampling distributions, law of large numbers, and the central limit theorem. Students considering graduate work in Statistics or Operations Research should take this course instead of 36-225. 3 hr. rec. Prerequisite: 21-122

36-326
Probability and Mathematical Statistics II — **Spring: 9 units**
An introduction to the theory of statistical inference. Topics include likelihood functions, estimation, confidence intervals, hypothesis testing, Bayesian inference, regression, and the analysis of variance.
3 hrs. rec. Prerequisite: 36-325.

36-401,36-402
Advanced Data Analysis I, II — **Fall and Spring: 9 units**
The material in this course concentrates on methods for analyzing complex data. The emphasis is on description validation and its interpretation. The specific topics include simple numeric and graphic summaries, tabular displays, linear and nonlinear regression models, the analysis of designed experiments, and other topics of interest as time permits. Real-world examples will be drawn from engineering and the various physical and social sciences. 3 hrs. rec. Prerequisite: 36-226 or 36-326.

36-410
Elementary Applied Probability — **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 taken from reliability theory, queuing theory, inventory theory, and various applications in the social and physical sciences. 3 hrs. rec. Prerequisite: 36-225 or 36-325.

36-430
Statistical Software Packages — **Spring: 9 units**
The use of statistical software packages to analyze data is studied in this course. Major packages, such as SPSS, BMDP, SAS and MINITAB are examined, especially with respect to their handling of the analysis of variance and regression. Other packages, such as ISP and GLIM, will be considered as time permits. An introduction to issues in statistical computing will also be given. Familiarity with computing facilities at CMU will be assumed. 3 hrs. rec. Prerequisite: 36-309 or 36-401.

36-461
Statistical Modeling — **Fall and Spring: 9 units**
The format and content of the course are flexible and vary, depending on demand. Historical applications of statistical methods to real problems of data analysis may be studied, or special topics in probability and statistics such as decision theory, biostatistics, time series analysis, Bayesian statistics and nonparametric statistics may be covered. 3 hrs. rec. Prerequisite: 36-226 or 36-326.

36-495
Independent Study — **Units to be arranged**

36-501/-502
Honors Thesis — **Fall and Spring: 9 units**
Statistics majors who qualify for the H&SS Senior Honors Program are given the opportunity to conduct original research under the direction of an individual faculty member. Research topics are selected jointly by the student and faculty advisor. Prerequisite: Senior standing, department permission, and admission to the H&SS Honors Program.

Graduate Courses

The following graduate courses are available to undergraduate students who have appropriate prerequisites and permission of the instructor. Descriptions of these and other graduate courses may be found in the graduate catalog of the Department of Statistics.

36-701	Perspectives on Statistics
36-703	Intermediate Probability
36-705	Intermediate Statistics
36-707	Regression Analysis
36-708	Linear Models and Experimental Design
36-711	Statistical Computing
36-715	Applied Stochastic Processes
36-720	Discrete Multivariate Analysis
36-722	Continuous Multivariate Analysis
36-724	Applied Bayesian Methods
36-726	Statistical Practice
36-728	Time Series Analysis I
36-730	Time Series Analysis II
36-732	Topics in Biostatistics
36-734	Survey Sampling
36-742	Statistical Methods for H&SS Ph.D. Students
36-743	Statistical Methods for the Behavioral and Social Sciences
36-744	Experimental Design for Behavioral and Social Sciences
36-753	Probability Theory and Stochastic Processes I
36-754	Probability Theory and Stochastic Processes II
36-755	Advanced Statistical Theory I
36-756	Advanced Statistical Theory II
36-757	Advanced Data Analysis
36-760	Linear Statistical Models
36-761	Advanced Statistical Computing

Carnegie Institute of Technology Interdisciplinary

Undergraduate Courses

39-405
Engineering Design:
Creation of Products and Processes — **Fall or Spring: 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 on design methods applicable to 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. Individual or group projects on selected aspects of the design process. Prerequisite: open to all seniors and graduate students in CIT. Other students may take the course with the instructor's permission.

39-500
CIT Honors Research — **Fall or Spring: Units Variable**
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.

39-647
Independent Study in
Engineering Design — **Fall or Spring : 3 to 12 units**
Investigation of a special topic in engineering design under the direction of a faculty member. The topic usually involves open-ended research problems whose solution requires some elements of synthesis, analysis, evaluation and both oral and written communications. Prerequisite: Junior standing in CIT.

39-648
Special Topics: Wearable Computer Design and Fabrication — **9-12 units**
This course deals with rapic prototyping, manufacture, and applications of a new generation of wearable computers, with head-mounted display. The design of wearable computers is a multidisciplinary process including: Electronic design, mechanical design, software development, and human-computer interaction. Two classes of wearable computers will be further developed: embedded, custom designed VuMan series, and general purpose Navigator series. Electronic design includes the custom designed computer board, electronic interfacing, and power supply. Industrial designers and mechanical engineers team to design and manufacture with in-house facilities a variety of conformable/ lightweight housings. A software development environment and user interface builders support software and application development. Current applications include: Global Position Sensing, Hypertext documents, speech recognition, wireless communications, and digital imaging. Prerequisites: Jr. or Sr. standing in CIT, SCS or CFA.

39-649
Special Topics :
Green Engineering and Design — **Fall or Spring: 3 to 12 Units**
This course is offered periodically and involves investigation of inter-disciplinary topics in "green" engineering and design of special or current interest to the faculty an students of Carnegie Institute of Technology. "Green" engineering and design involves consideration of systematic environmental effects and sustainable development considerations in the planning, design, manufacturing and operation of products and processes. Emphasis is on the fundamentals of evolving areas of green engineering science and technology. Topics vary to reflect new developments and interests. Prerequisite: Instructor's permission.

39-747
Advanced Independent
Study in Engineering Design — **Fall or Spring, 3 to 12 units**
Advanced investigation of a special topic in engineering design under the direction of a faculty member. The topic usually involves open-ended research problems whose solution requires some elements of synthesis, analysis, evaluation and both oral and written communications. Prerequisite: Graduate Student Status in CIT.

Graduate Courses

The following graduate courses are available in Colloids and Surfaces to undergraduate students who have appropriate prerequisites and permission of the instructor. Descriptions of these and other graduate courses may be found in the graduate catalogue. All of these courses may not be offered in any given year.

39-801 Colloids, Polymers and Surfaces Laboratory I
39-802 Colloids, Polymers and Surfaces Laboratory II

Biomedical Engineering

Undergraduate Courses

42-100
Biomedical Engineering Seminar — **Fall/Spring: 3 units**
A seminar-like introduction to the applications of technology in medicine and biology. In a one hour weekly meeting, a series of speakers describe real world problems and their progress toward a solution. An introduction to the physiology and/or analytic techniques requisite to a clear perception of the problem environment is provided.

42-500
Physiology (emphasis on neurophysiology) — **Fall: 9 units**
An introduction to mammalian physiology presented in the context of control systems with emphasis on functional interactions within and between systems. Physiological systems to be covered include neuroanatomy; electrophysiology; neurophysiology; muscle physiology; sensory physiology; and learning and cortical physiology. Prerequisite: a general biology course.

42-501
Physiology (emphasis on circulatory system) — **Spring: 9 units**
An introduction to mammalian physiology presented in the context of control systems with emphasis on functional interactions within and between systems. However, during this semester, physiological systems to be covered include circulation; respiration; gastrointestinal; and endocrine physiology. Prerequisite: a general biology course.

42-560
Undergraduate Project — **Fall/Spring: Variable units**
Students work with a faculty member affiliated with Biomedical Engineering at the University or in a hospital. Emphasizing resourcefulness and initiative, the student with his advisor will evolve a project with both research and development aspects. Prerequisite: Consent of advisor.

42-604
Biological Transport — **Spring: 9 units**
Analysis of transport phenomena in life processes on the molecular, cellular, organ, and organism levels. 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.

42-609 (also known as 03-609)
Fermentation Processes — **Fall: 9 units**
First half of course: microbial physiology and metabolism; fermentations and respiration; metabolic regulation; bioconversions; recombinant DNA methodology and gene cloning; and environmental microbiology. Second half of course: separation and purification, kinetics and design of biological reactors and waste treatment; mass transfer limitations within cell suspensions; control of fermentation processes. Prerequisites: 03-121, Modern Biology, 03-230 Genetics, and 03-331 Biochemistry, or permission of instructor.

42-636 (also known as 12-636)
Environmental Engineering: Air Pollution — **Fall: 9 units**
Problems and methodologies for studies of environmental management, with an emphasis on air pollution; characterization of pollutant sources; behavior of aerosol and gaseous pollutants in the atmosphere; micrometeorology as it relates to pollutant transport; human health effects, focusing on the respiratory system; methods of air pollutant measurement; statistical treatment of data; regulation of air pollutants, including procedures by which standards are developed and enforced by regulatory agencies. Prerequisite: 12-331, Fluid Mechanics, or equivalent.

42-644
Medical Devices — **Fall: 9 units**
Phenomenological and mechanistic descriptions of processes such as wear, corrosion, corrosion fatigue, and fretting are discussed. Characterization of bone and other biological materials as they relate to device performance requirements. Assessment of biocompatibility. Case studies of orthopedic fixation devices and prostheses, pacemakers, heart valves, and artificial organs. Introduction to legal and regulatory aspects of performance and failure.

42-652
Musculoskeletal Biomechanics — **Spring: 9 units**
This course applies engineering mechanics to the human musculoskeletal system. It crosses traditional boundaries, drawing upon engineering principles and techniques to tackle the complexity of biological structure. Topics include the mechanical analysis of bone, muscle, and synovial joints; structural characterization; and dynamics of gait. The course is designed to illustrate the range of topics in biomechanics, to identify major research areas, and to point to some unsolved problems. Prerequisites: 21-260 Differential Equations; 24-141 Statics and Dynamics; 24-202 Mechanical and Deformable Solids.

42-677
Rehabilitation Engineering **Fall: 9 units**
Rehabilitation engineering concentrates on system integration. It draws on knowledge from all the classical engineering disciplines. Although it encompasses the application of technology to restoring lost or absent human functions, its focus is different from the medical/bioengineering approaches of direct repair of replacement (e.g. prosthetics). Rather, rehabilitation engineering is concerned with developing systems to restore functional competency in broad areas of human endeavor such as mobility, communication, and recreation. The course will use case studies to illustrate the process of rehabilitation engineering for the restoration of competency in a variety of human activities for disabilities that include sensory, motor, and cognitive losses. Prerequisites: Physiology, or permission of instructor, plus at least one engineering laboratory course.

42-680
Biomedical Instrumentation for Acquisition and Processing of Biophysical Signals **Spring: 9 units**
This course will consider the design of instrumentation systems that acquire and process biophysical signals that reflect the condition of a physiological system. The origin and characteristics of signals will be discussed. Transducers for signal acquisition will be characterized and problems outlined. Interface and processing circuitry will be presented. Lastly, because circuits and systems interface with humans, electrical hazards and safety will be considered. Prerequisites: basic courses in electronic components and circuits.

42-695
Sensory Processes: Perception and Psychophysics **Fall: 12 units**
(alternate years)
This course provides an appreciation for how methods of scientific and engineering experimentation and analysis are applied to improving our understanding of human sensory systems. Topics include discussions of psychophysical measurement techniques, selected results indicating relationships between these results and the physiology of the systems. Emphasis will be placed on the development of quantitative models of perception. Prerequisite: 36-211, Probability and Applied Statistics for Physical Science and Engineers I, or permission of instructor.

42-820
Experimental Electrophysiology **Spring: 12 units**
This is a hands-on laboratory course on the principles of bioelectrical recording, stimulation and processing of electrophysiological data. Living nerve and muscle tissue are maintained in life-support systems. The student learns to use electric stimulators and electrodes and to record the action potentials and resting membrane potentials from the muscles and nerves, as well as the muscular contractions. There are parallel, non-invasive studies on human electrophysiology, such as EEG brain potentials and EMG muscle potentials. Minicomputers and general-purpose computers are used for averaging of bioelectrical data in time domain and in frequency domain. Prerequisite: Permission by the instructor in the senior year.

Note: Course descriptions of those courses that are required or elected to fulfill the Biomedical Engineering Minor but bear other department numbers may be found in the respective department course description section:

36-253	Introduction to Biostatistics
03-121	Modern Biology
03-231	Genetics
03-330	Biochemistry
03-360	The Biology of the Brain
03-438	Physical Biochemistry
03-439	Introduction to Biophysics
03-441	Molecular Biology of Prokaryotes
03-510	Computational Biology/Chemistry (also known as 09-560)
03-533	NMR in Biomedical Sciences

Course Descriptions

Architecture

Undergraduate Courses

48-096,7
Architecture for Non-Majors I,II **Fall and Spring: 9 units**
Architecture for Non-Majors I and II are designed to introduce students from other disciplines to the history, technology, and design skills of architecture. The goal of the course is to assist students in making insightful observations, reasoned analyses and informed interpretations of buildings. The course provides a brief introduction to architectural history, an overview of drawing fundamentals, and an exploration of architectural ideas through various design exercises using model making and drawing to develop projects. Each course is divided into two parts: history and theory discussions will comprise a portion, and design and drawing exercises will comprise the other portion. These courses taken as a pair are acceptable to meet the architectural design component of the general Minor in Architecture.

48-030
Introduction to Computer Modeling **Fall: 9 units**
This course is built around the twice-weekly computing sequence of 48-100. It provides an introduction to the conceptual basis of computer modeling systems. Several modeling systems are presented and explained, primarily through hands-on experience at computer work stations. Through the use of programs such as Architron, used on the Macintosh, students learn to generate and use axonometric and perspective representations as fundamental design documents. Beyond requirements of computing sequence of 48-100, additional out of class work is required of those students taking 48-030. 6 hr. lec. and studio. Course is open to students from other disciplines.

48-035
Introduction to Architectural Drawing **Spring: 9 units**
This course is built around the twice-weekly drawing sequence of 48-105. It consists of free-hand and constructed exercises on the topics of: perspective, solid and void, contour, shade and shadow construction, surface illumination and surface material. Topics are introduced through figure drawing and subsequently applied to architectural subjects. Work is submitted in three portfolio submissions of approximately three weeks duration each. Beyond requirements of drawing sequence of 48-105, additional summary portfolio of work conducted outside of class is required of those students taking 48-035. 6 hrs. lec. and studio. Course opened to students in other disciplines.

48-100
Architectural Design and Computer Modeling **Fall: 18 units**
Centered on the activity of making and representing things and guided by the clarity of craftsmanship, this studio presents three 4-5 week problems: 1) the design of a house which is formed by environmental forces, 2) the design and construction of an environment which is considered from the inside, and 3) the design and construction of a piece of furniture. Traditional means of representation are used along side computational means. 12 hrs. studio and lec. Prerequisite: Entry into department or approval of minor sequence

48-105
Architectural Design and Drawing **Spring: 18 units**
This studio introduces visual, structural, and material fundamentals within the context of architecture and provides an overview of the nature, and breadth of the profession and discipline of architecture. In support of this overview, the studio features a lecture series by instructors from all sequences within the upper levels of the curriculum. Work includes: architectural design problems and abstract exercises that focus upon particular concepts and skills coupled with a sequence of drawing exercises. Design projects typically range from one week to three weeks in length. The twice-weekly drawing sequence consists of free-hand and constructed exercises on the topics of: perspective, solid and void, contour, shade and shadow construction, surface illumination and surface material. Topics are introduced through figure drawing and subsequently applied to architectural subjects. Work submitted in three portfolio submissions of four weeks duration each. 12 hrs. studio and lec. Prerequisite: 48-100

48-140
Introduction to Architectural History **Spring: 9 units**
This lecture course is the first in the architectural history sequence. It is a broad survey of key buildings from ancient Egypt to the present. Greatest attention is accorded to European and American examples but lectures are also devoted to the architecture of Pre-Columbian, Islamic and Asian Cultures. Among the issues addressed in the lectures and reading assignments are the various systems employed to order architectural compositions, the role of buildings as vehicles for the expression of social ideas, and the history of the architectural profession. The goals of this course are to establish a chronological framework for future studies in architecture, to develop skills of description and formal analysis and to develop basic skills for historical research. 3 hrs. lec. Prerequisite: 79-104

48-200
Architectural Design and Composition **Fall: 18 units**
This studio is an introduction to architectural composition, how the parts of a building can be assembled to form a meaningful whole. Understanding the compositional principles which characterize the buildings of the past and present and applying them with intent and significance in the design studio are the central thrusts of this course. 9 hrs. studio and lec. Prerequisite: 48-105

Course Descriptions

48-205
Architectural Design and Construction I — **Spring: 18 units**
This studio is concerned with the detailed development of the architectural design for small scale buildings as informed by the technical knowledge related to the act of construction. The material and assembly issues of structural systems constructed of wood, masonry, steel and concrete are elaborated. The lecture portion of the course focuses on the application and integration of knowledge acquired in the parallel Building Structures I course. 7 hrs. studio, 2 hrs. lecture. Prerequisite: 48-200, 48-210, Corequisite: 48-215.

48-210
Statics — **Fall: 9 units**
Introduction to vector mechanics; force systems; equilibrium of rigid bodies; centroids and moments of inertia; applications to beams and trusses. 3 hrs. lec. Prerequisites: 21-121, 33-106

48-215
Structures — **Spring: 9 units**
This course treats topics of structural behavior and member design, including loads, materials, internal stress, beams, columns, trusses, frames, cables, arches, grids, shells, membranes, and space frames. The goal of synthesizing complete structures with basic structural subsystems is also introduced. Emphasis is placed on continuity with the analytical foundations established in 48-210 Statics. 3 hrs. lec. Prerequisites: 48-210 or 12-207

48-2xx
Architectural History Lecture — **Fall and Spring 9 units**
Various survey lecture courses. Requirements typically include mid-term and final examinations, book reviews, analysis essays and a research paper. 3 hrs. lec. Prerequisite 48-140

48-300
Architectural Design and Building Construction II — **Fall: 18 units**
This studio is concerned with the detailed design development relating to spatial, visual and consrnuctional performance and integrity of larger scale buildings. The focus of the studio is the design of the structural, enclosure and the issues of constructability and technical innovation. The lecture portion of the course concentrates on the application and integration of knowledge acquired in the previous studio and in the parallel course, Materials and Assemblies. 7 hrs. studio, 2 hrs. lecture. Prerequisite: 48-205, Corequisite: 48-310.

48-305
Architectural Design and The Building Site — **Spring: 18 units**
Focusing on topics of earthwork, soils behavior, foundation systems, retaining walls, pavements, water management, and planting, and guided by studies in ethnography and ecology, this studio explores the imparatives for intelligent stewardship of natural resources and the reciprocal orders of buildings and landscape. 9 hrs. studio and lec. Prerequisite: 48-300, 48-310.

48-310
Materials and Assemblies — **Fall: 9 units**
Thoroughly examines the material and assembly aspects of steel and concrete. The two course projects are intended to provide in-depth experience with each material. Steel and concrete will be discussed with regard to their manufacture, intrinsic possibilities and limitations as building materials and the methods of their selection, drawing, specifying and constructing. Prerequisite: 48-215 Structures.

48-315
Environmental Systems — **Spring: 9 units**
This course introduces architectural design responses for energy conservation, human comfort, and the site specific dynamics of climate. Students are expected to combine an understanding of the basic laws of comfort and heat flow with the variables of local climate, designing the most viable energy measures from siting, massing, organization, enclosure detailing, opening control, to system integration and management. To stress the significance of architectural design decision-making on energy consumption and comfort, full design specifications and hand calculations are completed for a residential scale building. An overview of world energy consumption in buildings and energy design standards is challenged by lectures of the state of the art in building energy conservation and passive heating and cooling technologies. The course ends with a focus on the design integration of natural conditioning systems and the potentially dynamic interface of mechanical systems in small and large scale buildings. Prerequisites: 33-108Physics for Building Sciences

48-320
Decision Making and Architecture — **Fall: 9 units**
This course is an introduction to rational methods in architectural design. It aims to develop understanding of concepts of rationality and decision-making in architectural design, rational methods and their use in architectural problems, and the relationship of rational methods to the intuitive design process and abilities Abilities in recognizing architectural problems for which rational methods are useful, applying these methods to new problems, and critically viewing the design process in relation to personal and professional terms will also be developed. Prerequisites: 73-100 Economics, or 36-209 or 36-211 Probability and Statistics.

48-321
Psychology of Habitation — **Spring: 9 units**
An introduction to the socio/psychological relationships between people and the man-made environments they inhabit. The emphasis is on developing design capabilities, particularly, the capability to anticipate the consequences of design decisions for people who experience and use buildings.

48-330
Perspective Drawing — **Fall: 9 units**
Studio drawing course which addresses perspective with respect to three distinct understandings of visual perception: Tranactionalist, Ecological, and Gestalt. The limitations of perspective as a representation of the visual world are also examined at the conclusion of the course in the more speculative context of the instructor's own work. Course includes a review of perspective construction from orthographic views, but the majority of the work is free-hand. Understandings are developed initially in figure drawing exercises and then transferred to architectonic subjects. Work includes four portfolio submissions of three to four weeks duration each and one or two quizzes on lecture material. 3 hrs. studio and lec. Prerequisite: Sophomore standing, 48-100, 48-096,7 or 48-035 or equivalent. This course is open to students from other disciplines.

48-335
Color Drawing — **Spring: 9 units**
Studio drawing course that develops an intellectual understanding of various theories of color and practice in the use of color. The thoretical background of the course is devloped in lectures. Of prime importance are the views of Itten and Libby. Topics addressed in lectures and studio work are contrast of value, cold-warm contrast, and complimentary contrast. Materials used are colored pencil, water color, and pastel. Work includes four portfolio submissions of three to four weeks duration each. 3 hrs. studio and lec. Prerequisite: Sophomore standing, 48-330 or equivalent. This course is open to students from other disciplines.

48-400
Architectural Design and Occupancy — **Fall: 18 units**
Examining the psychological, perceptual, and physical factors that effect building design, this studio originates in an understanding that individuals and groups of people behave predictably. Built upon an understanding of statistical methods, it considers the building program in regard to characteristics of occupancy that are generalized into typologies, human factors and regulatory agreements. Typical projects include: multiple-family housing, small specialized use medical facilities, and small educational or religious facilities. 9 hrs. studio and lec. Prerequisite: 48-305, 48-320.

48-405
Arch. Design and Integration — **Spring: 18 units**
This studio examines the complex interrelationships between performance criteria, building systems, specification, evaluation and the design of a small but technically complex building. Typical projects include: laboratory, medical, and museum facilities. 9 hrs. studio and lec. Prerequisite: 48-400, Corequisite: 48-415.

48-410
Total Building Performance — **Fall: 9 units**
This course introduces the concept of Total Building Performance, clarifying the full range of building performance mandates required in today's architecture, including building integrity, thermal quality, acoustic quality, visual quality, air quality and spatial quality. The course proceeds to explore the relationships, opportunities and conflicts of these mandates, and the comprehension and integration of building systems necessary to achieve satisfactory performance in all areas. Prerequisite: 48-315.

48-415
Mechanical Systems — **Spring: 9 units**
This course introduces the mechanical engineering expertise in supporting building design for thermal comfort and air quality. The heating, ventilating and air conditioning (HVAC) component of the course will include: the role of HVAC systems within the broader context of energy effective and environmentally responsive building design; the range of system and hardware alternatives for the generation, distribution, and terminal delivery of space heating, cooling and ventilation; innovations in the design of HVAC systems and system interfaces (with structure, enclosure, and interior systems); and an introduction to the calculations and evaluation of system alternatives in relation to thermal performance, air quality, and acoustics. Students will be expected to reflect an understanding of this expertise in the studio setting through early design resolution of the HVAC space requirements, network configuration, and aesthetic implications. Prerequisite: 48-410.

48-420
Design Economics — **Fall: 9 units**
This course investigates the feasability of an architectural project, focusing on financial, cost and design considerations. Its primary objective is twofold: to provide students with quantitative skills for analysing 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. 3 hrs. lec Prerequisite: 73-100 or 36-209.

48-421
Urban Design **Spring: 9 units**
This seminar will explore urban design as a discipline within the profession of architecture and the role architects can play in the continuing evolution of our cities. This seminar's title, Felicity/city, is intended as a general expression of the goal of urban designers: the evolution of the "good" city in which the inhabitants are happy as individuals in relation to their environment and society; in which the spaces and places are appropriate in specifically local, physical, and cultural terms; in which social interrelationships are based on traditions that are at once historical and aspirational; and in which civic pride is related to a language of local beauty.

48-4xx
Departmental Elective **Spring and Fall: 9 Units**
Various courses on the topics of drawing/media, occupancy, criticism, architectural history, planning/management, engineering. Prerequisites: various.

48-500/5
Architectural Design and Urban Design **Fall/Spring : 18 units**
Using Pittsburgh as a laboratory, and in light of the historical, contextual, economic and political factors affecting its form, this studio focuses on comprehensive urban design and architectural intervention. 9 hrs. studio and lec. Prerequisite: 48-405

48-520
Professional Practice **Fall: 9 units**
This course examines the practice of Architecture in light of the legal and ethical responsibilities of the Architect. It analyzes the management of the Architect's office as required to provide the services that must be performed to produce a quality product for the client and an adequate income for the Architect.

Design

Undergraduate Courses

* Open to non-majors. Limited space.

51-114
Design Studio I **9 units**
This studio course is an introduction to the principles that can be applied to the development of images. The course will cover use of visual elements; line, shape, texture and space and the principles of visual organization. Color is integrated as a major component of the course. The projects assigned will cover a variety of materials and processes. Prerequisite: professional program status.

51-115
Design Studio II **9 units**
This studio course is an introduction to the principles that can be applied to the development of form. Students are introduced to the basic elements and principles of visual organization and how form can express meaning. The projects assigned will cover a variety of materials and processes. Prerequisite: professional program status.

*51-116
Calligraphy I Fall or Spring: 6 units
The art of agreed written symbols for agreed spoken sounds. Working with basic, simple, sans-serif Roman letterforms, their function, readability, forms relationships to each other and harmonious sequencing will be taught through weekly projects: 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 and/or parts thereof; demanding concentration and manual discipline; hand-eye coordination is developed. Brief intro to Historical development of our Western alphabet to 20th century typefaces, and tools and materials. Indispensable to graphic designers and communication majors; excellent discipline for art students and of interest to students of the Humanities. Open to all. Supply requirements are minimal.

*51-117
Calligraphy II **Fall or Spring: 6 units**
Advanced problems in calligraphy and lettering. New hand introduced; to be decided by student and instructor. Open to all. Pre-req. 51-116

*51-120
Advanced Calligraphy I **Fall or Spring: 6 units**
Two directions may be taken. (1.) Enlarging 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 limited repertoire of scripts such as Roman, Italic, Sans serif. Open to all. Pre-req. 51-117

*51-121
Advanced Calligraphy II **Fall or Spring: 6 units**
Advanced problems from 51-120 or new direction determined by student and instructor.

51-126
Human Experience in Design **9 units**
This course focuses on three major themes: design and the human dimension, the design process, and environmental and systems design. The first section focuses on developing and understanding of human beings and their needs. The second phase explains how design responds to those needs and the various ways design is practiced. In the third phase students learn that design exists at several levels from individual products and messages to systematic planning. At the eco systems level design can have an impact on the earth's environment itself.

51-134
Drawing I **9 units**
The goal of this course is to introduce the students to a variety of drawing approaches. Students learn various methods of representation, communication, idea generation and form development. The course will introduce a variety of processes and materials and stresses a logical approach to the understanding and interpretation of structure, space and light. Drawing is viewed as a means to design thinking with emphasis placed on the analysis of existing man made and organic forms. Prerequisite: professional program status.

51-135
Drawing II **9 units**
This course builds upon the principles covered in design drawing I with the introduction of drawing systems and diagrammatic conventions in the second semester. In the axonometric section, perspective drawing systems will be covered. Mapping, charting, and diagramming will also be explored as means to analyze, understand and communicate various forms of visual, and at times, non-visual information. Projects are given that reinforce freehand sketching and provide the basis for an introduction to more sophisticated drawing instruments. This course expands the range of materials and processes available to the student and discusses the effect on visual expression.

51-155
Introduction to Photo Design **6 units**
This course introduces students to the camera and how it is used as a tool exploring the visual world and documenting work in the studio. Color slides are the means for discussing issues of composition, context, and ideas in photography and how it relates to design. Open only to design freshmen. Camera required. Lab fee.

51-160
Learning to Look: Introduction to the Visual Arts **9 units**
Discussions, lectures, presentations and personal explorations sensitize students to the communication implications of the visual world. Emphasis is placed on developing a vocabulary to describe relationships between form and content, problem and solution, the real and the ideal and other concerns of the professional designer. Prerequisite: professional program status.

51-161
Introduction to Design Thinking **9 Units**
The purpose of this course is to introduce students to the different approaches and types of products characteristic of communication design and industrial design. The work of selected individual designers will be discussed. We will also discuss specific similarities and differences between design and disciplines such as engineering, the fine arts, and architecture. This course should help the student decide the area of design in which they will major. Prerequisite: professional program status.

*51-170
Communication Design Fundamentals **Fall: 9 units**
Geared to students in other departments without prior experience in design, this one-semester course introduces them to the field of graphic design. Through a series of studio projects, lectures, and demonstrations, they become familiar with the visual and verbal vocabulary of graphic designers, with the design process, and with the communicative value of world and image. Macintosh proficiency. No prerequisite.

51-171
Communication Design Fundamentals **Spring: 9 units**
Geared to MAPW students.

*51-180
Industrial Design Fundamentals **Fall: 9 units**
A one semester course structured to help non-majors gain an understanding of 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. Lab fee. No prerequisite.

*51-201
Design History II **Spring: 9 units**
Survey of major developments and influences in the history of design.

51-204
Basic Typography: CD I **9 units**
Typography is the visual representation of language and typographic foundation for the understanding and appreciation of type in its various manifestations. It begins with setting type by hand and continues on the computer with a series of exercises covering basic visual and verbal vocabulary for typography. Issues covered will include principles of legibility and readability; the proper spacing and arrangement of letters, words and paragraphs on a page; and meaning through content and context. Lectures and visits to the Rare Book Room in the Library and the letterpress lab in the department will cover the historical development of letterforms and typefaces in the context of page and book design. Prerequisite: Professional program status.

Course Descriptions

51-208
ID Studio I: Generation of Form — **Fall: 9 units**
This course focuses on product aesthetics and basic formal systems it is the first studio for students in the industrial design program. It integrates the principles of three dimensional design, drawing and prototyping as it applies to product development. Students learn advanced prototyping skills, conceptual drawing and presentation skills and CAD. Prerequisite: Professional program status.

***51-210**
Beginning Photography — **Fall or Spring: 9 units**
A one-semester introductory course. After a technical orientation and experience with the photographic process, the major emphasis is placed on the aesthetics of black and white photography as a source of images. Intended primarily for students in other departments. Camera required; lab fee.

51-211
Intermediate Typography: CD II — **Spring: 9 units**
This course will focus on the integration of type and image. Type can be a single letter, a work, or text. Image can include a drawn image, a photograph, a computer-generated picture, or type itself. Type as image and type and image will be the basis for projects, lectures, and discussions. With an emphasis on the pragmatic and the expressive aspects of typography, students learn how typographic signals can support written information and influence meaning.

51-212
Design History I — **Fall: 9 units**
Survey of major developments and influences in the history of design.

51-213
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 message in powerful terms. Beginning with a perceptual understanding of color, this course will explore the many ways that color communicates. Students will work with both traditional and computer tools to appreciate their similarities and differences in the context of theoretical and applied projects.

51-218
How People Work: Human Factors — **Spring: 9 units**
This course is an introduction to the general field of applied human factors. It centers on anthropometric, perception and simple human-machine systems while providing the student with an introduction to the practice and roots of the human factors profession. The emphasis is on the application and use of existing factors and data rather than the generation of new studies and data. A lecture and project is employed.

51-220
Photography Darkroom I — **Fall: 4.5 units**
This course focuses on the fundamentals of black & white darkroom work. Students learn how to expose and develop film and make photographic prints. Working with the camera as a source of imagery for designers and the aesthetics of photography are also stressed. Required for all CD majors.

51-222
Basic Prototype Methods — **Spring: 4.5 units**
A half-semester MINI laboratory course introducing a range of materials, methods, and workshop techniques by which designers prototype designs in three dimensions. Prerequisite: Professional program status; studio and model shop tools are required; lab fee.

51-223
How Things Work: Mechanics and Electronics — **Spring: 9 units**
This course investigates the basic principles of mechanics and electronics. Through the combination of lectures and lab experiments students develop functional prototypes. Students use drawing, mechanical drawing and three dimensional models to develop an insight into mechanical and electrical systems. Required of ID students; no prerequisites.

51-224
Photography Darkroom II — **Fall: 4.5 units**
Continuation of 51-220.

***51-233**
Typography (for non-majors) — **Fall: 9 units**
Typography is the visual representation of language. The course takes an interdisciplinary approach to introduce students to the subject. The course content includes a broad range of typographic information; emphasis is placed on the utilitarian aspect of typography. Students learn how typographic signals can support written information and influence meaning. This course is recommended for industrial design majors, illustration majors, and technical and professional writing majors. Particular attention is paid to the fact that the class is comprised of non-graphic design majors. Whenever possible, course content is adjusted to show connections between typography and the students' major area of study. Two major exercise-based projects will be assigned. Lectures, demonstrations, class discussions and group critiques are used at various times throughout the semester to reinforce course content. Student evaluation is based on the ability to demonstrate principles taught. Students will be expected to purchase some basic supplies in order to complete the projects. Prerequisite: none; lab fee.

***51-250**
Color — **Fall or Spring: 9 units**
This course emphasizes perceptual understanding of color. Studio exercises are presented which demonstrate the relative quality of color. Assignments are presented which apply color theories and stimulate the imagination and personal use of color. These assignments explore compositional principles and harmony. This course is open to the university community. No prerequisite required.

51-262
Meaning of Form: ID II — **Spring: 9 units**
The course in product semantics introduces students to the symbolic aspect of design. Several projects are given and students are required to develop studies that express the meaning and function of products. Students use various methods of conceptual sketching and prototyping. Prerequisite: ID Studio 1 and ID Lab 1.

51-302
Contemporary Design: CD/ID — **Fall: 9 units**
Topics in contemporary design.

51-308
Drawing and Intent — **Fall or Spring: 9 units**
This course is designed for students with foundation drawing experience. We will explore the drawing process through primarily hand generated means with allowance for the integration of non-traditional drawing media. Several themes are explored centering around objects, people and places in a given context. Strong emphasis is placed on individual interpretation of these themes. Specific conceptual and technical skills will be discussed both individually and in groups as students explore the relationship between images and meaning. Prerequisite: Professional program status or instructor permission.

***51-310**
Advanced Photography — **Fall or Spring: 9 units**
An advanced course intended to further develop the students' knowledge of photo-history, black and white processes, and personal aesthetics. Camera required; lab fee. Prerequisite: previous darkroom experience.

51-331
Pre-press Production Methods — **Spring: 9 units**
A lecture/lab exploration of the processes and materials of the printing industry as related to the work of the communication designer. The role of electronic publishing tools in the preparation of "finished art" will be emphasized. Field trips to a printer and an electronic pre-press facility, as well as guest lectures from industry, keep this course up-to-date. Prerequisite: Professional program status or permission of the instructor; lab fee.

51-333
How People Work with Things (Adv. Hum. Facs.) — **Spring: 9 units**
It assumes literacy in anthropometry and the basic practices of system analysis and data application. It focuses on methods of analysis and design for complex human-machine interaction. While the course is still directed toward the needs of design students, participation of students from other disciplines is welcome. There are a variety of formats used in the class lecture, experiments and projects (primarily interdisciplinary team projects).

51-336
Advanced Typography: CD III — **Fall: 9 units**
This course deals with more complex issues, as it expands on the principles of typography and visual communication. Lengthier texts, large-scale type, a range of image sources, and working with grids and sequencing will be dealt with. An exploration of semantic potential to type, image, color, motion, and sound introduces the student to the expanding influence of the communication designer in the world of communication.

51-337
Information Design: CD IV — **Spring: 9 units**
Information may appear in a variety of forms, from purely functional to the ephemeral, yet all information must be designed. The visual organization and display of complex data will be the focus of this course. Each piece should be designed with clarity, simplicity, and a respect for the audience, guided by cognitive models of understanding. In this course the student will be applying principles learned in earlier courses in design, psychology, history and writing.

51-340
How Things are Made: ID Lab III — **Fall: 9 units**
This course introduces students to the manufacturing processes and material possibilities 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 manufacturing processes and materials. Students learn how to choose the appropriate materials and processes for a particular product application. Required of ID students; no prerequisites.

Course Descriptions

51-342
Experimental Imaging and Meaning — **9 units**
Images inform, seduce, confuse; they are drawn, collaged, photographed, or filmed; they are a frozen moment in time or choreographed movement. We see, use, and consume images (pictures) everyday, but spend little time analyzing their content, context, or meaning. The creation, manipulation, and use of images in the context of human-to-human communication will be the focus of this course, along with an analysis of how/why our culture has evolved from text-centered to image-centered.

51-345
Advanced Projects in Design Computing — **Spring: 9 units**
This course allows students to employ a mix of traditional and computer-based tools in an experimental and theoretical context. Emphasis is on erasing the boundaries between work done by computer and other means of production. Student projects are substantially self-directed, and result in an extensive final project. Prerequisite: Professional program status.

51-352
Signs, Symbols and Marks — **Fall: 9 units**
This course will focus on the formal development of pictorial signs (icons, symbols, marks, etc.) either as individual elements or as a family or system of compatible forms. An analytical process, which includes research, observation, idea generation, development, selection, and refinement, will be introduced in the context of the course projects. It will explore the messages they carry culturally, socially, and personally, through applications in two- and three-dimensional formats. This course is required of graphic design majors. Prerequisite: Professional program status.

51-353
Non-verbal Communication — **Spring: 9 units**
Non-verbal communication through images is subject to cultural conventions affecting meaning and interpretation. Images can be formulated, explored, and analyzed in order to affect their informational content and effectiveness. This course will place emphasis on how images function in the communication arena, as well as how various media can influence the construction of visual messages.

51-360
Product Design: ID III — **Fall: 9 units**
Work in this course prepares students for the Spring semester degree project. The course projects are chosen to give students an opportunity to use all of their creative, technical and theoretical skills in a business setting. Emphasis is given to interaction with engineering, marketing, and other professionals who influence the product development process. Prerequisite: Professional program status; studio and model shop tools are required; camera; lab fee.

51-361
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.

51-371
Junior Independent Study — **Fall and Spring: var. units**
Guidelines for independent study in the Design Office. Proposals must be approved before pre-registration. Prerequisites: 3.0 QPA minimum, professional program status, approved proposal.

*51-400
Design Principles: Professional Practice — **Fall: 9 units**
An interdisciplinary lecture course covering all aspects of design practice. Students learn to formulate a plan for professional practice, market creative services, manage projects, and understand legal and ethical issues. It will also deal with the changing role of the design profession and the aesthetic considerations in actual practice. Visiting professionals, case studies, and supplementary reading provide resources for class discussion. No prerequisite.

51-401
Topics in Design Studies — **Spring: 9 units**

51-402
Exhibition Design — **Fall: 9 units**

51-403
Kinetic Information Display — **Fall or Spring: 9 units**
An extension of typography courses that deal with type in two- and three-dimensional contexts, this course adds the dimension of time, which suggests motion. The rich history and language of film will be the basis for explorations into new ways of communicating with type, image, motion, and sound. This course is open to students with strong typographic skills and curiosity about the future of visual communication.

51-404
Human-Computer Interface Design — **Fall or Spring: 9 units**
The user interface for an interactive computer-driven system refers to the means of interaction between the user and the system. How easy is it to use, and did the user accomplish what s/he set out to do? Designing the user interface is a multi-disciplinary task, one that draws upon the fields of visual communication, cognitive psychology, linguistics, and system design. This course will cover the principles involved with designing user interfaces, focusing on the visual aspects of a specific project. This course is open to upper-level students from various disciplines across campus. Programming is not required.

51-410
Fundamentals of Joinery & Furniture Design — **Fall: 9 units**
Intensive introduction to traditional joinery techniques and the properties of wood through the use of textbook studies and lab experiments. Emphasis placed on how these properties influence design decisions. Students will learn how to set up, sharpen and use traditional hand powered tools. Limited enrollment. Prerequisites: Professional program status and permission of the instructor; lab fee and material purchases required.

51-411
Furniture Design — **Spring: 9 units**
A continuation of 51-410, this course explores a much broader range of issues related to furniture design. Students will identify and define in a proposal the area of furniture design they intend to investigate — then produce one or more furniture pieces developed from their findings. Assigned readings and a series of in class discussions will focus on the influence of workmanship in design. Prerequisite: 51-410; lab fee & material purchases required.

51-421
Individual Senior Project: ID — **Spring: 9 units**
Students in the final semester of the senior year are required to choose a topic for in depth study and analysis. The project is primarily self directed and faculty serve as advisors. Students are urged to work with industry in actual product applications. Prerequisite: Professional program status.

51-425
Individual Senior Project: CD — **Spring: 9 units**
Students in the final semester of the senior year are required to choose a topic for in depth study and analysis. The project is primarily self directed and faculty serve as advisors. Prerequisite: Professional program status.

51-440
Environmental Communication (Signage) — **Fall: 9 units**
In this course, students will be exposed to the design process, the techniques, the materials and technology available to the designer in the creation of environmental signage. Students will work with a real problem, investigating, documenting, designing, and creating models/prototypes within the constraints of a given architectural structure and its specific needs. Prerequisite: Upper level Design and Architecture students only.

51-442
Map Design — **9 units**
Students will be taught the principles of maps and map making: coordinates, scale, distance, direction, content, and definition of information through contrast, color, layering, micro/macro views, and two- and three-dimensional representations. The course will emphasize the application of basic design principles, the development of specific visual/graphic languages, and the communication of large amounts of data with clarity.

51-443
Visual Language — **9 units**
What we intend to say, how we say it, and to whom we say it are specific problem of design. As with spoken language, visual language can define, describe, and imply meaning. This course is concerned with the study and development of individual methods for arriving at expressive and meaningful solutions to design problems. Individual experimentation and a free use of media will be encouraged.

51-445
Visual Interface Design — **9 units**
The user interface for an interactive computer-driven system refers to the means of interaction between the user and the system. How easy is it to use, and did the user accomplish what s/he set out to do? Designing the user interface is a multi-disciplinary task, one that draws upon the fields of visual communication, cognitive psychology, linguistics, and system design. This course will cover the principles involved with designing user interfaces, focusing on the visual aspects of a specific project. This course is open to upper-level students from various disciplines across campus. Programming is not required.

51-446
Experimental Books — **9 units**
What is the essence of a book? What are its properties, its boundaries, its traditions? This course will explore the creation and production of a book, making use of tools that range from the letterpress to the computer, and considering models as varied as a sequence of pages (linear) and hypermedia (non-linear, three-dimensional). This course is for students with an interest in extending the boundaries of applied typography and image generation/manipulation.

51-447
Packaging **9 units**
A comprehensive exposure to packaging to include product development, branding, model making, structural package design, with the application of graphics to the product and package. Generally an externally supported course.

51-450
Communication Design Team Projects **Fall: 12 units**
Emphasis for this semester is on graphic design in a cross-professional situation. Projects include packaging design, information design, and book design utilizing photography. Goals include: a) developing a professional attitude and atmosphere, utilizing applied visual communication projects, b) refining the understanding of the design process, with client contact when possible, and c) sharpening the skills introduced in earlier semesters. Prerequisite: Professional program status.

51-453
Information Design **Spring: 9 units**
Information may appear in a variety of forms, from purely functional to the ephemeral, yet all information must be designed The visual organization and display of complex data will be the focus of this course. Each piece should be designing with clarity, simplicity, and a respect for the audience, guided by cognitive models of understanding. In this course, the student will be applying principles learned in earlier semesters in design, psychology, history, and writing. This course is required of graphic design majors. Prerequisite: 51-452.

51-454
Industrial Design Team Projects **Fall: 12 units**
Work in this course prepares students for the Spring semester degree project. The course projects are chosen to give students an opportunity to use all of their creative, technical and theoretical skills in a business setting. Emphasis is given to interaction with engineering, marketing, and other professionals who influence the product development process. Prerequisite: Professional program status; studio and model shop tools are required; camera; lab fee.

51-460
Professional Preparation **Spring: 3 units**
3 unit mini-course for both CD and ID seniors This course will help students to prepare themselves for post-college experiences, whether it be a job in the Design field or graduate study. It will focus on portfolio preparation, job search, and interviewing skills.

51-471
Senior Independent Study **Fall or Spring: var. units**
Independent Study guidelines available in Design Office. Proposals must be approved before pre-registration. Prerequisites: 3.0 QPA minimum, professional program status and approved proposal.

51-480
How Products Will Be Made: New Technologies **9 units**
This course introduces students to the manufacturing processes and material possibilities that are considered in product design and development. Through the combination of lecture, demonstration and field trips students learn the advantages and disadvantages of various manufacturing processes and materials. Students learn how to choose the appropriate materials and processes for a particular product application.

51-491
Design, Manufacturing and Marketing of New Products **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 multidisciplinary groups on the actual development of products. In addition to the product development project, the course includes lectures on innovation strategy, opportunity identification, designing products, object representation and manufacturability rules, computer-assisted design and prototyping, concept testing and protocol analysis, redesign issues, market testing, manufacturing and production, and product introduction and management. Open to graduate and senior level engineering students, industrial administration students and design students.

Drama

Undergraduate Courses

Please note that wherever a course is listed as "Fall & Spring" that the Fall semester is a prerequsite for the Spring semester.

** Open to non-majors. Instructor's permission required.

54-101/2
Acting I: Exploration of the Actor's Craft/Basic Acting Techniques/Dynamics **Fall & Spring: variable 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 student's creative resources.
Dynamics: A physical and vocal warm-up in preparation for the acting classes. Exercises for focus, relaxation, flexibility and concentration. An opportunity for the student to understand the need for a suitable individual warm-up.

54-103/4
Voice & Speech I: Vocal-Physical Exploration/Voice in Action/Phonetics **Fall & Spring: variable units**
Instruction in the organic work needed for basic voice production and the voco/physical connection.
Phonetics: Basic principles of expression of meaning and emotion through sound and language. Scansion: verse and metrics analysis. Textual analysis: imaging, phrasing, communication. Phonetics and ear- training: principles of good speech for the American stage.

54-105/6,
Acting Lab I: Text/Rhythm/Directing **Fall & Spring: variable units**
Text: How to read scripts. Use of the printed text as the theater artist's primary resource. Investigation of techniques to examine scripts for playwrights' intentions, methods, meanings. This course is an extension of acting for Freshmen.
Rhythm: "Discovery and Development of Internal Rhythm" is a creation of Victoria Santa Cruz, based upon rhythmic combinations of African roots. Through the execution of exercises, the student may understand, organically, what it means to live a situation and not to anticipate it. The progressive nature of these exercises guides the student to more subtle levels of inner connection, and an understanding of the liberating effects of calling upon the interior rhythm.

54-107/8
Movement I: Intro to Movement & Stage Combat **Fall & Spring: 4 units**
Work in this preliminary year of movement training concentrates on the basics, learning a physical vocabulary and developing a physical imagination. Corporeal education includes breathing, stretching, body dynamics, movement analysis, dramatic acrobatics and physical improvisation. The student also studies stage combat, including hand-to-hand, quarterstaff, and single rapier, leading to scene work incorporating these skills.

54-119/20, 54-219/20,
Music Theatre Workshop I, II **Fall & Spring: variable units**
An introduction to the integration of the techniques of dance, singing and acting as required for the various forms of musical theatre. Coaching in the the ability to work spontaneously and with reality in the imagined world of the musical.

54-121/2
Directing I: The Art of Directing **Fall & Spring: 12 units**
How the director reads a play; developing a basic theatrical and critical vocabulary; the actor/director relationship.

54-123/4
Dance I **Fall & Spring: 6 units**
Foundation of classical ballet with concentration on neuro-muscular- skeletal principles that relate to acting and voice. Introduction to movement patterns for contemporary concert dance. Carnegie Examination Syllabus I and II covered.

54-125/6, 54-225/6
Music Theatre Skills I, II **Fall & Spring: 3 units**
An introduction into music skills for the musical theatre student. The goal of this course is to develop good ear training and a foundation of basic harmony skills.

54-127/8, 217/8
Piano Skills I, II **Fall & Spring: 2 units**
Introduction in basic piano and harmony skills for the student of musical theatre.

54-131/2
Basic Design :Composition & Drawing Techniques/Introduction of Color **Fall & Spring: 12 units**
Exploration of design elements in both two- and three-dimensional compositions to expand the visual experience. A classical approach to drawing techniques, developing the science of three dimensional form on a two dimensional surface through the use of light and dark. Communication of ideas through drawing.

54-157/8
Production I: Directors **Fall or Spring: 6 units**
Stage managing or assistant stage managing in the Studio or Kresge Theatres.

Course Descriptions

54-159/60, 54-259/60
Stage Crew I, II — **Fall or Spring: 4 units**
Hands on experience in most asspects of building and running a production.

54-161/2**
Production Preparation I — **Fall or Spring: 6 units**
Basic instruction and practice, through preparation and crew assignments, in building and handling scenery, costumes, props, and lighting.

54-165/6
Sound Design I, II — **Fall & 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.

54-171/2
Drafting — **Fall & Spring: 6 units**
Graphic communication of the theatrical design idea through finished draftings: designer's elevations, working drawings, plans, elevations, sections, detail and prop drawings. Particular emphasis on theatrical drafting conventions,solutions of technical problems and computer aided design techniques.

54-173/4
Technical Production I — **Fall & Spring: 6 units**
Tools, materials, and methodology for construction of stage scenery and props. Emphasis on traditional methods and materials as well as innovative techniques using adapted technologies. Training in safe use and maintenance of hand and power tools.

54-183/4**
Fundamentals of Drama — **Fall & Spring: 6 units**
How to read and understand dramatic texts. This lecture and seminar course introduces methods and vocabulary necessary for reading plays with an ability to discern the performance implicit in them and the ideas generated by them. Dramatic masterpieces from various periods will be studied.

54-187/88
Introduction to Playwriting — **Fall or Spring: 3 units**
An investigation of the techniques needed to develope scripts for playwright's intentions,methods, and meanings.

54-201/2
Acting II:Contemporary and Classical Scene Study — **Fall & Spring: 10 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 actor's inner resources to be supported by the craft techniques.

54-203/4
Voice & Speech II: Vocal Performance/Poetry/Shakespeare — **Fall & Spring: 6 units**
Basic principles of expression of meaning and emotion through sound and language. Breathing, relaxation, articulation, centering. Scansion: verse and metrics analysis. Textual analysis: imaging, phrasing, communication. Phonetics and ear- training: principles of good speech for the American stage.

54-205/6 — **Fall & Spring: variable units**
Acting Lab II: Rhythm/Exploration/Styles/Text/Directing
Rhythm: A continuation of the skills taught in the first year.
Styles: A short survey of lifestyles from the 14th to the 20th century, approaches to working with behavior shaped by beliefs, conventions, customs and clothing through the centuries and re-created organically for the theatre of today.
Exploration: Exercises to develop the actor's ability to work in the moment through a spontaneous inner connection to the immediate imaginary situation. These exercises balance the intellectual exploration required on a text, giving the student an organic, dynamic experience through improvisation.
Text: Study of Shakespearean text from the actors' point of view, focus on developing tools useful in the analysis of poetic drama.
Directing: Actor participation in the development of the Director's skills.

54-207/8
Movement II:Lecoq Neutral Mask/Expressive Mask — **Fall & Spring: 4 units**
Study in this second year of physical acting training centers around Lecoq mask work. This includes preparatory improvisation and movement analysis, neutral mask and expressive mask. Group projects also form an integral part of this year's learning process.

54-210
Director's Workshop — **Fall & Spring: 6 units**
A study of the techniques used to support the acting process for work with classical scripts. The exploration of character, relationships and language and the use of these elements to reveal the reality within the imagined world of the play.

54-214
Elementary Dance II — **Spring: 4 units**
Study of the fundamental principles of classical ballet technique applied to the development of physical expression, rhythm and control for the student of acting.

54-221/2
Directing II:The Director's Tools — **Fall & Spring: 6 units**
Introduction to the fundamental concepts and techniques of realizing a texts on stage; the relationship between analysis and staging; director/designer relationship.

54-223/4
Dance II — **Fall & Spring: 6 units**
Intermediate classical ballet technique and contemporary concert dance with introduction to theatre dance forms based on ethnic dance and tap fundamentals. Carnegie Examination Syllabus III and IV are covered.

54-231/2
Stage Design — **Fall & Spring: 6 or 9 units**
Basic design principles applied toward design for the stage, integrating scenery, costumes and lights into visual statements relevant to the interpretation of a play.

54-237/8
Scene Painting I — **Fall & Spring: 4 units**
Basic standard methods of scene painting techniques. Studio work in in lining, trompe l'oeil ornament, drapery, etc. Students must provide scene painting brushes and muslin.

54-239/40**
History of Architecture and Decor — **Fall & Spring: 4 or 6 units**
Survey of the interaction of style and form in the historical and national style line of: architectural form, interior decoration, furniture design. Focus is on the reason or meaning of form and its origin in either a natural, social, economic, or spiritual environment.

54-245/6**
History of Clothing — **Fall & Spring: 4 or 6 units**
A guide to historical shapes with emphasis on the basic period silhouette, the manner in which it is trimmed, how the costume is worn and the social influences on it. Presented by illustrated lecture and slides of primary sources with supplementary research projects.

54-251/2**
Introduction to Lighting — **Fall & Spring: 6 units**
Basic theories of stage lighting emphasizing technical and aesthetic aspects, leading to practical planning of light plots for individual plays. Coursework includes evaluations of lighting of departmental productions.

54-261/2
Production Preparation II — **Fall or Spring: 9 units**
Planning, executing, and supervising production work in set construction, scene painting, costume, lighting, properties.

54-263/4
Welding — **Fall or Spring: 4 units**
This introduction into welding concentrates on the basics of arc welding and builds a conscious awareness of good welding safety principles.

54-273/4
Technical Production II — **Fall & Spring: 9 units**
Lecture and practice in advanced stagecraft techniques. Approaching the translation of design ideas into practical construction methods, through a collaborative process. Study and practice in production drafting methods. Special problems in construction, assembly, rigging and handling of scenery.

54-277/8
Stage Management — **Fall & Spring: 4 units**
Studies in all aspects of stage management: organizational skills of the rehearsal process, chronicling the production from the first meeting to completion, appreciation of the managerial aspects of the performing arts, calling the show, and professional objectives.

54-281/2, 54-381/2**
History of Drama I, II — **Fall or Spring: 3 units each**
History of Drama is divided into seven week mini courses, each devoted to a particular genre, style, country, playwright or other historical theatre topic.

54-283/4
Fundamentals of Directing — **Fall or Spring: 4 units**
Study of the principles and techniques of play direction, with demonstrations and exercises. With permission of instructor and submission of prerequisite material.

54-294
Make-Up — **Spring: 2 units**
Basic techniques of stage make-up and their adaptation to theatrical styles.

54-301/2
Acting III: Styles and Genres — **Fall & spring: 9 units**
Exploration of the actors personal process. Exercises to strengthen the actors use of self through the development of the inner emotional and imaginative resources. A full, natural connection to the text through action. The use of classical texts to develop the individual actor's abilities with tragic and comedic techniques as a support to the natural, creative talent.

Course Descriptions

54-303/4
Voice & Speech III: Speaking Voice/Tutorials/Dialects/Accents **Fall & Spring: 6 units**
Voice and Speech: Advanced work and individual coaching based on problems found in rehearsal and performance. Study of European Dialects.
Dialects: The study of the regional use of sound, rhythm and language in the English speaking countries. The development of the ability to work with unfamiliar sound and placement so that it becomes, as natural speech, an integral part in the building of a believable character in the imagined world of the play.

54-305/6
Acting Lab III: Rhythm/Directing **Fall & spring: variable units**
Rhythm: A continuation of the skills developed in the first and second years.
Directing: Actor participation in the development of the Director's skills.

54-307/8
Movement III : Pantomime Blanche/Commedia and Clown **Fall & Spring: 4 units**
The third year includes in-depth studies of physical theatre styles: Commedia dell'Arte, Greek Chorus, Story Narrative, Theatrical Clown, Buffoon, Political Farce, Eccentric Characterization. All styles are studied in their historical period and then re-created for our times. The class functions as a creative ensemble during this year.

54-309/10, 54-409/10
Theatre Lab I, II **Fall or Spring: 4 units**
Projects based on original material to explore the collaborative relationship of actor, director, and playwright.

54-311/2
Studio & Performance **Fall & Spring: 9 units**
Performance training through projects at different levels of difficulty and staging, directed by students and presented in the studio theatre. The actor has the opportunity to put into practice with his/her peers, in a creative and experimental atmosphere, the principles and techniques developed in the classroom.

54-319/20, 54-419/20
Music Theatre Workshop **Fall & Spring: 4 units**
Advanced study in the integration of dance, singing, and acting as three equally necessary components of the musical theatre performance. Coaching in audition techniques is also given.

54-321/2
Directing III: Styles and Genres **Fall & Spring: 9 units**
An advanced exploration of the principles of directing through all steps necessary to bring a text to life on stage. The director's task on a theoretical and practical level is discussed and scenes with acting students performing are used for in-depth work on major texts.

54-323/4
Dance III **Fall & Spring: 4 units**
Advanced dance work emphasizing jazz, modern and tap.

54-327/8
Music Literature & Repertoire **Fall & Spring: 3 units**
A brief introduction to the periods of music theatre from the late 19th century to the present day. Students have the opportunity to study individual songs in the correct style and appreciate the different approaches required to perform the major composers and lyricists.

54-329/30
Elementary Voice **Fall & Spring: 3 units**
A course designed to introduce actors to the basic fundamentals and techniques of the singing voice. Application of these skills are then applied to singing repertoire suitable for future auditions in the first semester. The second semester is spent applying skills in performance which is then presented in a final project.

54-331/2
Scene Design I **Fall & Spring: 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.

54-337/8
Scene Painting II **Fall & Spring: 4 units**
A continuation of the study and practice in scene painting techniques. Studio work in detailing and portraiture.

54-341/2
Costume Design I **Fall & Spring: 9 units**
Course follows a chronological sequence dealing with the transaction of historical costume forms and details into theatrical terms. Emphasis on the use of design principles to communicate and express character, mood, style, etc. Figure drawing and painting techniques are incorporated into the course. Studies in design techniques with a basic approach to the figure and how it is costumed to suit the production. Emphasis on interpretation, director-designer communication, and the design process.

54-343/4
Costume Construction I **Fall & Spring: 6 units**
Study of and practical work in primary costume construction principles; emphasis on the development of patterns from the basic costume shapes through history.

54-351/2 **
Lighting Design I **Fall & Spring: 9 units**
Emphasis on developing a design process through script analysis and the practical application of lighting in lab exercises. Includes problems of design for different theatrical spaces. Lighting designers for departmental productions are chosen from this class; the course includes discussion and evaluation of their work.

54-358/9, 54-458/9
Production III, IV: Directors **Fall or Spring: 10 units**
Assignements as stage manager or assistant director for the Studio and Kresge Theatres.

54-361/2, 54-461/2
Production Preparation III, IV **Fall or Spring: variable units**
Advanced students are assigned positions as head or assistant head of various technical crews, i.e, lights, costumes, properties, paints.

54-372
Special Scenic Crafts **Spring: 9 units**
Study and practice in special skills applicable to scenery and property construction. Furniture repair and upholstery techniques. Basic materials and skills of scenic soft goods. Students will be instructed in a broad range of molding and casting skills.

54-373/4
Technical Production III **Fall & Spring: 9 units**
Further study of advanced scenic techniques and processes. Detailed examination of the production process from design drawings to the stage. Introduction to the physics of stage machinery. Examination of alternative materials for theatrical construction. Project assignments in problem solving, analyzing, planning and drafting of productions.

54-383/4
Critical Writing **Fall & Spring: 4 units**
A writing intensive course which focuses on developing skills for the analysis and criticism of drama and performance.

54-401/2
Acting IV: Camera and Audition Techniques **Fall & Spring: 9 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.

54-403/4 **Fall & Spring: 6 units**
Voice & Speech IV: Text & Styles/Advanced Vocal Projets
More advanced work and individual coaching based on problems found in rehearsal and performance. Study of American dialects.

54-407/8
Movement IV: Advanced Stage Combat **Fall & Spring: 6 units**
Special projects during this final year are designed to suit each class and its needs. Study might include the following: certification in stage combat with the Society of Americal Fight Directors, yoga, Feldenkrais or physical comedy.

54-411/2
Rehearsal & Performance **Fall & Spring: 15 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.

54-415/6
Dialects **Fall & Spring: 3 units**

54-421/2 **Fall & Spring: 9 units**
Directing IV: Camera and 20th Century Techniques/Directing Theories
Introduction to single and multicamera studio directing and performance. Encounter major 20th century theatrical and dramatic movements.

54-423/4
Dance IV **Fall & Spring: 6 units**
Continuation of Dance III with emphasis on sustained solo work based on the demands of music theatre choreography.

54-431/2
Scene Design II **Fall & Spring: 9 units**
Individual development through advanced work in interpretation, styles, and the relationship of the designer to other theatre artists. Designers for productions will be selected from students taking this course.

54-441/2
Costume Design II **Fall & Spring: 9 units**
Advanced studies in costume design — the use of research. Continued designer/director working relationship. Assignment to design a studio or major production.

54-443/4
Costume Construction II **Fall & Spring: 6 units**
Advanced work in costume building; individually assigned to strengthen the skills of the students.

54-451/2
Lighting Design II **Fall & Spring: 9 units**
Advanced problems of design in a variety of venues: dance, opera, musical theatre, industrials, concerts, and architecture lighting designers for departmental productions are chosen from this class; the course includes discussion and evaluation of their work.

54-473/4
Technical Production IV **Fall & Spring: 9 units**
Seminar class in the processes of technical production. Preparation for entry into the professional arena, or for further study at a graduate level. The technical director's portfolio. Personnel management and problem solving. Students will discuss and analyze the technical aspects of department productions, as well as engaging in collaborative projects with students in design classes.

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.

54-495/6
Intern Projects **Fall or Spring: variable units**
Assignment to professional theatre organizations designed to meet the professional needs of advanced-standing students. By permission of the Head of the Department.

54-497/8
Independent Study **Fall or Spring: variable units**
A course set up for the student to explore in more detail an area of theatre in which the faculty member is particularly knowledgeable or highly skilled.

54-500
Voice Class/Lessons **Fall or Spring: 6 units**
A convocation in which musical theatre students may perform musical pieces for one another. This time is designed to give the student a testing ground for studio repertoire or possible audition material. Private voice instruction designed to develop the fundamentals and techniques of the singing voice.

Course Descriptions

Music

Undergraduate Courses

Most Department of Music courses are open to students from other departments except those involving individual instruction. (See Studio for Non-Majors, 57-107/108.) Before registering students must contact the Director of Student Services to confirm placement.

57-107/108
Studio for Non-Majors **Fall or Spring: 3-9 units**
Private lessons on major instruments for non-music majors. Appropriate fee will be charged according to length of lesson. Practice facilities and instrument ownership are the responsibility of the student. Instructor permission required for continuation of lessons for more than one semester.

57-111/112
Dance I /II **Fall or Spring: 3 units**
Jazz is a dance technique unique to the United States. The warmup activities are designed to prepare the body for the specific demands of its style of movement. The music, while basically jazz, may range from gospel to punk rock. This course is designed for voice majors.
Levels one and two consist of intensive body stretching, body awareness, body discipline, understanding the use of technique and conditioning.

57-151
16th Century Counterpoint **Fall: 6 units**
This course is a study of vocal melody writing and the combining of melodies in two-part counterpoint, according to very precise rules derived from 16th century polyphonic style. Great care is given to the learning of all intervals, melodic and harmonic, to the definition of consonance and dissonance and to the proper use of non-harmonic tones. Ecclesiastical modes are used and principles of canonic and imitative writing are studied and put into practice.

57-152
Harmony I **Spring: 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. Most of the students taking this course have already taken 16th Century Counterpoint.

57-153
Harmony II **Fall: 6 units**
This course is a continuation of the study of commonpractice harmony, using Piston's Harmony. All dissonant and chromatic harmony has to be explored and learned.

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.

57-161/162
Eurhythmics I/II **Fall or Spring: 3 units**
All undergraduate music students are scheduled to take Dalcroze Eurhythmics for four semesters. Eurhythmics V and VI are required only for those students applying for Dalcroze Certification but are optional for all music students. Students entering Eurhythmics V must have completed satisfactorily Eurhythmics I to IV. The curriculum is conceived to prepare the students with a comprehensive education and experience in rhythm. The courses are designed to develop rhythmic skills through listening, rhythmic reading and notation and to bring about an understanding of rhythm in its relation to other parameters of music. Rhythmic movement, an integral part of the Dalcroze approach, is used to reinforce rhythmic and music concepts and also to convey to students an awareness of the physical demands of performing. In all classes, music concepts and objectives are illustrated with pertinent music examples.

57-163/164
Eurhythmics III/IV **Fall or Spring: 3 units**
Continuation of 57-161/162.

57-165/166
Eurhythmics V/VI **Fall or Spring: 3 units**
Advanced work in Dalcroze pedagogy and improvisation.

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.

57-181/182
Solfege I/II **Fall or Spring: 6 units**
This course is designed to improve the student's ability to analyze music aurally and to sing at sight music in traditional meters and tonalities using the fixed "doh" system.

Course Descriptions

57-183
Solfege III/IV — **Fall or Spring: 6 units**
The long-range objective of an ear-training/sightsinging class is to develop the inner hearing, that is, the ability to look at a music score and hear it accurately without actually producing the sound. For this to take place, memory of and fluency with the tonal and rhythmic language of music is necessary. To reach this objective, exercises, singing, and listening material will build on the skills developed in Solfege I and II.

57-191/192
Keyboard Studies I/II — **Fall or Spring: 3 units**
To develop a practical keyboard facility, musicianship and reading skills including harmonization, transposition, sight-reading, and improvisation are emphasized.

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 century to the 20th century, using the stage representation of certain standard operatic character types over the past 400 years as a point of departure. Reading assignments and listening to music are equally important for class sessions, but reading and thinking ability are emphasized on tests and exams.

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, but reading and thinking ability are emphasized on tests and exams.

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, but reading and thinking ability are emphasized on tests and exams.

57-205
20th Century Music History — **Spring: 9 units**
This course explores the main currents of musical thought and style in the 20th century, starting with Debussy. Of special importance are the emergence of popular music as a separate category, the concept of randomness, and the new relativistic view of musical time and space. Reading assignments and listening to music are equally important for class sessions, but reading and thinking ability are emphasized on tests and exams.

57-211/212
Dance III/IV — **Fall or Spring: 3 units**
See 57-111/112. Levels three and four emphasize technique.

57-220
English Diction — **Fall: 3 units**
The objective of this one semester course is to help singers sing English songs from the Classical and Musical Theater repertoire with clarity, accuracy, ease, uniformity and expressiveness; to illuminate meaning and 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 in 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 the application by performance with piano accompaniment.

57-223
German Diction — **Spring: 3 units**
A study of the fundamentals of German 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.

57-225
Contemporary Ensemble — **Fall or Spring: 3 units**
This ensemble is oriented towards the performance of works from our century. The ensemble and the repertoire is very flexible and intend to show 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 20th 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 goes from works for chamber ensemble to concerts and chamber opera.

57-227
Jazz Ensemble — **Fall or Spring: 3 units**
Ensemble A is the more experienced or advanced of our Jazz Ensembles. The students will rehearse and perform as much repertoire as possible. Sight-reading and record listening sessions are featured. The performance of Thad Jones, Boss Brass, Woody Herman, and Maynard Ferguson compositions help prepare the student for a professional free-lance music career. Grading criteria weighs heavily on consistent attendance, on arrival time, attitude, rehearsal alertness, and preparation of music.
Ensemble B is the less experienced of our Jazz Ensembles. The students will learn and refine big band articulations, phrasing, and sight-reading skills. Open jazz improvisation sessions in record listening are included. Performance in four concerts a year and learning repertoire are emphasized. These ensembles frequently invite and utilize more members than are required to allow as many students as possible to gain this ensemble experience. Grading criteria includes attendance, promptness, personal progress, and general professional attitude.

57-228
Chamber Music — **Fall or Spring: 3 units**
Performance is required at the end of each semester. The students will deal with problems of intonation and balance which will vary with the different combinations of instruments and combinations of ranges. The students will arrive at interpretive conclusions that are stylistically sound, yet individualistic and creative. Students will develop effective rehearsal techniques.

57-240/241
Acting I/II — **Fall or Spring: 6 units**
Acting for the singer/dancer will include beginning technique in movement (awareness of the body), improvisation and monologue (including audition material and aria as a monologue work).

57-257
Orchestration I — **Fall: 6 units**
This is an introductory course for all music majors. It is 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.

57-258
20th Century Techniques — **Spring: 6 units**
This course is open to all music majors and required for sophomore composition majors. The most important techniques from Debussy to the present will be reviewed in terms of melody, harmony, and form. Tonality, serialism and aleatoric devices will be studied. Compositional techniques of the Twentieth 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.

57-260
Introduction to Schenker Analysis — **Fall: 6 units**
The course will be based on this famous theoretician's highly practical and provocative advice to performers as summarized in his unpublished work "Art of Performance". Irene Schreier studied with two students of Schenker and is in the process of translating the book from the German. Drawing on her experience as a concert pianist, she will demonstrate the ideas through her own playing and in discussions of informal student performances. The repertoire, ranging from Bach through Brahms, will emphasize the piano literature, but will also include chamber music, orchestral examples, and the German "Lied". The course is open to all performance majors.

57-262
Schenker Analysis and Performance — **Spring: 6 units**
This famous theoretician's highly practical and provocative advice to performers, as summarized in his still unpublished "Art of Performance," will be discussed together with his theories, and related to informal student performances. The repertoire, from Bach through Brahms, will include chamber music, piano solo works, orchestral examples and the German Lied, depending on course participants. Open to all performance majors.

57-266
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 (fugatti) - 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 Lutoslavsky). 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, the student writes a Fugue for string quartet.

Course Descriptions

57-271
Orchestration II **Fall: 6 units**
This course is designed for junior composition majors; others are admitted by evaluation of the professor. 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.

57-272
Orchestration III **Spring: 6 units**
This course is designed for junior composition majors; others are admitted by evaluation of the professor. It is an extension of Orchestration II and combines orchestration and composition.

57-291/292
Keyboard Studies III/IV **Fall or Spring: 3 units**
Continuation of 57-191/192.

57-315/316
Dance V/VI **Fall or Spring: 3 units**
See 57-111/112. Levels five and six stress full body control and dance combinations varying in style. Also, the art of auditioning is explored.

57-325/326
Opera Music Theater Workshop I/II **Fall or Spring: 6 units**
A performance oriented course required of all Junior, Senior, and Graduate Voice Majors. The intent is to integrate the skills learned in Voice Lessons, Acting Classes, Dance Classes, and the Workshop itself to the performance arena. There are four levels of performance: "In-Class" presentations of scenes and arias from appropriate opera and music theater repertoire, "Audition Classes" (primarily arias), evaluated by an outside jury of guest experts, Convocations/ School Shows for area public schools and organizations, and evening performances of scenes and/or complete works open to the general public. The repertoire is agreed upon by all the faculty involved: voice teachers, coaches, acting teachers, directors, and when necessary, dance masters with the hope that the students will experience input from all the areas concerned with the development of a performing artist. Class assignments whether written or oral are meant to enhance the process of transfer from the studio or rehearsal hall to the stage.

57-332
Introduction to Conducting **Fall: 6 units**
This course is aimed towards the development of 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.

57-334
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's Kiltie Band will be part of the course content.

57-333
Band and Choral Arranging **Spring: 6 units**
This course is set up primarily, but not exclusively, for the future music educator/ conductor. In it, the student will become familiarized with the particulars of the band/wind and choral ensemble mediums; their history, development, repertoire, instrumentation, and idioms are studied in depth.

57-336
Instrumental/Choral Conducting **Spring: 6 units**
This course is a continuation of Introduction to Conducting. Thus, basic training in conducting is required. The course starts going into a more detailed conducting technique, adding those subjects related to choral conducting. This is followed by the study and the analysis of interpretation from the point of view of the conductor and ends stressing a set of important practical items, including the psychological attitude and the leadership a conductor must develop as well as the organization and achievement of a fruitful rehearsal technique. The students work periodically with a pianist, a soloist or a chamber ensemble on traditional works and on their own compositions in the case of composition majors.

57-337/338
Sound Recording I/II **Fall or Spring: 6 units**
The major emphasis for Sound Recording I will be on stereo recording of a wide range of classical instruments in a concert hall situation. The equipment includes analog and digital tape recorders, an eight-channel mixer, and a modest array of outboard devices (digital reverb, noise reduction, equalizers, etc.) Tape editing and splicing, using both spoken voice and music as source materials will also be covered.

Sound Recording II will cover more advanced recording techniques and more complex recording situations. These include multi-mike stereo recording, multi-track recording and mix-down, and multi-track recording with over-dubbing. Both live and synthesized sound sources will be used.

57-339/340
Acting III/IV **Fall or Spring: 6 units**
Continued work on improvisation and aria/monologue techniques graduating to scene work in relation to musical theater, opera, and dramatic work.

57-347
Electronic and Computer Music **Fall: 9 units**
Elementary techniques of composition utilizing the synthesizer and other sophisticated electronic equipment. Required for composition majors. The purpose of this course is to introduce the students to the Computer-Electronic Music Studio. Different digital and analog devices such as tape recorders, mixers, various synthesizers, as well as various computer music softwares will be demonstrated and discussed.

57-349
Supervised Theory Teaching I/II **Fall or Spring: 3-6 units**
This course is designed to provide 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. Class enrollment limited to a maximum of two students per class.

57-355
Secondary Guided Teaching **Fall: 3 units**
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. At this level, the student is expected to observe and to assist the cooperating teacher. A log of each visitation is to be made. Approximately one-half day per week (two hours, school time) will be spent at this level of field experience.

57-356
Elementary Guided Teaching **Spring: 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 preschool children in the Carnegie Mellon Laboratory School and with elementary age children in the Pittsburgh Public Schools.

57-360
Brass Methods **Fall: 3 units**
This course covers one of the four sections of instruments with which the instrumental music teacher needs to be familiar. Brass methods will begin with class sessions containing information about brass commonalities, such as history and development, harmonic series, design, care, mouthpieces, etc. Following these topics, the instruments themselves will be studied in the following order: trumpet, horn, trombone, and baritone/tuba. The last two class sessions will consist of imitative teaching done by members of the class.

57-361
Percussion Methods **Fall: 3 units**
This class is designed to give the non-percussion major a background in the fundamentals of teaching percussion. The main focus of the course is snare drum. The students spend most of their time learning the basic concepts of beginning snare drum so they will be prepared to teach beginning students of any grade level. Much time is devoted to proper stance, grip and stroke, in order to insure a good foundation for a beginning student. Also covered are the various mallet instruments, timpani and all small hand percussion. Students are instructed in marching percussion and learn about purchasing proper equipment for the various levels of learning in common school programs.

57-362
Woodwind Methods **Spring: 3 units**
This course covers one of the four sections of instruments with which the instrumental music teacher needs to be familiar. Woodwind methods will begin with class sessions containing information about woodwind commalities, such as history and development, harmonic series, design, care, reeds, mouthpieces, etc. Following these topics, the instruments themselves will be studied.

57-363
String Methods **Spring: 3 units**
String Methods is designed to prepare 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.

57-375
Music in the Elementary School **Spring: 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.

Course Descriptions

57-376
Music in the Secondary School **Fall: 6 units**
This course is the last of a series of methods courses intended to aid the prospective teacher in becoming familiar with the various aspects of public school music teaching. A wide range of topics involving secondary school music is covered, from the theoretical to the practical and from the general to the specific.

57-391/392
Keyboard Studies V/VI **Fall or Spring: 3 units**
Continuation of 57-191/192.

57-408
Form and Analysis **Fall: 6 units**
An in-depth study of the compositional processes and patterns, hierarchy of phrase structures, and harmonic and contrapuntal textures of selected tonal works, including an introduction to Schenkerian Analysis.

57-415/416
Dance VII/VIII **Fall or Spring: 3 units**
See 57-111/112. Levels seven and eight explore advanced jazz and ballet technique.

57-417
Concert Choir **Fall or Spring: 6 units**
Music students majoring in voice are required to participate in at least one major vocal ensemble each semester. Students are placed in either the Concert Choir or the Repertory Chorus at the discretion of the Director of Choral Studies. Major ensembles are open to all Carnegie Mellon students. Audition required.

57-418/
Wind Ensemble **Fall or Spring: 6 units**
The wind and percussion extension of the CMU orchestral program. Literature focuses mainly on the wind works of composers of stature. Rotating seating plans will prevail at the discretion of the faculty, within and between major ensembles. Major ensembles are open to all Carnegie Mellon students. Audition required.

57-419
Repertory Chorus **Fall or Spring: 6 units**
See 57-417.

57-420
Jazz Choir **Fall or Spring: 3 units**
A highly selective group of mixed voices who perform contemporary jazz vocal arrangements. Open to all CMU students. Audition required.

57-425/426
Opera Music Theater Workshop III/IV **Fall or Spring: 6 units**
Continuation of 57-325/326.

57-429
Beginning Piano for Children **Fall or Spring: 3 units**
This course is 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.

57- 430
Philharmonic Orchestra **Fall or Spring: 6 units**
Music students majoring in an orchestral instrument are required to participate in at least one major instrumental ensemble each semester. Rotating seating plans will prevail at the discretion of the faculty, within and between Philharmonic Orchestra and Wind Ensemble. Major ensembles are open to all CMU students. Audition required.

57-431
Italian Literature and Repertoire **Fall: 3 units**
The course is designed to provide a bibliography of repertoire in the Italian language. Material will be limited to art songs and cantatas and will be presented via individual student performances in class. Research assignments will be required for selected anthologies or for works by specific composers. Repertoire will be examined according to vocal requirements, musical style and programmatic function.

57-433/434
Music Theatre Literature and Repertoire **Fall or Spring: 3 units**
The purpose of this course is to expose students to songs and styles of Musical Theatre between the years 1866 (THE BLACK CROOK) and 1970 (APPLAUSE). For each composer and/or period, the student is expected to learn an assigned number of songs and to be somewhat familiar with the show.

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 Twentieth Century are studied in the context of musical style, vocal demands and programmatic considerations. Repertoire focuses upon 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, occasional 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 and Contemporary
Literature and Repertoire **Spring: 3 units**
The course is designed to provide 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 occasional recorded performances. Research assignments will be required for selected anthologies or for works by specific composers. Repertoire will be examined according to vocal requirements, musical style and programmatic function. The repertoire will consist primarily of works by British and American composers, but works by Russian and Scandinavian composers will also be included.

57-447
Solo Trumpet Literature and Repertoire **Fall or Spring: 3 units**
This course is designed to introduce the serious trumpet student, through performance and discussion, to the solo trumpet literature ranging from the early baroque through the most contemporary composition. Great emphasis is placed upon the literature of both baroque and classical periods, The course also provides a forum for not only formal faculty input, but also for informal discussion by the class.

57-439/440
Acting V/VI **Fall or Spring: 6 units**
More intense work on improvisation, monologues, scenes, culminating with work on One Acts (audition material will still be part of the class).

57-451/452
Jazz Orchestration **Fall or Spring: 6 units**
The techniques of scoring for large jazz bands.

57-453/454
Jazz Improvisation I **Fall or Spring: 3 units**
Jazz Improvisation I begins by assuming that everyone in the class knows absolutely nothing about jazz. We learn chords and jazz scales. In addition, there is a brief look at Jazz History. Each student will develop both an academic and a practical knowledge of improvisation. Teaching techniques used include individual performance of assignments, listening to records, solfeggio for developing aural skills and discussions of local radio and concert performances. Knowledge of jazz composition forms including 12 bar blues, gospel jazz and 32 bar standard song form are learned and used.

57-455/456
Jazz Improvisation II **Fall or Spring: 3 units**
Jazz Improvisation II contains a strong emphasis on repertoire. It is expected that jazz forms, scales and chord structures have been learned in Jazz Improvisation I. Developing repertoire is the primary goal of this course. Miles Davis, Duke Ellington and Sonny Rollins are a few of the composers studied in depth. The main objective of this course is to give the students a working knowledge of sufficient jazz styles and repertoire to prepare them for professional engagements.

57-460
Score Reading
and Keyboard Harmony **Fall: 6 units**
This course is for pianists, organists, composers, 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.

57-xxx
Studio **Fall or Spring: 9-12 units**
A one hour private lesson per week for all music majors. Voice Majors receive an additional half-hour of professional vocal coaching per week.

57-500	Voice
57-501	Piano
57-502	Organ
57-503	Harp
57-505	Violin
57-506	Viola
57-507	Violoncello
57-508	String Bass
57-509	Guitar
57-510	Flute
57-511	Oboe
57-512	Clarinet
57-513	Bassoon
57-514	Saxophone
57-515	Horn

57-516 Trumpet
57-517 Trombone
57-518 Euphonium/Baritone
57-519 Tuba
57-520 Percussion
57-521 Composition
57-522 Bagpipe

57-604
Practice Teaching **Spring: 24 units**
Cooperating teachers in selected area schools supervise fifth year music education majors in practice teaching. Elementary, junior high (middle), and high school experiences are covered over the course of a semester.

57-607
Vocal Methods **Fall: 3 units**
Group instruction in basic vocal concept and technique. Laboratory experience in the analysis and remedy of common vocal problems to develop a background in vocal pedagogy.

57-608
Observation **Spring: 3 units**
The first level of field experience in the public schools, encompassing elementary, middle, and high school levels.

57-609
Independent Study **Fall or Spring: 3-9 units**
Students undertake a critical examination of some aspects of music on an independent basis under the supervision of a faculty member. They choose their topic and contract with the Project Director (faculty sponsor) as to when and how the research will be completed. Open to upperclassmen. Prerequisite: 3.0 cumulative average.

Art

Undergraduate Courses

Concept Studios

60-101
Concept Studio I - The Self and the Human Being **Fall: 10 units**
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 four Concept Studios are addressed through a sequence of structured, media-independent projects. The focuses of Concept Studio I are the self and the human being. Open to freshmen admitted to the Art Department or through departmental permission.

60-102
Concept Studio II - Space and Time **Spring: 10 units**
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. Prerequisite: 60-101 or departmental permission.

60-201
Concept Studio III - Systems **Fall: 10 units**
A continuation of Concept Studios I and II with a focus on systems. The utility of systems, the discovery of existing systems, and the generation of systems are addressed through projects. Prerequisite: 60-101 and 60-102 or departmental permission.

60-202
Concept Studio IV - Processes **Spring: 10 units**
A continuation of Concept Studio I, II, and III with a focus on processes. A variety of approaches to the structuring of time and the relationship to results is investigated through projects. Includes preparation for the Sophomore Review. Prerequisite: 60-101, 60-102 and 60-201 or departmental permission.

60-301
Concept Studio V - Context **Fall: 10 units**
This course is the first semester of a two-semester course sequence related to artmaking in a context within the Pittsburgh community and outside of the university. A relationship with an organization is developed and artmaking is carried out within the context of that organization. Prerequisite: 60-101, 60-102, 60-201 and 60-202 or departmental permission.

60-302
Concept Studio VI - Context **Spring: 10 units**
This course is a continuation of Concept Studio V. Prerequisite: 60-101, 60-102, 60-201, 60-202 and 60-301 or departmental permission.

60-401
Concept Studio VII - Individual Project **Fall: 10 units**
In this course the student initiates a comprehensive two-semester project to be completed in Concept Studio VIII. Prerequisite: 60-101, 60-102, 60-201, 60-202, 60-301 and 60-302 or departmental permission.

Course Descriptions

60-402
Concept Studio VIII - Individual Project **Spring: 10 units**
A continuation of the project initiated in Concept Studio VII which culminates in a final presentation in conjunction with the Senior Review. Prerequisite: 60-101, 60-102, 60-201, 60-202, 60-301, 60-302, and 60-401 or departmental permission.

Media Studios

Electronic Media Studios

60-110
Electronic Media Studio I **Fall: 10 units**
An introduction to the computer as a multi-purpose artmaking tool, utilizing software application programs. Students explore the computer in developing two-dimensional imagery. A variety of hardcopy output optionsare explored. This course incorporates Computer Skills Workshop, a university requirement for all students. Open only to freshmen admitted to the Art Department or by departmental permission.

60-210
Electronic Media Studio II **Spring: 10 units**
An introductory exploration of video as an art form. Focuses on the skills necessary for the creation of video projects through discussions and examples of processes, techniques and aesthetic/conceptual issues used in video art. Course content will also include a survey of video related to multi-media, performance and installation work, computer manipulation and imaging, telecommunications and interactive formats. Prerequisite: 60-110 or departmental permission.

Three-Dimensional Media Studios

60-130
Three-Dimensional 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 concerns. Students are introduced to welding techniques, wood fabrication and ceramic processes. Students become proficient with a variety of hand and power tools. Open only to freshmen admitted to the Art Department or departmental permission.

60-230
Three-Dimensional 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. Prerequisite: 60-130 or departmental permission.

Two-Dimensional Media Studios

60-150
Two-Dimensional Media Studio I **Fall: 10 units**
The first of a two-semester sequence introducing the tools, materials, and concepts of two-dimensional image-making. The sequence proceeds in general from limited media to a multiplicity of media, from limited color to full color, from dry to wet media, from pattern to three-dimensional illusion to synthetic and illogical imagery. Assignments are initially structured and over two semesters become less structured. Open only to freshmen admitted to the Art Department or departmental permission.

60-151
Two-Dimensional Media Studio II **Spring: 10 units**
A continuation of Two-Dimensional Media Studio I. Includes an expansion of drawing concerns; an introduction to transfer media (basic printing processes, photocopy manipulation, and multi-media explorations); and exposure to painterly issues. Prerequisite: 60-150 or by departmental permission.

60-250
Two-Dimensional Media Studio III **Fall: 10 units**
A pragmatic introduction to tools, materials, and techniques of painting, including instruction in the fabrication of sound painting supports and the application of permanent grounds. Students become conversant with the range of visual options unique to the vocabulary of painting. Prerequisite: 60-150 and 60-151 or by departmental permission.

60-251
Two-Dimensional Media Studio IV **Spring: 10 units**
An introduction to the three major areas of printmaking: Intaglio, Lithography, and Serigraphy. Provides students with an overview of printmaking in its historical context and shows the impact of the print processes on contemporary art. Prerequisite: 60-150, 60-151 and 60-250 or by departmental permission.

Course Descriptions

Advanced Studios

Electronic and Time-Based Work (ETB)

60-410
Advanced ETB: Computer Drawing and Painting **Fall or Spring: 10 units**
Studio focus on computer applications to create static drawing and painting using a variety of input and output devices. Graphic programming for image generation may be introduced. Prerequisites: 60-110 and 60-210, or by consent of instructor.

60-412
Advanced ETB: Computer Graphic Programming **Fall or Spring: 10 units**
Programming of computer languages to produce static and animated graphic imagery. Prerequisites: 60-110 and 60-210, or by onsent of instructor. Previous programming experience not required.

60-414
Advanced ETB: 2-D Computer Animation **Fall or Spring: 10 units**
Studio focus on two-dimensional animation. Cel-type animation, in-betweening, and real-time recording are presented. Pre-production skills including concept development, scripting, and storyboarding are emphasized. Film and video output options are explored. Prerequisites: 60-110 and 60-210, or by consent of instructor.

60-415
Advanced ETB:
3-D Computer Modeling and Animation **Fall or Spring: 10 units**
Studio focus on three-dimensional modeling and animation applications. Modeling basics presented include primitives, extruded and lathed objects, spline-based modeling, light source and camera views. Rendering techniques are connected to output printing as well as animation for video. Prerequisites: 60-110 and 60-210, or by consent of instructor.

60-416
Advanced ETB:
Mechanical, Electrical and Electronic Systems **Fall or Spring: 10 units**
Studio focus on the use of motion and motion linkage hardware, basic electricity and switching devices, sensors, timing systems, and coordination of audio-visual and mechanical systems. Prerequisites: 60-110 and 60-210, or by consent of instructor.

60-417
Advanced ETB:
Video Production and Post-Production **Fall or Spring: 10 units**
Studio focus on techniques and issues associated with video artmaking. Production and post-production processes are addressed along with scripting, storyboarding and proposal writing. Prerequisites: 60-110 and 60-210, or by consent of instructor.

60-419
Advanced ETB: Performance and Installation **Fall or Spring: 10 units**
Explores the use of sound, lighting, video image projection and other audio-visual technologies as components in installation and performance artworks. Prerequisites: 60-110 and 60-210, or by consent of instructor.

60-420
Advanced ETB:
Networking and Telecommunications **Fall or Spring: 10 units**
Studio focus on the use of global, interactive electronic communications media for artmaking. Processes and technologies addressed include telephone, fax, electronic mail, slowscan, satellite, and video phone. Collaboration, public art, and multidisciplinary domains are investigated. Prerequisites: 60-110 and 60-210, or by consent of instructor.

60-421
Advanced ETB: Digital Photography **Fall or Spring: 10 units**
Studio focus on applications, devices and techniques employing light-sensitive input. Concentration on manipulation and composition of digitized imagery from video and scanner input. Prerequisites: 60-110 and 60-210, or by consent of instructor.

60-422
Advanced ETB: Robotic Art Studio **Fall or Spring: 10 units**
Studio focus on the use of programmable micro-controllers in the development of intelligent, interactive artworks. Cross-listed with Computer Science #15499. Prerequisites: 60-110 and 60-210, or by consent of instructor.

60-429
Advanced ETB: Special Topics **Fall or Spring: 10 units**
Studio focus on specific topics associated with electronic and time-based media. Prerequisites: 60-110 and 60-210, or by consent of instructor.

Sculpture, Installation and Site-Work (SIS)

60-430
Advanced SIS: Sculpture **Fall or Spring: 10 units**
A broad-spectrum studio encompassing the diversity of contemporary sculptural activities, including objects, installations, and site work. Prerequisites: 60-130 and 60-230, or by permission of instructor.

60-431
Advanced SIS: Installation **Fall or Spring: 10 units**
Studio focus on relatively large scale works which often involve an ensemble of objects or phenomena in a particular space. Both temporary and permanent works are addressed. Prerequisites: 60-130 and 60-230, or by permission of instructor.

60-432
Advanced SIS: Site Work **Fall or Spring: 10 units**
Studio focus on work designed for a specific site. Object work, installations, and environmental work are included. Site analysis, environmental impact, and social dimensions are addressed. Prerequisites: 60-130 and 60-230, or by permission of instructor.

60-433
Advanced SIS: Clay **Fall or Spring: 10 units**
Studio focus on ceramic materials and processes as applied to sculptural issues. Fabrication, glazing, and kiln-firing are addressed. Prerequisites: 60-130 and 60-230, or by permission of instructor.

60-434
Advanced SIS: Foundry **Fall or Spring: 10 units**
Studio focus on metal casting processes. Objects are created in clay, wax, wood and plaster and cast into bronze or aluminum. Fabrication and welding techniques are presented. Prerequisites: 60-130 and 60-230, or permission of instructor.

60-435
Advanced SIS: Metals **Fall or Spring: 10 units**
Studio focus on fabrication using light metalworking techniques including forming, joining, and finishing. Metal stretching, forging, brazing, texturing and patination are also presented. Prerequisites: 60-130 and 60-230, or by permission of instructor.

60-436
Advanced SIS: Wood **Fall or Spring: 10 units**
Studio focus on wood construction, assemblage, and carving processes. Tools and materials specific to working with wood are presented. Prerequisites: 60-130 and 60-230, or by permission of instructor.

60-449
Advanced SIS: Special Topics **Fall or Spring: 10 units**
Studio focus on specific topics associated with sculpture, installation and site work. Prerequisites: 60-130 and 60-230, or by permission of instructor.

Painting, Drawing and Printmaking (PDP)

60-450
Advanced PDP: Drawing **Fall or Spring: 10 units**
Studio focus on drawing experiences designed to develop observational, compositional, technical, expressive and conceptual skills. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or by consent of instructor.

60-451
Advanced PDP: Anatomy and Figure in Drawing **Fall or Spring: 10 units**
Studio focus on the human figure as a source of expression in drawing. Introduction to the landmarks of anatomical bone and muscle structure. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or consent of instructor.

60-452
Advanced PDP: Idea Generation in Drawing **Fall or Spring: 10 units**
Studio focus on the development of skills involved with the generation of ideas as a central component in the process of drawing. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or by consent of instructor.

60-453
Advanced PDP: Painting **Fall or Spring: 10 units**
Studio focus on the development of painting concepts and skills, understanding interrelationships between form and content in painting, and understanding historical and contemporary issues as they pertain to personal vision and poetic and practical aspects of painting. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or by consent of instructor.

60-454
Advanced PDP: Idea Generation in Painting **Fall or Spring: 10 units**
Studio focus on the development of skills involved with the generation of ideas as a central component in the process of painting. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or by consent of instructor.

60-455
Advanced PDP: Printmaking - Intaglio **Fall or Spring: 10 units**
Studio focus on the processes and issues of intaglio printmaking. Included are photo intaglio, carborundum print and collagraphy. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or by consent of instructor.

60-456
Advanced PDP: Printmaking - Lithography **Fall or Spring: 10 units**
Studio focus on the processes and issues of lithographic printmaking. Includes both traditional stone and aluminum plate processes along with photographic techniques. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or by consent of instructor.

60-458
Advanced PDP: Printmaking - Serigraphy **Fall or Spring: 10 units**
Studio focus on processes and artmaking issues related to water-based/acrylic serigraphy. Emphasis on individual conceptual/artistic development. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or by consent of instructor.

60-459
Advanced PDP: Idea Generation in Printmaking **Fall or Spring: 10 units**
Studio focus on the development of skills involved with the generation of ideas as a central component in the processes of printmaking. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or by consent of instructor.

60-469
Advanced PDP: Special Topics **Fall or Spring: 10 units**
Studio focus on specific topics associated with painting, drawing and printmaking. Prerequisites: 60-150, 60-151, 60-250 and 60-251, or by consent of instructor.

Non-Medium Specific Studios

60-599
Studio Independent Study
A tutorial course in which students work on a one-to-one basis on self-generated individual projects with an instructor of their choice. Prerequisite: Junior/senior status. Prior to enrolling for independent study, students must have an Independent Study Form signed by the instructor. Forms are available in the art office.

60-5xx
Studio Topics **Fall or Spring: 10 units**
Special Non-Medium-Specific topics in studio. Prerequisites: Junior/senior status, or consent of instructor.

Academic Courses

60-610/611
The Arts, Time and World Civilization I/II **Fall and Spring: 18 units**
A chronological exploration of selected examples from the visual arts. Addresses ancient to contemporary times, across global cultures. Contextual issues investigated for both distinctive differences and cross-linkages in human experience and expression. Open only to freshmen admitted to the Art Department or departmental permission.

60-620
The Roots of Modernism: 19th Century Art **Fall or Spring: 9 units**
Explores the influence of social, political, economic and technological forces on art from the end of the 18th century through the 19th century. Examines Louis XIV, Winckelmann, the French Revolution, the demise of traditional patronage, the rise of newspapers and criticism, the invention of photography, and the rising power of the middle class. Prerequisite: Sophomore status. Priority for art majors.

60-621
Early Modernism **Fall or Spring: 9 units**
Examines movements in the development of modern art including Impressionism, Symbolism, Expressionism, Cubism and Futurism. Investigates non-western influences from Japan, Africa, Egypt, Byzantine art and folk arts. Prerequisite: Sophomore status. Priority for art majors.

60-622
Art from 1965 to the Present **Fall or Spring: 9 units**
The art of Late Modernism, from Formalism to the present, analyzed for both visual characteristics and social content. Investigates artwork itself and writings about the artwork. Addresses how the technologies of photography, video and computers have expanded artists' thinking and visual boundaries. Prerequisite: Sophomore status. Priority for art majors.

60-629
Renaissance Art **Fall or Spring: 9 units**
Explores the painting, sculpture and architecture of the Italian Renaissance. Investigates art historical problems and theories related to the era. Students conduct and present their own original research. Prerequisite: Sophomore status. Priority for art majors.

60-631
Picasso and 20th Century Painting **Fall or Spring: 9 units**
Explores the visual inventiveness of Picasso from age 13 to his death at age 92 in 1973. Analyzes his fusion of intellect, emotion, invention and tradition. Investigates his role in 20th century painting. Focuses on iconography as well as biography. Prerequisite: Sophomore status. Priority for art majors.

60-632
Brancusi and 20th Century Sculpture **Fall or Spring: 9 units**
Examines Brancusi and his role in the development of 20th century sculpture. Investigates the personal heritage of this Romanian artist. Explores the stimulating environment of Paris in the early 20th century. Prerequisite: Sophomore status. Priority for art majors.

Course Descriptions

60-640
The History of Photography and Video **Fall or Spring: 9 units**
Traces the evolution of photography as an art form and a technological process. Discusses imagery in the context of social, political, economic and technological issues. Explores the development of video from the 1970s. Prerequisite: Sophomore status. Priority for art majors.

60-641
Twentieth Century Sculpture **Fall or Spring: 9 units**
Presents the history of 20th century sculpture with emphasis on sculptors active in the first half of the century. Investigates the evolution of sculptural form and content. Prerequisite: Sophomore status. Priority for art majors.

60-642
Women Artists **Fall or Spring: 9 units**
Examines the art of contemporary American women since the late sixties. Focuses on events and issues that led to the 2nd and 3rd waves of women in the arts. Students read essays by leading feminist historians. Prerequisite: Sophomore status. Priority for art majors.

60-643
Art and Religion **Fall or Spring: 9 units**
Explores major artistic manifestations prompted by religious beliefs. Emphasizes visual arts in the context of historical, philosophical and eschatological explanations. Major religions presented. Prerequisite: Sophomore status. Priority for art majors.

60-644
High Art; Low Art **Fall or Spring: 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. Prerequisite: Sophomore status. Priority for art majors.

60-645
Critical Theory and Social Change:
Art Criticism 1968-90 **Fall or Spring: 9 units**
The evolution of contemporary art discussed in social, political and economic context. Focuses on events such as Vietnam, civil rights, feminism, cable television, computers and rapid communication. Students read key critical essays by social and art critics. Prerequisite: Sophomore status. Priority for art majors.

60-669
Special Topics in Art History/Theory **Fall and Spring: 9 units**
Each year, visiting art history/theory faculty offer three or four special topics which supplement the regularly scheduled cycle of courses. Prerequisite: Sophomore status. Priority for art majors.

60-699
Art History/Theory Independent Study **Fall and Spring: 9 units**
A tutorial course in which students work on a one-to-one basis on self-generated individual projects with an instructor of their choice. Prerequisite: Junior/senior status. Prior to enrolling for independent study, students must have an Independent Study Form signed by the instructor. Forms are available in the art office.

College of Fine Arts Interdisciplinary

Undergraduate Courses

62-102/3
Modern Dance Workshop **6 units**
A modern dance class based on the philosophy of the Martha Graham technique. The class is designed to encourage exploration and discovery of the roots of physical movement and control. The class also covers fundamental and technical aspects of modern dance as a classical performing arts form.

62-116/117
Calligraphy I and II **Fall and Spring: 6 units**
The art of line and form in letter design, work image and page layout.

62-120/121
Advanced Calligraphy I and II **Fall and Spring: 6 units**

62-130/131
Ballet Elective -Sec. A **Fall and Spring: 6 units**
An intermediate/advanced level ballet class with a focus on clean, clear, correct execution of the classical dance vocabulary. Permission of the instructor required.

Ballet Elective - Sec. B
A beginning level ballet class with emphasis on proper body alignment while learning fundamental ballet steps and movements.

62-151/2
Acting Elective **Fall and 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. The second semester develops and expands upon the work learned in the first semester.

62-153/4
Introduction to Playwriting for Non-Drama Majors **Fall and Spring: 9 units**
An understanding of a play's structure, plot, character, and action from a playwright's point of view. Experience in construction through a one-act play. Students work on character, dialogue, plot, etc.

62-155/156
Advanced Playwriting **Fall and Spring: 9 units**
Advanced Playwriting is a continuation of Introduction to Playwriting for Non-Drama Majors. It emphasizes the development of an artistic sensibility, an appreciation for the writing process, and the strengthening of particular techniques. Depending on the needs and interests of the students, this course may be general in scope or may concentrate on particular topics like comedy writing, scriptwriting, and writing for the radio. Special attention is given to the development of the writer's voice and broadening his or her particular writing skills. Prerequisite: 62-153/4.

62-161/2
Photography, Video, Filmmaking **Fall and Spring: 9 units**
Any course offered by Pittsburgh Filmmakers

College of Humanities and Social Sciences Interdisciplinary Program

Undergraduate Courses

66-198
Research Training: H&SS Interdisciplinary **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. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as "elective" units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. Prerequisites/restrictions: For H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

66-210
Science and Technology for the Environment **Spring: 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 the 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.

66-250
Introduction to Religion **Fall: 9 units**
The objective of this course is to introduce students to the variety of intellectual disciplines by which the religions of mankind can be studied and some of the typical foci of such study. Topics to be covered in the course include: What is religion? Religious studies vis-a-vis theology; literary, historical, anthropological, sociological, psychological, philosophical, phenomenological approaches to religion; the sacred/holy; myth, symbol, doctrine; ritual; society and the sacred; deity; cosmogony, religious anthropology, theodicy; ethics, soteriology, eschatology; secularism and pluralism.

66-315
The Holocaust in Historical Perspective **Fall/Spring: 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 will discuss what implications and issues arise from this watershed event in World and Jewish history. It will descend into the world of the Holocaust not only by reading about events and viewing several films, but also by meeting some Holocaust survivors themselves. No prerequisites.

66-316
The Literature of Elie Wiesel and the Message of the Holocaust **Fall/Spring: 9 units**
This course will study, in both historic and literary dimensions, the contributions of Elie Wiesel, the pre-eminent Jewish writer and voice of the Holocaust. The approach will be offered in a modified seminar style. Students will read widely from the representative literature, both in primary and secondary sources, and then team with other students for in-class presentations. Papers are required on themes developed in Elie Wiesel's literature.

66-501/502
Honors Thesis I, II **Fall /Spring: 9 units each**
This sequence is open only to those seniors whose intellectual promise and academic performance have resulted in invitations to participate in the H&SS Senior Honors Program. The first half is designed as a readings course, and the second as the culmination of an original, year-long independent research project. By definition, this particular sequence would be interdisciplinary in nature, and is generally intended only for qualified students in the H&SS Student Defined Major program. Research topics are selected by faculty and students. Prerequisites: senior standing; minimum of 3.50 cumulative QPA in one's major, and 3.25 overall; permission of the H&SS Dean's Office.

Physical Education

Undergraduate Courses

◦ Semester Long Courses:

69-109
Karate **Fall or Spring: 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).

69-150
Beginning Swimming **Fall or Spring: 6 units**
This basic course is designed to equip the non-swimmer with fundamental skills and knowledge to assure reasonable safety in, on or about the water. Areas covered include the basic swimming strokes, basic diving, safe and efficient entry into the water, and some elementary forms of rescue.

69-157
Intermediate/Swimmers **Fall or 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. The experienced swimmer will have the opportunity to perfect their strokes.

69-153
Advanced Lifeguarding **Fall or Spring: 6 units**
The American Red Cross Lifeguard Training course material will be taught. Prerequisites: Students must be 17 years or older, be in sound physical condition and have a Red Cross First Aid and CPR Certificate. Students who are certified will be eligible to be employed as lifeguards.

° Mini Courses (half semester):

69-101
Racquetball **Fall or Spring: 3 units**
This course is designed to aid in developing the fundamental skills involved in racquetball. Techniques, rules and strategy are stressed. It is hoped that the student will develop a reasonable level of proficiency to enable participation on a leisure-time basis.

69-102
Weight Training **Fall or Spring: 3 units**
(Introductory & Intermediate)
This course is designed to provide the opportunity for the inexperienced student to learn the effectiveness of a carefully planned weight training program as a method of body development and the contributing benefit to performance in many sports.

69-108
Jogging for Fitness **Fall or Spring: 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.

69-110
Personal Fitness **Fall or Spring: 3 units**
This course will be a conditioning course prescribed partially by the individual with assistance from the instructor to insure that the desired results will be achieved or at least pursued correctly. Individual goals will be the main concern. Stretching, aerobics, weight training and nutrition will be discussed.

69-111
Triathlon **Fall or Spring: 3 units**
This course is designed to familiarize students with the three triathlon skills .. swimming, biking, running and to develop an endurance training program.

69-130
Tennis **Fall or Spring: 3 units**
This course is designed to familiarize the student with the rules of tennis and to develop the skills needed to become proficient for recreational play.

69-131
Volleyball **Fall or Spring: 3 units**
This course is designed to familiarize the student with the rules of volleyball and to develop the skills needed to become proficient for recreational play.

69-134
Golf **Fall or Spring: 3 units**
This course is designed to give the student all the skills necessary to play a satisfactory game of golf. The long game, the short game and putting are covered. It is a leisure time sport that is challenging and can be used by the student for the rest of his/her life.

69-135
Soccer Skills **Fall or Spring: 3 units**
This course is designed to familiarize the student with the rules of soccer and to develop the skills needed to become proficient for recreational play.

69-136
Basketball Skills **Fall or Spring: 3 units**
This course is designed to familiarize the student with the rules of basketball and to develop the skills needed to become proficient for recreational play.

69-155
Aerobic Filness **Fall or 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 **Fall or Spring: 3 units**
A basic course in treatment and care of injuries in emergency situations. Topics will include legal liability, prevention of injuries, nutrition and cardiovascular conditioning. The course will conclude with theoretical and practical application of cardiopulmonary resuscitation. Upon completion of the course students will receive Red Cross Certification.

Course Descriptions

Industrial Management

Undergraduate Courses

70-101
Introduction to Business Management **Fall and Spring: 9 units**
The purpose of this course is to provide an overview of business and the various functional aspects of the firm. Objectives are, first, to develop an understanding of the process and rationale behind business decision making within society; second, to introduce the various functional disciplines of business and how they interrelate within the firm.

70-103
Introduction to Management Science **Fall or Spring: 9 units**
An overview of techniques and methodologies for managerial decision making. The course is designed for undergraduate engineering and science students and assumes a strong background in mathematics. Typical topics covered include: linear programming, network optimization, integer programming, multiple optimization, decision analysis and utility theory. Prerequisite: (21-111 or 21-121).

70-121
Financial Accounting **Fall and Spring: 9 units**
Financial accounting is a system by which the financial implications of all activities of a business are evaluated, recorded, and reported systematically in the form of financial records and statements. The ability to understand financial statements as well as financial records of a business is essential in running a business as well as in investing in a business. This course is intended to provide introductory knowledge and skills needed for understanding financial statements and records. The course is conducted mostly on the basis of lectures, discussions, and exercises.

70-122
Introduction to Accounting **Fall or Spring: 9 units**
This course provides the knowledge and skills necessary for the student to be able to understand financial statements and records. It also provides an introduction to cost accounting systems which provide the means for identifying, measuring and communicating information to users within business (and other) organizations. Corequisite: 70-220.

70-160
Introduction to Graphic Communications **Fall or Spring: 9 units**
Students are taught the basic fundamentals of the various processes used for graphic reproduction and communication. They learn how to identify different art and reproduction techniques and explore their applications.

70-192
Graphic Reproduction Technology **Fall: 9 units**
The study of continuous-tone and halftone photography, color separation and correction, image assembly, and color proofing. Emphasis is on the quantitative and qualitative relationships between stages in the reproduction processes. This course is taught by the staff of the Graphic Arts Technical Foundation at the GATF Technical Center. Lecture/lab. Prerequisite: 70-160

70-193
Printing Process Sciences **Spring: 9 units**
The study of the technology of printing processes — lithography, gravure, letterpress, flexography, impactless and screen printing. Topics covered include methods of assembly, presswork, and printability considerations for each process. Emphasis is on the chemical, physical, and mathematical aspects on the processes. Taught by the Graphic Arts Technical Foundation. Lecture/lab. Prerequisites: 70-160, 70-192.

70-220
Probability and Statistics for Business **Fall or Spring: 9 units**
Elementary ideas in probability, statistics and data analysis presented in the context of their importance to modern business management. Pre-requisite: 21-259.

70-251
Managerial Economics **Fall or Spring: 9 units**
This course presents microeconomic theory — which describes the behavior of individual consumers, households and firms — with a practical emphasis on issues important to businesses. Pre-requisites: 21-259, (73-100 or 73-110).

70-311
Organizational Behavior I **Fall and Spring: 9 units**
This course examines the factors which influence individual and group behavior in the context of the work place. Topics covered include perception, group behavior, decision making, motivation, and leadership. Each student is required to complete 3 hours of experiments in the GSIA Research Pool.

70-312
Organizational Behavior II **Spring: 9 units**
This course examines organizations and inter-organizational relationships. Major topics covered include the design of organizations, managing organizational environments, power and politics in organizations, and organizational change. Emphasis is placed on applying course concepts to a variety of situations arising in contemporary organizations. Prerequisite: 70-311.

Course Descriptions

70-313
Organizational Power and Politics — **Fall or Spring: 9 units**
Using case studies and the their own experience, students are taught to analyze organizational relationships, dependencies and internal power relationships; to develop creative implementation strategies; and to gain cooperation in the work setting. Emphasis is placed on the structural bases for power as they affect individuals within organizations and the introduction of diagnostic techniques for analyzing the distribution and bases of power. Prerequisite: 70-311.

70-332
Business and Society — **Fall and Spring: 9 units**
This course provides an overview of the following topics: government regulation of large and small businesses; legal policy; government and business associations; securities regulation; employment law; and international law. Underlying these topics is a pervasive discussion of values in a business society; social implications of business policies and corporate social responsibility; and ethics.

70-335
Business and Labor — **Fall: 9 units**
(Not offered every year.) This course focuses on the major legal factors that determine wages, working conditions, and the structure of employment and unemployment. The course analyzes the determination and implications of manpower and industrial relations policies of business firms, the development and role of labor unions and collective bargaining, and related public policy issues.

70-340
Business Communications — **Fall and Spring: 9 units**
In this course, students gain an understanding of the purposes and processes of communication in business and learn how to create communications tools that meet the needs of a variety of business audiences. As well as working individually on cases and projects, students also develop their skills in collaborative communication. Students have opportunities to evaluate and improve their oral communications skills through a number of exercises, including videotaping. Prerequisite: 76-100 or 76-101.

70-350
Regression and Forecasting — **Fall and Spring: 9 units**
The theory and applications of multi-variate regression analysis, with particular emphasis on business applications. Prerequisites: 70-220, (73-100 or 73-110).

70-361
Foundations of Law — **Fall or Spring: 9 units**
This course examines law as a social process for the resolution of disputes. The course considers the development and role of law in modern society with particular reference to the application of basic legal principles to modern industrial administration. The objective is to engender a fundamental understanding of the role of law, including understanding the process of constitutional development through judicial interpretation of the law in the United States. The course stresses understanding of legal reasoning as well as familiarization of legal procedures and processes.

70-363
Law in Modern American Society — **Fall or Spring: 9 units**
This course offers students a practical approach to the procedures and certain basic principles of the law under which the legal system operates. Attention is given to effective analysis of legal problems, as well as to certain aspects of the law of contracts and other fields of law relevant to life in today's world. Students have an opportunity to select areas of interest to them.

70-365
International Trade and International Law — **Fall or Spring: 9 units**
This course provides an understanding of the international legal system and legal principles and processes as they affect the economic decisions of enterprises and governments. It focuses on the specifics of trade policy; explores the concept of industrial policy in the U.S. and other countries; and examines how businesses are affected by international efforts to regulate foreign investment and multi-national companies and by the concerns of developing countries about the international economic system. Key international economic institutions such as GATT and IMF and the European Community are examined.

70-369
Mergers and Acquisitions — **Fall or Spring: 9 units**
This course will examine the motives behind merger and takeover activity and the structuring and terms of the deals. Poison pills, golden parachutes, bust-up fees and crown jewel provisions will all be analyzed by examining actual documents. The course will clear away the fog created by the complex web of legal, financial and regulatory rules which apply to hostile tender offers and merger transactions.

70-371
Production I — **Fall and Spring: 9 units**
An introduction to production and operations management that covers both manufacturing and services. The course addresses the history and recent performance of operations management on the one hand and how to solve management problems on the other. It deals with design and planning issues (capacity and location planning, facility layout) as well as operational issues (inventory management, material requirements planning, scheduling, project management). It also discusses such recent developments as computer integrated manufacturing, flexible manufacturing systems, and just-in-time inventory systems. Prerequisites: (21-257 or 21-292), (36-210, 36-226 or 70-220). Enrollment preference given to IM majors, approved double majors, and approved minors.

70-381
Marketing — **Fall and Spring: 9 units**
An introduction to the nature and fundamentals of the marketing activity. Topics include the analysis of the economic factors influencing buyer behavior, marketing research, market segmentation, development of marketing programs (new product, price, advertising and distribution decisions), and international marketing. Each student is required to complete 3 hours of experiments in the GSIA Research Pool. Prerequisite: (36-209, 36-225 or 70-220). Enrollment preference given to IM majors, approved double majors, and approved minors.

70-391
Finance I — **Fall and Spring: 9 units**
The course examines 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: (21-257 or 21-292), (70-121 or 70-122), (36-210, 36-226 or 70-220). Enrollment preference given to IM majors, approved double majors, and approved minors.

70-393
FAST I — **Fall and Spring: 9 units**
The Financial Analysis and Securities Trading system (FAST) 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: (21-257 or 21-292), (70-121 or 70-122), (36-210, 36-226 or 70-220). Enrollment limited to IM majors, approved double majors, and approved minors.

70-394
FAST II — **Fall and Spring: 9 units**
Using the Financial Analysis and Securities Trading System (see FAST I course description above), this course studies the relevance, valuation and trading of derivative securities: financial assets that derive their value from the value of an underlying set of securities. Popular examples are options and futures contracts. The course primarily focuses on derivatives written on stocks, market indices and foreign currencies. Prerequisite: (70-391 or 70-393). Enrollment limited to IM majors, approved double majors, and approved minors.

70-401
Management Game — **Spring: 9 units**
This course is designed to integrate the managerial concepts and techniques studied earlier in the curriculum and to focus on elements of organizational structure and behavior. Student teams assume the role of top management of firms competing in a typical consumer goods industry simulated by the Carnegie Mellon University Management Game. Each team is responsible to a Board of Directors comprised of business masters students. Emphasis is placed on the development of sound organizational decision structures as well as the formulation of effective competitive strategies. Prerequisite: 70-371, 70-381, 70-391, (70-121 or 70-122). Open only to senior IM majors and double majors.

70-411
Leadership and Followership for Professional Effectiveness — **Fall or Spring: 9 units**
This interdisciplinary course explores different models of leadership and followership at both philosophical and practical levels. These concepts are then examined for relevance to the students' professional and personal lives. In addition to providing class discussions and exercises, the course gives students an opportunity to interact with visiting successful executives and professionals.

70-415
Entrepreneurship — **Spring: 9 units**
The course will discuss the characteristics, motivations and environment of entrepreneurs and the process of entrepreneurship — creativity, risk taking, planning, financing and management. Throughout the course, specific "real life" examples will be discussed to further enhance the text. Elements of a business plan will be explored with emphasis on finding products/services suitable for new ventures. An abbreviated business plan will be developed by teams of four students. Business ethics will be discussed as they relate to entrepreneurship. Senior status or permission of instructor required.

70-422
Cost Accounting — **Fall and Spring: 9 units**
Cost accounting systems provide the means for identifying, measuring, and communicating information to users within the organization. The primary objective of this course is to develop an understanding of traditional cost accounting systems: that is, the usefulness and limitations of these systems for facilitating and influencing the decision making process within the organization. A secondary objective is to use microcomputers for applying spreadsheet concepts to management accounting problems. Students will be required to apply Lotus 1-2-3 to problems arising from this course. Prerequisites: 99-101, 70-121, (36-210, 36-226 or 70-220). Enrollment preference given to IM majors, approved double majors, and approved minors.

Course Descriptions

70-426
Advanced Accounting **Offered intermittently: 9 units**
This course builds upon both the managerial and financial accounting prerequisites. With respect to managerial accounting, this course emphasizes case studies. This material is selected to provide richer insight into the fundamentals covered in earlier accounting courses. With respect to financial accounting, this course further prepares students to read financial statements and the financial press. Prerequisite: (70-122 or 70-422). Enrollment preference given to IM majors, approved double majors, and approved minors.

70-430
International Management **Spring: 9 units**
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 marketing, multinational finance, accounting, and taxation are also examined. Prerequisites are at least junior standing and successful completion of (73-100 or 73-110).

70-432
Women in Management **Fall or Spring: 9 units**
This course investigates issues affecting women in management fields using demographic information, historic data, biographies, and short fiction. Special attention will be paid to the personal qualities necessary for "success" in management positions, and to some of the organizational factors affecting women's positions in business. Prerequisites: (76-100 or 76-101), 70-311, (73-100 or 73-110).

70-433
The Manager's Role in Society **Fall: 9 units**
(Not offered every year)
Nearly every manager will at some time in his or her career be confronted with a situation in which the manager must trade off personal well being and values. Such situations can arise when the interests of the organization are inconsistent with the individual's values, or simply when the individual perceives potential personal gain by departing from his or her values. The objective of this course is to heighten sensitivities to, and to develop frameworks for, dealing personally with such conflicts. Examples include: incurring long-term costs (e.g., environmental degradation) for short-term benefits (e.g., lower costs and higher profits); sacrificing personal integrity (e.g., accepting money for maintaining silence) for the sake of the organization's integrity (e.g., maintaining the reputation of the firm); taking credit for others' work; flirting to make a sale; expense account abuses; lying to employees; etc. In addition, the course considers the social responsibility of individuals, both as members of a broader society and as employees of a corporation.

70-440
Business Leadership and Strategy **Fall: 9 units**
This course is designed to provide the student with a general management perspective and an understanding of the total business enterprise. It builds upon previous course work in functional areas and provides insights and analytical tools which a general manager should have in order to plan and implement successful business strategy. The student will analyze complex business problems and formulate realistic strategic solutions. Emphasis is placed on the practical application of business theory by the student in his/her business career. Prerequisites: 70-371, 70-381, 70-391, (70-121 or 70-122). Open only to senior IM majors and double majors.

70-451
Management Information Systems **Fall and Spring: 9 units**
The objectives of this course are for students to obtain basic knowledge of the technology used in computer-based information systems and 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.

70-452
Managing the Knowledge-Based Organization **Fall or Spring: 9 units**
This course investigate the nature of modern, knowledge-based organizations and how to manage them. Firms from a variety of industries will be examined to see how they manage and develop their knowledge workers. Organizational theory, competitive strategy, sociology, cultural anthropology, information systems and cognitive science are used to explore issues of importance to knowledge-based firms. Prerequisite: 70-451.

70-455
Business Applications of Artificial Intelligence **Spring: 9 units**
Artificial intelligence (AI) refers to a broad range of technologies and approaches to solving problems. In recent years, the capabilities of these technologies have been demonstrated to be of significant value to corporations and, for some companies, they are an important part of the information systems applications portfolio. In this course we explore some of the fundamental issues in AI and cognitive science, examine some of the representative technologies, explore methods of development, and try to find the right set of questions to ask when considering AI projects. Prerequisite: 70-451.

70-456
Telecommunication and Network Management **Fall or Spring: 9 units**
This course will serve to introduce the students to the telecommunication and computer network technologies. The course will discuss computer telecommunications, local area networks and wide area networks. It will include topics such as 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. Prerequisite: 70-451

70-457
Technology Innovation and Implementation in Organizations **Spring: 9 units**
For all the investment in computer-based technology by American firms, there is often a persistent gap between potential value of the technology and the firm's ability to put it to work effectively. The objective of this course is to provide prospective managers with the practical and theoretical backgrounds with which to design and evaluate strategies for innovating, acquiring, and integrating technologies into the workplace so that anticipated benefits can be obtained by the firm. Prerequisite: 70-451.

70-471
Production II **Fall: 9 units**
Further examination of the objectives, constraints, and processes associated with the production of products in industrial organizations. Topics include: process design investment, replacement analysis, human factors, project design, facilities layout, facilities location, short term forecasting, aggregate planning, inventories, scheduling, control. There is extensive usage of cases, computer work, homework, and exams. Prerequisite: 70-371.

70-472
Total Quality Management for Manufacturing **Fall or Spring: 9 units**
An introduction to the principles of quality management. Philosophies of major innovators, as well as commonly used statistical techniques of quality management, form the primary focus of the course. Prerequisites: (70-121 or 70-122), (36-210, 36-226 or 70-220), 70-371.

70-473
Modeling for Operations Management Applications **Fall: 9 units**
The purpose of this course is to expose the student to real-world operations management research, both by listening to reports of the research of others, and by participating in real-world research as a member of a project team. Up to two dozen investigators doing such research from both on and off campus (including many companies) give presentations to the students throughout the semester. At the same time students form their own team, write one or more research proposals, contact cooperative companies, carry out a project, and give final reports. Extensive support from the instructor is available. Prerequisite: 70-471 or permission of instructor.

70-475
Combinatorial Optimization: Networks and Applications **Fall: 9 units**
(Co-listed in the Math Department as 21-483)
(Not offered every year)
This course covers such topics as shortest and longest path problems, networks maximum flows, minimum cost flows, matchings in graphs and spanning trees. Numerous applications are given such as scheduling, location of warehouses, vehicle routing and many others. Prerequisites: 21-257; or equivalent.

70-477
Sequencing and Scheduling **Spring: 9 units**
(Not offered every year)
This course covers such topics as flow shop scheduling, job shop scheduling, project scheduling (PERT and CPM) with and without resource constraints, personnel scheduling. Topics such as MRP, OPT and KANBAN are also discussed. Prerequisites: 21-257; 70-220 or equivalent.

70-479
Location and Distribution **Fall: 9 units**
(Not offered every year)
Topics to be discussed include plant and warehouse location, location of emergency service facilities, machine layout, transportation and vehicle routing. Applications are given in the areas of production, marketing and finance. Prerequisites: 21-257; or equivalent.

70-481
Marketing Research I **Fall or Spring: 9 units**
The purpose of this course is to teach multiple research techniques used in marketing. This course is an applied marketing course that gives insight into how various techniques are used in marketing research firms. The course will consist of three projects and a final. The first project is designed to teach students about research survey methods. The second is an experiment in which the whole class is involved. The third, an individual project, is designed to teach quantitative research techniques. Prerequisite: 70-381.

70-491
Finance II **Fall or Spring: 9 units**
This course features issues of topical interest from investment analysis and corporate finance. Topics covered include option pricing, future and forward markets, hedging, debt and bankruptcy, dividend policy, and takeovers and mergers. Prerequisite: 70-391.

70-492
Projects in Investment **Fall or Spring: 9 units**
Students gain an understanding of financial theories through the development of basis computer programs that can be applied in a real world environment.. Typical projects include: obtaining the efficient frontier of 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. Prerequisite: 70-391.

70-493
Derivative Securities **Fall or Spring: 9 units**
(Not offered every year)
This course focuses on the pricing and applications of derivative securities. The course introduces the necessary mathematical tools, presents a general theoretical approach for the pricing of derivative securities using the Black-Scholes model, and applies this material to the most common derivative securities. These include indices, currencies, financial instruments and commodities, and options on indices, currencies and futures contracts. Prerequisite: 70-391.

70-494
International Aspects of Finance **Fall or Spring: 9 units**
This course explores how the predictions of basic financial models are affected by the presence of other countries and the introduction of foreign exchanges. Prerequisite: 70-391.

70-495
Corporate Finance **Fall or Spring: 9 units**
This course focuses on how firms make decisions on investments, financing and dividend payout policies, as well as some other advanced topics in finance. Prerequisite: 70-391.

70-499
Internship **Fall or Spring: 9 units**
(Enrollment only by permission of the IM Program)

70-500/501
Honors Thesis I, II **Fall and Spring: 9 units**
(Enrollment only by permission of the IM Program)

70-502
Independent Study in Management/Production **Fall or Spring: 9 units**
(Enrollment only by permission of the IM Program)

70-503
Independent Study in Marketing **Fall or Spring: 9 units**
(Enrollment only by permission of the IM Program)

70-504
Independent Study in Organizational Behavior **Fall or Spring: 9 units**
(Enrollment only by permission of the IM Program)

70-505
Independent Study in Finance **Fall or Spring: 9 units**
(Enrollment only by permission of the IM Program)

70-510/511
Management Research Experience, I/II **Fall and Spring: 9 units (or by arrangement)**
This seminar is designed for advanced undergraduate IM students who are seriously contemplating graduate study and a career in research. The course gives students an opportunity to "live through" all phases of the research process. As part of the requirements for the course, students design, execute, write-up, evaluate, and present their own management-oriented research study. Students may work individually or in pairs. All students are expected to participate in weekly discussions, both as presenters of their own research and as involved evaluators of group members' work. As a group, students will do a small amount of reading focused on the research process. As individuals working on specific research problems, they will develop their own reading agenda in support of their study. To preserve the intensity of the interaction between students and faculty, course size is necessarily limited. Requirements for successful completion of the research experience include: (1) delivery of a completed manuscript reporting the study; (2) oral presentation of the study to the group (and others who may be invited to attend), and (3) active participation in group discussions to include critically reviewing others' work and making practical suggestions for helping them improve the work.

70-520
Publicity and Public Relations **Fall and Spring: 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 fund 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 writing ability.

70-631
Graphic Communications Material **Fall: 9 units**
The study of the manufacture, performance, and testing of photosensitive materials, inks, papers, adhesives, and other materials used in the printing and allied industries. Included is understanding of the chemical, metallurgical, and rheological properties of the materials. Taught by the Graphic Arts Technical Foundation at the GATF Technical Center. Lecture/lab. Prerequisites: 70-160, 70-192, 70-193.

70-632
Printing Systems **Spring: 9 units**
The study of control systems, printing plant design (including safety and environmental control), finishing operations, and quality control. Included is understanding of systems, sciences, engineering, and measurement. A study of recent research of print quality specification as well as cost/quality relationships are included. This course is taught by the staff of the Graphic Arts Technical Foundation at the GATF Technical Center. Final course in lecture/lab sequence.

70-633
Graphic Communications Seminar **Fall or Spring: 9 units**
Includes a study in techno-economic forecasting, including determination of methodology for evaluating new developments and initiation of their employment in commercial applications. Preparation of a report on a chosen technology is required. Course also includes field trips to trade exhibits and to firms in various commercial and specialized printing businesses. Prerequisite: 70-160.

70-637
Electronic Print & New Media Production **Fall: 9 units**
Applications of computer systems in creating and managing electronic print and new media projects, with emphasis on the latter in creating effective communication pieces. Goals are to use desktop publishing applications, animations and authoring applications, and the ability to input and use different types of information, including text, photographs, illustrations, animations, sound effects and voice.

70-639
Advanced Interactive Media Workshop **Fall or Spring: 9 units**
A project-based course focusing on interactive media presentations for business. Students form teams which produce several interactive media presentations throughout the semester. Prerequisite: 70-637.

70-650
Independent Study in Graphic Communications **Fall or Spring: variable units**
Students conduct research or engage in internships under the supervision of faculty, staff of the Graphic Arts Technical Foundation, or firms in industry on projects related to management and technology in graphic communications. Students identify projects and prepare proposals for the approval and evaluation upon completion of the project. Prerequisite: 70-160.

Economics

Undergraduate Courses

73-100
Principles of Economics **Fall and Spring: 9 units**
An introductory course in the development and use of economic tools for analysis of public policy issues. The course begins with an introduction to the central problem of organizing an economy and allocating resources, emphasizing an overview of the market system in a private enterprise economy. Demand and supply analysis and the elements of long-run competitive equilibrium are developed. This is followed by an analysis of the foundations of consumer behavior which determine market supply and demand. The course concludes with an examination of cases in which the competitive paradigm does not hold (monopoly, oligopoly), and a consideration of the problem of multi-market equilibrium in a private enterprise economy. In addition to serving as an introduction to economic analysis, the course is also intended to provide the necessary methodological basis for students who go on to take courses in intermediate economic analysis. 2 hours lecture, 1 hour recitation.

73-110
Laboratory Economics **Fall: 9 units**
A major part of economic analysis (and of other social sciences as well) is devoted to the study of how individuals and societies make choices. This course gives students a "hands on" introduction to the many ideas and theories economists have developed to explain choice behavior. Unlike conventional introductory courses, the material is presented primarily through the use of in-class experiments which give students direct experience with how economic and related political mechanisms work. After each experiment, the class discusses what the experiment was designed to show, what it says about how real social institutions work, and how economists go about modeling the phenomena observed in the experiment.

Course Descriptions

73-198
Research Training: Economics **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. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as "elective" units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. Prerequisites/restrictions: For H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

73-250
Intermediate Microeconomics **Fall and Spring: 9 units**
The process by which the decisions of business firms and households, interacting through a price system, influence the allocation of resources in a market economy. Conditions for economic efficiency are developed, and the effects of various forms of market structure on the behavior of firms and households and on economic welfare are analyzed. Numerous illustrations are provided of the manner in which theoretical propositions explain and predict actual events in the economy. Microeconomic theory is used as the basis for formulating public policy guidelines. 2 hours lecture, 1 hour recitation. Prerequisites: 73-100 and 21-112 or 21-122.

73-260
Econometrics I **Fall: 9 units**
Statistical analysis is at the heart of all empirical studies in economics. Facility with the use of these tools provides the student of economics with the means for making sense out of what can otherwise be an overwhelming mass of data. The econometrics sequence is, therefore, designed to introduce students in economics to the statistical tools and concepts that economists use most frequently. The first course in this sequence, Econometrics 1, has three parts. The first two parts introduce and develop concepts in probability and statistics that are used extensively in econometrics. Initially this takes the student through a discussion of probability distributions, cumulative distribution functions, probability density functions, and random variables. This is followed by a discussion of sampling theory and statistical inference, including estimation, confidence intervals and hypothesis testing. The last part of the course is an introduction to the least squares estimator of the univariate and bivariate linear regression model. Prerequisite: 36-201 and 36-202.

73-300
Intermediate Macroeconomics **Fall and Spring: 9 units**
A critical evaluation of empirical and theoretical findings of economists with respect to such problems as unemployment, inflation, business cycles, technological change, and growth. The roles of aggregate consumer spending, business investment, money, and government spending and taxation in determining the level of gross national product are emphasized. The course examines alternative fiscal and monetary policies aimed at promoting such goals as full employment, stable prices, and long-run economic growth. 2 hours lecture, 1 hour recitation. Prerequisite: 73-250.

73-330
Comparative Economic Systems **Intermittent: 9 units**
A comparison of the spectrum of economic systems, from capitalism through socialism to communism. Each system is evaluated with respect to how well it allocates resources. In particular, the significance of external economies, public goods, degree of economic maturity, and existing economic, social, and political institutions is analyzed. Prerequisite: 73-250.

73-340
Labor Economics **Fall or Spring: 9 units**
This course uses economic theory and data to analyze topics such as: (1) individuals' decisions about hours of work, investment in training or education, and choosing an occupation; (2) firms' decisions about hiring, training workers, and setting wage rates; and (3) the resulting wage and employment outcomes as influenced by union contracts and implicit employment contracts. Also considered are public policy recommendations concerning minimum wages, job training programs, hazards on the job, race and sex discrimination, and income inequality. Prerequisite: 73-250.

73-351
Public Finance **Spring or Fall: 9 units**
This course examines problems created by market failure and analyzes the incentives and institutions which can be used to alleviate these problems. We will consider applications such as education, environmental issues, defense, crime, and common resources. The common thread in these situations is that individual optimizing behavior does not necessarily lead to an outcome which is optimal for the society. We will evaluate possible solutions involving private, informal mechanisms as well as those requiring public sector intervention.

73-354
Law and Economics **Intermittent: 9 units**
In recent years, the use of economics to analyze legal issues and decide legal controversies has been extended far beyond its original domain of antitrust and public utility regulation. Now not only scholars but also courts and regulatory bodies routinely apply economic principles to issues as diverse as the control of crime, accident law, contract damages, judicial administration, financial regulation, and pollution. This course reviews the major findings of the scholarly literature on law and economics, and emphasizes the application of economics to specific problems. Absolutely no knowledge of law is presumed or required. Prerequisite: 73-250.

73-356
Political Economy of Public Institutions **Fall or Spring: 9 units**
This course provides the student with an introduction to formal political theory and the modeling of political processes in a rigorous scientific way. Several substantive issues and areas are examined, including: 1) the causes of public sector growth; 2) the politics of regulation; 3) the logic of legislative action; 4) simple majority rule elections; and 5) interest group decision-making. The perspective adopted here is that of extending contemporary economic theory to collective (e.g., governmental) choice institutions. Specifically, we consider, first, how economic theory can be applied to these issues and, second, how that theory can be modified usefully to model political, non-market phenomena. A brief introduction to game theory is included. 3 hours recitation. Prerequisite: 73-250 .

73-357
Regulation: Theory and Policy **Fall or Spring: 9 units**
There is hardly an aspect of our lives - our food, health care, work environment, the air we breathe, the places where we live - that is not subject to some government regulation. This course explores the origins, goals, and implementation of many major regulations. We use an analytical framework that considers the economic, political, and bureaucratic forces that create and shape regulation. This framework is developed and applied with reference to specific cases, including 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). Prerequisite: 73-250.

73-358
Economics of the Environment and Natural Resources **Fall or Spring: 9 units**
The economic theory of environmental degradation and public policies designed to deal with it; the theory of renewable and nonrenewable resources including their pricing and allocation over time. Implications for the intermediate term future (25 to 50 years hence) are modeled. 3 hours recitation. Prerequisite: 73-250.

73-359
Benefit-Cost Analysis **Fall or Spring: 9 units**
The evaluation of public and 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. 3 hours recitation. Prerequisite: 73-250.

73-360
Econometrics II **Spring: 9 units**
Econometrics 2 is a continuation of Econometrics 1. After reviewing elements of linear algebra, including the use of vector and matrix notation, students use it to analyze least squares estimation in the multivariate linear model. This is followed by a discussion of several of the assumptions on which least squares estimation is based, and what corrective actions should be taken if they are violated. The last part of the course moves into an analysis of random utility models of selection, and simultaneous equations models of supply and demand, to show how the techniques of regression analysis can be extended to quantify and test economic theories. Prerequisite: 73-360, or 36-225/226.

73-365
Industrial Organization **Fall or Spring: 9 units**
This course is concerned with the economic analysis of industrial markets that are not perfectly competitive. The effects of imperfect competition on firms' decisions (pricing, location, advertising, research and development, among others) are reviewed. Implications of these effects in terms of public policy are also discussed from a variety of perspectives. Finally, applications to actual markets are considered. Prerequisite: 73-250.

73-371
International Trade and Economic Development **Fall or Spring: 9 units**
This course examines the economic rationale for trade among nations and its consequences for the citizens of the nations involved. Topics to be considered include comparative advantage, gains from trade, possible gains from tax-subsidy programs, traditional and recent arguments for protection, and the effects of special trade arrangements such as regional trade zones. In addition, the course considers the effects of trade and other policies on economic growth and development. Emphasis is given to the principal analytical concepts and results relevant to the special problems of developing nations. Prerequisites: 73-250 and 73-300.

73-372
International Money and Finance **Fall or Spring: 9 units**
This course is devoted to economic analysis of exchange rate behavior, balance of payments adjustments, the financing of payments imbalances, and related topics in the areas of international monetary, macro, and financial economics. A simple but flexible model of exchange rate determination will be formulated and tested empirically. Considerable emphasis will be given to issues concerning alternative monetary arrangements such as fixed vs. flexible exchange rates, currency unions, and commodity-money standards. Some historical consideration of the pre-1914 gold standard and the 1945-1971 Bretton Woods system will be included, as well as institutional discussion of the present (and prospective) European Monetary System. Prerequisites: 73-250 and 73-300.

73-380
Strategy in Economics and Politics **Fall or Spring: 9 units**
If the superpowers want to avoid nuclear war, why is there an arms race? Why do corporations pay greenmail or use poison pills to avoid takeovers? There are many interesting situations like these in economics and politics, situations in which making the best decision requires one to consider how others will respond. This course studies many such situations, including economic examples such as entry deterrence, takeover bids, and strikes; and political examples such as the arms race and nuclear strategy, U.S. foreign policy, and elections. The course's goal is to draw out the fundamental principles underlying strategic decision making. Prerequisite: 73-250.

73-410
The Economics of Business Cycles **Intermittent: 9 units**
The purpose of this course is to educate the student in modern business cycle theory. The first part of the course surveys the empirical regularities which comprise fluctuations in aggregate economic activity which economists have labeled business cycles. The second part of the course discusses the existing macroeconomic models which students have learned in intermediate macroeconomics, while the third part of the course examines the policy implications of these models and the inadequacies of the models as economic explanations of cycles. The final part of the course discusses rational expectations models of the business cycle in considerable detail. The empirical implications of these new models are examined, and their policy implications are assessed. Prerequisites: 73-250 and 73-300.

73-420
Monetary Theory and Policy **Intermittent: 9 units**
This course is concerned with various topics in monetary and macroeconomics including anticipated inflation, hyperinflation, output effects of monetary policies, alternative techniques of monetary policy implementation, and the interaction of monetary and fiscal policy strategies. Analysis of these issues is conducted by means of simple but 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: 73-250 and 73-300.

73-430
Topics in the Economics of Uncertainty **Fall or Spring: 9 units**
The course is designed to investigate both the behavior of economic agents and the characteristics of markets in the face of uncertainty. The first third of the course deals with the behavior of individual agents and optimal choices under uncertainty. The second third of the course examines various notions of equilibrium in the face of uncertainty. We then consider various models which attempt to explain phenomena such as price dispersion and unemployment as arising from uncertainty. Prerequisites: 73-250 and 73-300.

73-458
Money and Banking **Fall and Spring: 9 units**
This course addresses several issues concerning money in our economic system. These include the definition of money and its role, an investigation of banks and their behavior, and the relationship of knowledge of the monetary system to controlling the economy. 3 hours recitation. Prerequisite: 73-300.

73-476
American Economic History **Fall or Spring: 9 units**
The study of economic history provides important perspective on current economic institutions and policies. A failure to understand the historical evolution of economic institutions or the variety of past economic experience is perhaps the worst shortcoming of many economists. The study of economic history provides an opportunity to test currently fashionable theories against data different from those used in their construction. In fact, this is a course in applied economics. The theories developed in the intermediate courses will be applied to episodes from the past in ways that increase understanding both of the specific historical episodes considered and the economic theories employed. Prerequisites: 73-250 and 73-300.

73-477/479
Issues in Economic Analysis and Policy **Fall or Spring: 9 units**
The subject matter of this course changes from year to year. Topics are chosen to illustrate the application of recent advances in economic analysis or to focus on contemporary policy problems. The format of the course typically involves both lecture sessions and sessions in which the discussion is led by students. Prerequisites: 73-250. Other prerequisites may be specified by the instructor.

73-495
Independent Study in Economics **Fall or Spring: variable 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 research project under the supervision of an appropriate faculty advisor. The nature and scope of the project are determined by the student and faculty advisor and may range from an in-depth survey of the literature to a detailed theoretical or empirical analysis of the topic in question.

73-500/501
Honors Thesis **Fall and Spring: 9 units**
Economics majors with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of individual faculty members. Research topics are selected by students and faculty. Prerequisites: Senior standing in the Economics Department and permission of faculty.

English

Undergraduate Courses

The English Department provides detailed descriptions of courses to be offered each term. These descriptions are available from the Department office, Baker Hall 259, in advance of registration. The following brief descriptions constitute a sample of courses the Department teaches; however, every course is not offered every term. Courses listed 3xx/7xx and 4xx/8xx are often listed for both upper-level undergraduate and graduate credit.

Numbering System:
Courses in the Department are numbered according to level of difficulty, and the middle number of the sequence indicates which program the course fits into. These program classifications are flexible. Consult with your advisor for more information. The following is a scheme for relating course numbers to the class of student for whom the course is primarily targeted:

76-100-199	Freshman
76-200-299	Sophomore
76-300-399	Sophomores, Juniors and Seniors
76-400-499	Juniors and Seniors and above
76-3xx/7xx	Open to Juniors and above, but designed for Masters students — juniors need permission
76-4xx/8xx	Open to Seniors and above, designed for Ph.D.s — seniors need permission
76-700	MA (Ph.D.'s may register for max of 9 units)
76-800	Ph.D. (MA's by permission only)

The following is a scheme for relating course numbers to the English Core and to the various English majors.

76-x1x	Course designed to accommodate multiple English majors
76-x2x	Course designed to accommodate multiple English majors
76-x3x	Course in Literary and Cultural Studies (LCS)
76-x4x	LCS
76-x5x	LCS
76-x6x	Course in Creative Writing
76-x7x	Course in Rhetorical Studies (RS) (includes Professional and Technical Writing)
76-x8x	RS
76-x9x	RS and Core Courses: Undergraduate: 293 294 Grad: 791 for MA Core, 891 for Ph.D. Core.

** Graduate courses may have different prerequisites, requirements, or unit value. Check with department for details.

An Introduction to English Studies: Argument and Interpretation
76-100 Argument **9 units**
76-101 Interpretation **9 units**
These courses are companion pieces that will give students who take them both a comprehensive and deeply inter-related grounding in communication processes. Either class taken alone (for 9 units) will serve as a Designated Writing Class; both teach writing along similar lines and both focus on the way in which the two elements of interpretation and argument work together in the processes of communication, and social and personal development. The class Argument builds on rhetorical theory and puts more emphasis on the formal aspects of developing an argument so as to make an intervention in a conversation, discourse community, or dispute. The class in Interpretation builds on social and cultural studies and puts more emphasis on the processes and problems of making sense of other people's positions and arguments as a central part of producing one's own position. Each class is self-contained. They can be taken singly or together, and there is no preferred sequence. The development of skills in both written and verbal communication (speech skills) is part of the curriculum in both classes. The Department offers equal numbers of sections of each class (according to the availability of resources) and students are scheduled into one or another primarily according to constraints of time-tabling.

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76-102/103
Recitations for 76-100 Argument & 76-101 Interpretation **6 units**
The purpose of these recitation sections is to provide additional help to students in developing their reading and writing skills. The sections have been designed such that the teaching assistants can work closely with individual students to aid their understanding of the material being presented in the corresponding Argument or Interpretation section, and furthermore, to help provide students with the skills needed to meet the requirements of these courses. The specific focus of the sections is twofold. First, the recitation sections provide more intense instruction in reading activities such as vocabulary building and comprehension monitoring, and writing activities such as paragraph and sentence development (e.g., grammar, mechanics). Second, the recitation section will reinforce and explicate material covered in the 76-100 and 76-101 sections. As such, time will be spent discussing textbook concepts, readings, supplementary course materials, and paper assignments. The recitation sections are run on a workshop basis and depend significantly on student input for their direction. The teaching assistants for 76-102/103 also maintain close contact with the teaching assistants for the 76-100/101 sections to further identify areas of focus which will be most beneficial to students.

76-170
Advanced Exposition **9 units**
The course focuses exclusively on argument. It is designed to develop a detailed knowledge of one theory of argument—Aristotelian—and a high level of skill in using it. Particular attention will be paid to arguments of value and policy (that something is good or bad, desirable or undesirable; that something should be done). Course work consists of readings, class discussions, and several papers.

76-198
Research Training: English **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 or creative experience through work on a faculty project or lab in ways that might stimulate and nurture subsequent interest in research participation. Faculty and students devise a personal and regularized meeting and task schedule. Each Research Training course is worth 9 units, which generally means a minimum for students of about 9 work-hours per week. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as "elective" units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. Prerequisites/restrictions: For H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

76-201
Cultural Practices and Literary Production **9 units**
This course is part of the H&SS General Education curriculum and several different versions of the class will be taught under this general rubric. The aim of each version of this course is to engage cultural analysis in a grounded and historically detailed way by focusing on the complex relationship between specific social institutions or cultural practices and literary texts. Students examine primary and secondary texts that illuminate a particular social institution or cultural practice (such as the commercialization of the theater in eighteenth-century England, the Jacobin-anti-Jacobin debates in late eighteenth-century England, or English abolitionism at turn of the eighteenth century). The approach is intended to be interdisciplinary, drawing from social history, literary history, and language studies in particular, but also from other disciplines concerned with social institutions and/or cultural practices (such as art history). While enriching students' knowledge about a particular social institution or cultural practice through the study of secondary works, the course also examines a diversity of the literary texts (broadly defined) that form a part of or comment upon that institution or practice. (For instance, one version of the class might study the historical and social dimensions of the Jacobin-anti-Jacobin debates around and through works such as Burke's Reflections on the French Revolution, Paine's Rights of Man, Wollstonecraft's Maria, and Godwin's Caleb Williams.)

76-206
Craft of Creative Writing **9 units**
This course gives students practice in the reading and writing of fiction and personal essays. In a workshop setting, students gain critical and analytical skills through discussing published work and work written by class members.

76-230
Biblical and Mythological Backgrounds of English Literature **9 units**
This course considers classical and Biblical narratives and drama as story, as expressions of idea or explanation, and as expressions of emotion. Readings vary, but are most frequently taken from The Odyssey, collections of Greek plays, The Aeneid, Ovid's Metamorphoses, and from current and older translations of the Bible. Readings are chosen both for their own value and for their relation to other literature. Prerequisites: credit for a designated writing course or permission of the instructor.

76-231 /232
Studies in British Literature and Culture **9 units**
Studies in British literature and culture organized according to period, form, or author. Prerequisites: credit for a designated writing course or permission of the instructor.

76-233
Studies in European Literature and Culture **9 units**
Studies in European literature and culture organized according to period, form, or author. Prerequisites: credit for a designated writing course or permission of the instructor.

76-234
Studies in World Literature and Culture **9 Units**
Studies in literatures and cultures of the world, organized according to nation, region, or theme. Prerequisites: credit for a designated writing course or permission of the instructor.

76-235
Studies in American Literature and Culture **9 units**
Studies in the literature and culture of the United States, organized according to period, form, or author. Prerequisites: credit for a designated writing course or permission of the instructor.

76-237
The Modern Novel **9 units**
The course in the modern novel considers some of the important social, intellectual, and aesthetic concerns of British and American novelists of the first half of the twentieth century: the problems of growing up in a ghetto; the relationships between men and women, parents and children, blacks and whites; the function of the artist in society; point of view; the form and function of the novel.

76-239
Introduction to Media Studies **9 units**
An introduction to the technology, history, semiotics, and ideology of the cinema. The course will include consideration of such topics as film technology, montage editing and continuity style editing, narrative forms and ideologies, non-narrative cinema, the history of the Hollywood institution, the history of film and filmmaking in non-Hollywood modes, and so on. Core course for film minors.

76-240
What Is Cultural Studies? **9 units**
An introduction to cultural studies, this course will proceed by way of detailed readings of particular cultural texts (literature, film and television, popular reading materials, music, the visual arts, etc.) in a specific cultural formation and era (the 19th Century American West, for example, or Britain since WWII). Through such readings the course will aim at producing a sense of the general theoretical and historical issues at stake in the analysis of cultures.

76-241
Introduction to Gender Studies **9 units**
This course will be devoted to introducing the predominant methodologies in gender studies—while touching on as many disciplines as possible. The course pursues questions arising from the study of the social construction of gender. A second focus will be on questions of cultural transformation.

76-242
Sex and Gender **9 units**
The movement of women toward legal and social equality in recent times has served to make the question of their relationship to men and to work as writers far more controversial and far more central to our consciousness about the way we read and write and speak. This course looks at some of these changes, taking into consideration language, views from the past, political/cultural stances and emotional stirrings in the work of contemporary women writers and filmmakers.

76-245
Shakespeare **9 units**
This course introduces students to some of Shakespeare's most exciting plays — and a major emphasis will be on the multiple enjoyments they have given audiences and readers for 400 years. But it will pose more wide-ranging questions. Why is Shakespeare considered a "great" author, part of the "canon" of literature? How have his plays been reproduced and adapted to changing social and political formations? What places do or could literature and drama have in relation to the dominant ideology of our culture? What is the relationship between enjoyment and meaning? What do (or might) Shakespeare's plays say (or be made to say) about today's pressing issues — about feminism, racism, colonialism, our place in Western culture? We will study a selection of the plays — especially A Midsummer Night's Dream, Measure for Measure, 1 Henry IV, Troilus and Cressida, Othello, King Lear, Pericles, Cymbeline, The Winter's Tale, The Tempest — and watch a number of videotaped performances. Prerequisites: credit for a designated writing course.

76-260
Study of Forms: Fiction **9 units**
This course gives students practice in reading and writing short fiction. In a workshop setting, students gain critical and analytical skills through discussing published fiction and fiction written by class members. Prerequisites: credit for a designated writing course; H&SS students have priority.

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76-265
Study of Forms: Poetry — **9 units**
This course gives students practice in reading and writing poetry. In a workshop setting, students gain critical and analytical skills through discussing published poems and poems written by class members. Prerequisites: credit for a designated writing course; H&SS students have priority.

76-268
Study of Forms: Drama — **9 units**
This course gives students practice in the reading and writing of drama. In a workshop setting, students gain critical and analytical skills through discussing published plays and scenes, acts, or one-act plays written by class members. Prerequisites: credit for a designated writing course; H&SS students have priority.

76-269
Study of Forms: Screenwriting — **9 units**
This course gives students practice in filmic and televisual reading and writing. In a workshop setting, students gain critical and analytical skills through discussing produced films and videos and short scripts written by class members. Prerequisites: credit for a designated writing course; H&SS students have priority.

76-271
Introduction to Professional and Technical Writing — **9 units**
This course, required for professional and technical writing majors, develops students' rhetorical awareness and writing skills across a range of professional genres directed to general audiences. Assignments reflect options for specialization in subsequent course work and writing career choices. The course features a series of carefully-sequenced, situation-based writing assignments spread over three broad and often overlapping areas — business/professional writing, media writing, and technical writing. Typical assignments include resumes and business correspondence, reviews, news coverage, feature articles, user instructions, consumer brochures, and software documentation. As they work through individual and group assignments, students learn to conceptualize, plan, and produce effective, professional-quality documents through an approach that emphasizes situational analysis and problem-solving skills. Particular attention is given to analyzing how the situational demands of context, purpose, and readers' needs shape the writer's selection and use of genre, content, and style. As a final project, students create a portfolio of polished writing samples to use in applying for internships and employment. Registration limited to English majors. Professional and Technical Writing majors have priority.

76-292
Reading Popular Culture — **9 Units**
An introduction to the study of mass or popular culture in contemporary life.

76-293
Rhetorical Traditions — **9 units**
Rhetoric is the study of the relationship between thought and expression. Rhetoric has provided systems for facilitating communication for almost 2500 years, making it one of the oldest academic disciplines in the West. "Rhetorical Traditions" introduces students to the ideas, issues and individuals that shaped rhetoric. some of the forces shaping rhetoric's traditions include the relationship between orality and literacy, the impact of cultural and religious views on discourse, and the role of technology in communication. By understanding these forces within their social contexts, students acquire a foundational knowledge of the nature and history of rhetoric, a discipline central to the Humanities. Required for all English Majors

76-294
Literary and Cultural Studies Core — **9 units**
This course is one of the three core requirements for all English majors. It examines the concepts, assumptions and terms upon which the Literary and Cultural studies program is based. We shall be concerned with "reading" cultural phenomena as systems of signification. The aim of the course is to help students come to terms with the multiplicity of ways in which meaning is produced historically, sanctioned socially, and transformed. Students will be required to direct their critical and analytic attention towards questions of historical and ideological positioning as well as of unconscious and structural determination. We will approach this task through readings of a diverse array of cultural "texts," such as literary forms, film, advertisements and other practices of everyday life.

76-320 /720**
Interviewing — **9 units**
This course examines some of the formats and effects available via electronic interviewing. How are shaped by such variables as the stance of the interviewer, the final display medium (e.g., print vs. video), the nature of the subject (technical vs. artistic vs. family history, etc.)? At a general level, how does taping as a practice imply political/cultural values?

76-321/721**
Documenting the Visual — **9 units**
Questions this course asks include: What do photographs mean, by themselves and in relation to texts? How does the pervasiveness of cameras and photo-images affect how people see the world? Typically students play the role of critical interpreters (as they might in a literature course), but they also have the option of creating their own photo-documents.

76-322 /722**
Reading the Built Landscape — **9 units**
This course examines the proposition that the built landscape is a "text"—reflecting the values of its owners and "authors," shaping the cultural and political consciousness of its users. A particular, recurring theme will be the treatment of "public space" in urban/suburban America. Teaching will draw from relatively recent texts at the intersection of geography, architecture, social history, photo documentation, and literature. As feasible, local field trips and student-made photo-documentation will be encouraged.

76-330/730**
Medieval Literary and Cultural Studies — **9 units**
Topics will vary. Consult the Department update on courses at registration time.

76-331/731**
16th Century Literary and Cultural Studies — **9 units**
Topics will vary. Consult the Department update on courses at registration time.

76-332/732**
17th Century Literary and Cultural Studies — **9 units**
Topics will vary. Consult the Department update on courses at registration time.

76-333/733**
18th Century Literary and Cultural Studies — **9 units**
Topics will vary. Consult the Department update on courses at registration time.

76-334/734,**
19th Century Literary and Cultural Studies — **9 units**
Topics will vary. Consult the Department update on courses at registration time.

76-335/735**
20th Century Literary and Cultural Studies — **9 units**
Topics will vary. Consult the Department update on courses at registration time.

76-337/737**
Working Class Literature — **9 units**
This course will read literature that examines how working and workplaces affect people's ideas of class, ethnicity, politics, gender, family, and personal lifestyles. Materials will include poetry, non-fiction and media, and range from the turn-of-the-century to the 1980's. Prerequisites: credit for a 200-level English course or permission of the instructor.

76-339/739**
Advanced Studies in Media — **9 units**
Studies in the history, theory, and analytical reading of print and electronic media, using the techniques of structural, contextual, and ideological analysis. For example: Writing for the Media, Youth Cultures, Reading Television. Prerequisites: credit for a 200-level English course or permission of the instructor.

76-340/341740/**741**
Advanced Cultural Studies — **9 units**
See 76-240 for a general description. These are higher level courses designed especially for majors in English.

76-342/742**
Theories of the Other — **9 units**
This course focuses on issues of alterity and "otherness." It provides an examination of the strategies by which demarcations between notions of Self and Other and corollary distinctions between high/low, first world/third world, masculine/feminine, and center/periphery, are deployed in various cultural discourses. The course is guided by an interdisciplinary impulse and its texts are drawn from disparate fields such as literature, film, philosophy, anthropology, and cultural studies.

76-344/744**
History of Literary Theory and Criticism — **9 units**
A study of some of the major thinkers, works, and issues which have shaped literary theory from Aristotle to New Criticism. Writings by such figures as Aristotle, Sidney, Johnson, Dryden, Coleridge, Arnold, Eliot, Richards, and Leavis may be included. Prerequisites: junior, senior, or graduate standing or permission of the instructor.

76-346/746**
Readings in Emergent Literatures — **9 units**
Will include literatures of Africa, Central and South America, India, as appropriate. The paramount concern of this course is the problem of reading representations of other cultural experiences, as opposed to the problem of representing other cultural experiences. Students will address those concerns through a collection of critical readings which present some of the critical and methodological issues involved in reading emergent literature.

76-347/348747/**748**
American Literary and Cultural Studies — **9 units**
Will include courses like 'American Innocence', the American novel of the early Modern period, Contemporary American literature, and 'American Fiction of the 20's and 30's'.

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76-349/749**
Feminist Historical Criticism **9 units**
This course combines a wide historical range of English literary texts with feminist criticism and theory. Feminist historical criticism combines a modern theoretical and political self consciousness with an attentiveness to the construction of gender in prior literary and cultural contexts. The course will study and critique modern feminist readings of English literature and culture from the Renaissance through the early nineteenth century.

76-353/753**
Reading Feminisms **9 units**
This course considers not feminism, but feminisms. The assumption will be that feminist discourses operate variously and diversely ; across a wide range of social and cultural issues and experiences. They are guided not necessarily by 'feminist theory.'

76-354/754**
Contemporary Literary Theory and Criticism **9 units**
An introduction to the issues of post-Saussurean theory and criticism, focusing on the major theories and theorists of our time, such as Bakhtin, Benjamin, Derrida, Foucault, Althusser, Iser, Barthes, Eagleton, Bloom. Particular attention will be given to developments since New Criticism and the emergence of poststructuralism. Prerequisites: junior, senior, or graduate standing or permission of the instructor.

76-365/465/765/**865**
Poetry Workshops, Beginning, and Advanced **9 units**
Poetry workshops are a series of courses involving discussion of poems produced by members of the class. Emphasis is on basic techniques of prosody, structure, and imagery. Prerequisites: for Poetry Workshops I or II, Study of Forms: Poetry (76-265) or permission of the instructor; Poetry Workshops III and IV, Poetry Workshops I or II or permission of the instructor.

76-364/764**
Reading Poems **9 units**
A "skills" course about ways of reading poems with pleasure and depth, treating them as a complicated kind of writing which can be baffling, but offers a lot in return for some time and attention. Reading poems means talking about them in some detail, working toward consensus about response to them. Readings are from a number of styles, from this century and from other centuries, in an attempt to see how kinds of poems and social expectations about them have varied. We will consider what audiences to which various poems are addressed and the kinds of effects these may have on how the poems are read. We will consider how technique in poems has interested writers of poems, and how knowing about it complicates and improves our operations as readers of poems.

76-371 /771**
Rhetoric in Social Interaction **9 units**
The course focuses on the rhetorical and ethical problems that arise in the conduct of professional life. Students develop proficiency in responding to these problems through (1) studying contemporary rhetorical theories, (2) applying these theories to their own writing, and (3) critically analyzing articles and speeches. Prerequisites: 76-270, 76-271, or permission of the instructor.

76-372/772**
Journalism I **9 units**
Against a background of reading in current and past practices of journalism, the major thrust of this course will be in-depth reportage and storywriting for the faculty newspaper, Focus. Subject to the judgment of the editors, students will see good writing rewarded by actual publication. Students will also be introduced to technical aspects of journalism such as lay-out and design. Prerequisites: credit for a 200-level writing course; junior, senior, and graduate English majors have priority; others by permission of the instructor.

76-373/773**
Language in Graphic Design **9 units**
Graphic designers use language in order to propose designs that do not yet exist; to present finished designs to clients; and to create designs in collaboration with other designers and professionals. This course covers these three functions of language in graphic design. More specifically, it offers practice in — and reflection on — the uses of language in oral presentations, group decision-making and problem-solving, and the writing of documents like proposals and manuals. Practice in these activities will be tied as much as possible to actual studio projects here at CMU and to representative work of professional design firms.

76-374 /774**
Argument **9 units**
This course is concerned with the theory and practice of argument: with what an argument is, what makes an argument good or bad, and how arguments are best constructed, analyzed and evaluated. The course will explore these questions by drawing upon rhetorical, philosophical, and psychological theories; empirical research; and examples of arguments. An important focus of the course is on developing the abilities necessary for arguing effectively in various contexts. Prerequisites: Credit for 76-271 or permission of the instructor. Priority to junior and senior writing majors.

76-375/775**
Magazine Writing **9 units**
Students will produce writing suitable to magazine publication: forms such as a researched nonfiction article, a short fictional sketch, a talk-of-the-town column, a book review, a film or stage or TV review, a researched biographical profile, a short work of verse, and a cartoon. Some research and interviewing techniques will be considered. Prerequisites: credit for a 200-level English course or permission of instructor. English majors have priority.

76-377/777/A
Rhetoric of Fiction **9 units**
This class will introduce students to a number of major literary works of fiction, primarily novels and short stories, but including a few short poems as well. Students will read the works for enjoyment and to begin to develop a critical sense of the social importance of fictional works. One of the most influential and important works of literary interpretation and rhetorical theory in recent times is Wayne Booth's The Rhetoric of Fiction. This class is named after that book, and will deal with Booth's views, and some of the texts he discusses. Like the famous American critic and rhetorician, Kenneth Burke (born in Pittsburgh, died last year), Booth asks us to think about the kinds of claims that imaginative works make on us. Burke thought of imaginative constructions as strategic responses to situations, or answers to questions posed by particular social and historical contexts–he saw literature, in short, as 'equipment for living'. Following Burke and Booth, we shall consider what kind of rhetorical address imaginative works make to us as readers, what kind of solutions to what kinds of problems they seem to offer, what kinds of arguments they can be seen to be making. Such a rhetorical approach to cultural understanding offers a much richer understanding than the usual aesthetic approach, and allows students to develop a practical and common-sense critical vocabulary useful in everyday life.

76-378/778**
Rhetoric and the Writing Process **9 units**
This course explores the connections between rhetoric and writing, between a public act and a personal thinking process, by exploring classical, cognitive, social accounts of what a "rhetorician" does. Students apply theory to their own writing and to rhetorical problems in academic or community settings and use close observation of their own problem-solving process as a basis for systematic reflection about the strategies, schemas, conflicts and negotiations that mark a rhetorical process.

76-378/778**
Rhetoric and the Writing Process: Community Literacy **9 units**
(limited enrollment)
This course explores the connections between rhetoric as a public and social act and writing as a personal, strategic process by focusing on issues in literacy and intercultural communication. Students apply theory in a nine week experience as community literacy Mentors helping inner city teenager address urban problems. The course combines the opportunity to test theory and study literacy in action, with the chance to conduct a systematic observation of writing as a public, personal, and interpersonal negotiation. (This section requires direct permission of the instructor.)

76-379
Technical Communications for Engineers **9 units**
This course is designed for junior/senior engineering students who want to improve their abilities in practical, professional communication, e.g., research reports, proposals, technical memos, policy statements to government agencies. The object of the course is to help students write clear, concise technical prose for specific audiences. Assignments are based on recent research in decision-making, problem-solving, and rhetoric, and will be tied, when possible, to projects in technical courses or to work the students are doing for industrial co-ops. CIT students only. Prerequisites: credit for a designated writing course; priority to seniors. A CIT student may not receive credit for both 76-270 and 76-379 to fulfill H&SS distribution requirements.

76-380
Special Topics in Professional Genres **9 units**
Topics will vary. Will include courses like Medical Writing, Science Writing, Corporate Communications and Writing for the Marketplace

76-381/781**
Contemporary Rhetorical Theory **9 units**
This course examines current research of prominent rhetoricians. Stressing reading from primary sources, topics for discussion include the process of symbolization, the relationship of ethics to language, argument theory, and speech-act philosophy. The objectives of this course are to provide knowledge of theory and model construction that have direct relevance to the teaching and practice of effective communication. Prerequisites: 76-371, senior or graduate standing, or permission of instructor.

76-382/782** **9 units**
Image, Icon, Text: "post" Modern Rhetorics of the Visual Verbal
This class is intended in the first instance for students in the new joint MA degree offered by the Departments of English and Design at CMU (The MA in Communication Planning and Design). It is suitable also for graduate students in other degree programs in English and Design (for now, the MA in English, Rhetoric or LCT, and the MAPW). It is available also to advanced undergraduates in either Department, with the permission of the instructor. Post-structural theory has problematized the issue of the reliability of the constructed message, and of the audience. It has brought new complexity to the understanding of

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situation and context. An early round of literary theory simply insisted on the multiplicity of meanings of any text. Some early theorists found satisfaction simply in the pleasure of the play activity in producing multiple 'readings' of any given text. Subsequently this multiplicity was seen as an indeterminacy of meaning and an infinitely variable set of contexts. Post-structural theory is largely rhetorical theory concerned with problems of citing (quotation or iteration), and of changes of meaning attributable to re-siting (re-contextualizing) any constructed meaning.
Briefly: this class can be thought of as practical training in the exercise of interpretive subtleties, when the 3 dimensional nature of public space complicates issues, and when the communication mode is mixed (visual and verbal combined, or multi-media in general.) We'll begin by considering some aesthetic and social reflections on the reception of visual imagery (John Berger, Ways of Seeing, Rudolf Arnheim The Power Of The Center : A Study Of Composition In The Visual and selections from Visual Thinking. Selections from The Language of Images, Iconology : Image, text, ideology, Art and the public sphere, all by W.J.T. Mitchell.) We'll then look at some discussions of rhetoric and public space: Aristotle, John Dewey, Kenneth Burke, Mikhail Bakhtin, Paul de Man, J. Habermas. In addition, we will discuss ways in which structural and post-structural theory contributes, if it does, to an understanding of public communication: brief selections from Walter Benjamin, Illuminations, Roland Barthes, Image Music Text, Mythologies, Camera Lucida, J. Derrida, selections, Paul De Man selections, Baudrillard selections, Jorge L. Borges, selected stories. Note: there will be room for students to tailor the reading list to particular interests they may have.

76-383/783**
The Architecture of the Paragraph **3-6 units**
This mini-course is concerned with the paragraph, though to adequately address issues of the paragraph one must also consider sentences as components of paragraphs, and 'chunks' of paragraphs as well. The course seeks to cultivate an understanding of the theoretical issues associated with the paragraph and a high degree of skill in producing them.

76-384/784**
Problems—Their Nature, Analysis, and Formulation **3-6 units**
This mini-course seeks to develop a detailed understanding of the nature of problems (where they are, how they arise), the role of problems in inquiry and communication, how one can develop understanding and intellectual control of the problematic experience, and how one can formulate problems effectively. The course is designed to develop an important ability for both the professional writer and the research scholar, and will be of special interest to students in the MAPW program.

76-385 /785**
Introduction to Discourse Analysis **9 units**
Topics covered in this course will include: types and genres of discourse, aspects of text structure, and the relationship between discourse and grammatical structure.

76-386/786**
Sociolinguistics **9 units**
Topics in this course will include: linguistic variation in society (both at the individual [micro] level and the group [macro] level), prescriptive rules and their social context, and language and power relationships.

76-387/787**
Comparative Rhetoric **9 units**
This course will survey current approaches to cross-cultural studies of rhetoric, explore the theoretical and methodological issues involved and identify possible directions in which comparative studies of rhetoric will develop. It is concerned with problems traditionally grouped under the rubrics of contrastive rhetoric and intercultural communication. Yet it aims to broaden the scope of investigation by bringing in other perspectives(e.g., the philosophical, the ethnographical or the translation-theoretical perspective) and by paying special attention to rhetoric as a methodological principle for comparative studies in general.

76-390/790**
Style **9 units**
The "Plain English" movement, which began about a decade ago, is making steady headway in business and government. In this course we will examine and practice "Plain English." Style is a course in theory and practice of writing clear, efficient prose for a variety of purposes in business, government, and elsewhere.

76-391/791**
Planning and Testing Documents **9 units**
This course develops skills of planning, writing and evaluating documents, such as brochures, business forms, instructional texts, contracts, proposals and manuals. This course provides theory and practice in designing complex documents from start to finish.

76-392/792**
Integrating Visual and Verbal Text **9 units**
This course is an advanced introduction to a central topic in document design: the integration of visual and verbal texts. It seeks to help students develop a detailed understanding of the rhetorical relations between visual and verbal texts (how they arise, how they can be created, and how they can be effectively maintained). The course draws on theory and research in psychology, rhetoric, and visual design about how people respond to prose and pictures and about what document designers can do to more sensitively take readers' needs into account. Students will learn to analyze the interplay of visual and verbal texts in ads, catalogs, textbooks, videos, reports, information graphics, instruction guides, and other documents. In so doing, they will become familiar with the vocabularies of professional writers and designers, especially important in communicating, negotiating, and defending one's design decisions. Students will gain practice in constructing alternative textual representations, shifting from visual to verbal, from verbal to visual, and from single mode to mixed mode presentations. Course work involves document design exercises, an individual project, and a collaborative project. Advanced knowledge of using desktop publishing software prior to entering the course is expected.
Although this course is intended primarily for English majors, students from other disciplines are welcome. ADVANCED WRITING COURSE OR VISUAL DESIGN COURSE. Prerequisites: Credit for 76-271 and one 300-level or 400-level writing course. Senior writing majors and Masters in Professional Writing Students have priority. Experience with Microsoft Word and Pagemaker (or the equivalent) is expected prior to entering the course. "Fundamentals of Graphic Design," "Typography for Non-majors," or "Desktop Publishing" is strongly recommended.

76-397/797**
Research in Document Design:
Principles and Applications **9 units**
Intended for MAPW students and junior and senior English majors, this course is designed to help students move beyond the introductory level of professional and technical communication. The course has two goals: first, to help writers use research to guide their decision making in document design; second, to build writers' skills in making oral and written arguments for their design choices. Students will acquire experience in reading and critiquing research relevant to the design of documents and derive, when possible, principles and heuristics for visual and verbal design. During the first part of the course, students will become familiar with the ongoing debates in the research community in document design. During the second part, students will prepare a research-based proposal for solving a communications problem faced by an organization and then give a formal oral presentation of the proposal to a panel of Pittsburgh business leaders who will evaluate the effectiveness of both the written and oral version.

76-424/824**
Pedagogy of Writing **9 units**
The Course seeks to develop not only a body of knowledge about teaching writing but a useful level of skill in the design of effective courses; to that end, one method of course and program design will be studied in detail. Evaluation of the effectiveness of particular course designs will not be treated in any detail; had we world enough and time we would do so, since evaluation is best treated as an aspect of course planning rather than separate from it and subsequent to it. Students may elect to study the issue, however, as part of the major project for the course. The readings in the course are intended to emphasize the relation of theory and research to classroom practice. Recent research that bears on the design of writing courses will be introduced as a means of raising the issue of research-based writing courses. Various theoretical issues having to do with writing will be also introduced as they bear on course design: e.g., basic approaches to the teaching of writing and their theoretical foundations; functions of writing; conceptions of composing and the possibility of instruction; the relation of rhetorical aims to course design. The course is intended for those seeking careers in teaching English. (English here includes rhetoric, composition, literary and cultural studies, and English as a second language.)

76-/431/432/831**832**
Advanced Studies in
British Literary and Cultural Studies **9 units**
Seminars focusing on British literary movements, forms, periods, or authors. For example: Re-Reading the English Renaissance, Shakespeare, Milton, The 17th Century and the New Historiography. Prerequisites: junior, senior, or graduate standing, credit for a 300-level literature course, or permission of the instructor.

76-433/833**
Advanced Studies in
European Literature and Culture **9 units**
Seminars focusing on European literary movements, forms, periods, or authors. For example: studies in the 'Enlightenment', Modernism in the Arts, studies in groups of individual authors and theorists. Prerequisites: junior, senior, or graduate standing, credit for a 300-level literature course, or permission of the instructor.

76-434/834**
Advanced Studies in
World Literature and Culture **9 units**
Seminars focusing on literatures and cultures of the world.
Prerequisites: junior, senior, or graduate standing, credit for a 300-level literature course, or permission of the instructor.

76-435/835**
Advanced Studies in
American Literature and Culture **9 units**
Seminars focusing on literary and cultural movements, forms, periods, or authors in the United States. Prerequisites: junior, senior, or graduate standing, credit for a 300-level literature course, or permission of the instructor.

Course Descriptions

76-437/837**
Cultures/Values/Texts **9 units**
This course is required for all majors in Literary and Cultural Studies and is intended as a "capstone" course, dealing with problems and possibilities of cross-cultural interpretation, focusing on representations in fiction, film, television, journalism etc., produced both 'inside' and 'outside' a particular culture. One recurrent concern of the course is the way in which values (and ideologies) influence the production and reception of representations. Prerequisites: junior, senior, or graduate standing, credit for a 300-level literature course, or permission of the instructor.

76-439/839**
Advanced Seminar In Media Studies **9 units**
See 76-339 for a general description of the area

76-444
Enlightenment Sexualities **9 units**
This course will engage in reading two kinds of narratives about sexuality: 1) modern historical narratives about the nature of human sexuality and its relationship to gender identity and sexual orientation, and 2) eighteenth-century British narratives that relate a gendered, personal identity to a story of sexual misconduct or transgression. We will begin by looking at how the histories of Michel Foucault, Thomas Laqueur and Nancy Armstrong, for example, narrativize the development of modern sexual identities. We will ask questions about how gender is organized in these historical narratives—does it follow developmental patterns? Is it thought of in oppositional terms (masculine and feminine as opposites)? What range of possibilities do these histories allow in thinking about gender as an organizing principal of sexual desire? In particular, we will ask what significance does the eighteenth century, a particularly crucial period of change in all these historical narratives, have in the formulation of modern categories of gender and sexual orientation. The main business of the class will then be reading novels and autobiographies written by authors such as Samuel Richardson, Charlotte Charke, John Cleland, Henry Fielding, and Eliza Haywood. What stories about sexuality are told in these texts? How are these stories related to gendered identities and/or identities of sexual orientation? What roles do these stories play in defining the limits for sexual behavior and in formulating identities based on that behavior? In sum, we'll be looking at modern historical narratives of sexuality and gender, particularly as they figure the eighteenth century, and at eighteenth-century British narratives about sex and identity drawn from popular culture. The goal of our study will be both to learn more about how sexuality and gender are imagined in eighteenth-century British popular texts and to learn more about how our own histories construct the field of sexual possibility.

76-446/846**
Advanced Seminar In
Emergent Literatures/Cultures **9 units**
Topics will vary. Will include courses like 'Travel, Tourism and Knowing', and 'The Literature of the Black World'. See 76-346/-746.

76-453-455/853-855**
Advanced Studies In Literary and Cultural Theory **9 units**
Special advanced seminars in topics of literary and cultural theory. For example: Marxist theory, Freudian theory, Foucault, Lacan, Derrida, De Man, the Frankfurt School.

76-460/461/462/860/**861/**862**
Fiction Workshops **9 units each**
Fiction workshops are a series of courses designed to develop students' analytical writing, and Critical skills in fiction. The students' own work will be closely examined by the instructor and other members of the class. Prerequisites for Study of Forms: Fiction (76-260) or permission of the instructor.

76-463/863**
Form and Theory of Fiction **9 units**
Readings and review of the various forms of fiction and the different and collaborative theories that inform them.

76-467 /867**
Outsiders Speak: The Art of Autobiography **9 units**
Students will be reading and practicing different forms of autobiography. Prerequisite: Study of Forms. H&SS students have priority. Fulfills workshop requirement for Creative Writing majors.

76-468/868**
Fiction Workshop: The Novel **9 units**
This is a two semester workshop during which students will study and review the theories and aspects of the novel (Forster, James, Gardner, etc.) while trying their hands on the form itself. This workshop is open to advanced writers in Creative Writing, Professional Writing and Graduate Students, but requires the instructor's review for admission.

It is not to be expected that an entire novel, or even a novella, can be written in the course of two semesters, but substantial material should be put on paper for class review. A synopsis or outline of the proposed work will also be required. Both semesters must be taken. For Creative Writing majors, this workshop will count for two of their workshop requirements.

76-469/869**
Screenwriting Workshop **9 units**
This workshop develops students' analytical writing and critical skills in screenwriting. The students' own work will be closely examined by the instructor and other members of the course. Prerequisites: Study of Forms: Screenwriting or permission of the instructor. H&SS students have priority. Fulfills workshop requirement for Creative Writing majors.

76-470/870**
Professional and Technical Writing **9 units**
In this project-based course, students confront document design problems of various kinds for specific purposes and audiences: for example, designing and writing brochures, technical manuals, research reports, step-by-step procedures, and users' materials. For each project, students write a proposal, submit progress reports, and prepare a final report describing their process of solving the communications problem they had. Students also present oral reports of articles and research in the fields of technical writing and document design. Prerequisites: 76-271 or permission of the instructor. This course is required for Technical Writing majors.

76-471
Writing for the Professions **9 units**
This course in applied rhetoric is designed for pre-professional students in majors other than English. It is appropriate for both non-H&SS and H&SS majors. The course works to develop students' rhetorical awareness and writing skills across a range of professional genres directed to general audiences. Students in the course learn to communicate technical information in their own and related fields to a spectrum of educated but non-expert audiences, e.g., supervisors, clients, peers, professionals in organizations, and the general public. Working through a series of carefully-sequenced, situation-based writing assignments, students learn to conceptualize, plan, and produce effective, professional-quality examples of the standard written genres common to all fields — proposals, correspondence, reports, instructions, product and process descriptions, oral presentations, and articles for general audience publications. The approach to these genres emphasizes situational analysis and problem-solving skills. Particular attention is given to understanding how the situational constraints of context, purpose, and readers' needs shape the writer's selection of appropriate genre, content, and style. Registration limited to junior and senior non-English majors; seniors given preference.

76- 472/872**
Journalism II **9 units**
Students work with the editor of the faculty-staff newspaper, Focus, to produce articles, interviews, or other publishable features. Prerequisites: credit for a 200-level writing course or permission of the instructor. English majors have priority; others by permission.

76-475/875
Writing and Software Engineering **9 units**
Technical writers in software development firms are often called upon to participate as members of the software design team. In addition to end-user documentation, writers are often called upon to help develop and modify software development documents. These documents explain both to the team and the client the strategy and schedule through which design concepts will be turned into working software products. Software development documents are important because they embody the fundamental working assumptions and theories of software engineering. Students in this course will be introduced to these assumptions and theories as they work in teams to modify software development documents from a simulated software engineering project. Students will also be taught how to integrate these documents into a larger and complete set of software engineering documents. Beyond an introduction to software engineering and the types of documentation required for it, students will gain hands-on experience in project planning and development, both face-to-face and over networks. They will learn about style guides and standards and how to design their own style templates within standards. Students will also be using software that is itself fast becoming an industry standard [Frame-Maker].

76-476/876**
The Rhetoric of Science **9 units**
This course investigates scientific writing and scientific publication as a social and rhetorical system, one focused on group persuasion. Topics include conventions of scientific unity, citation, diffusion of information and the evolution of the journal.

76-479/879**
Computers and Writing **12 units**
This course introduces students to the nature of the computer and computing, with emphasis on it as a tool for aiding in (1) the evaluation of writing, (2) the teaching of writing, and (3) the conceptualization of writing and reading processes. Topics to be covered include a survey of programs used to evaluate writing, a survey of programs used to teach writing, and procedures for analyzing and designing programs that can produce or understand discourse. Students will carry out several small programming assignments Prerequisites: graduate standing; seniors by permission of the instructor.

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76-480/880**
Desktop Publishing **9 units**
This course seeks to familiarize the student with the wide variety of fundamental skills and knowledge necessary to practice effective, informed desktop publishing. Through means of a curriculum centered on the production of ten hands-on desktop-produced pieces, students learn and implement basic principles in graphic design and professional writing, in the process developing a facility with Macintosh hardware and software. The course culminates in the assembly of a professional portfolio which the student may use to assist him or her in the search for internships and post-graduate employment.

76-481/2/881/2**
History of Rhetoric I and II **9 units**
These courses survey the history of rhetoric in Western civilization from its beginnings in ancient Greece to its recent resurgence. Rhetoric is studied not only as theory but as an intellectual, educational, and political force helping to shape the society from which it emerges. Prerequisites: credit for 76-371 or permission of instructor.

76-484/884**
Discourse Analysis **9 units**
This course is a survey of different approaches to larger-than-sentence units in the study of texts, focusing especially on the question of the relationship between text structure and clause-internal grammar. The course will include readings in functional syntax from the Prague School 'Functional Sentence Perspective' to recent work on 'Preferred Argument Structure' and the study of several approaches to discourse analysis including the Summer School of Linguistics and Halliday's Systemic Grammar.

76-488/888**
Contemporary Theories of Invention **9 units**
The course considers various modern theories of rhetorical invention, their underlying assumptions, and their uses in the production and analysis of discourse. To the extent necessary for an understanding of the theories, the course also considers conceptions of the composing process, epistemological and psychological issues, and the influence of historical contexts in which arts of invention were developed. Prerequisites: graduate standing: seniors by permission of the instructor.

76-491/891**
Contemporary Rhetoric **9 units**
Rhetoric has reemerged in our time as a multifaceted and dynamic field of inquiry covering a wide range of pedagogical, hermeneutical and theoretical practices. Yet it remains a discipline in anxious search of its own identity. This course will focus attention on the self-defining of contemporary oratory, comparing different perspectives on its purpose, scope, functions, methods and conceptual ground, taking a close look at the way the interaction of these diverse views has contributed to the shaping of its problematics, and reflecting on the dialectic relationship between the new rhetoric and the prevalent cultural and discursive conditions, especially its relationship with the rhetorical tradition and with other disciplines of discourse studies.

76-492/892**
Major Figures in Rhetoric (Two mini-courses) **6 units**
A. Habermas
This mini-course aims at a critical assessment, from the perspective of contemporary rhetoric, of Habermas's theory of communicative action and his entire project of reconstructing rationality on the communicative basis. The interest of our investigation will be focused on how the Habermasian conception of communication and social action can best be appropriated and utilized in the forging of a new conceptual foundation for contemporary rhetoric.

B. Derrida
The purpose of this mini-course is to read Derrida as a rhetorician rather than a philosopher or critical theorist, and to find out the extent to which his texts are amenable to a rhetorical reinterpretation. Major topics for discussion include: difference and deconstructive invention, concept and metaphor, context as construct, and the ethics of argumentation.

76-496/896**
Metaphor **9 units**
No other concept in classical rhetoric has undergone greater vicissitudes than metaphor. One looked down upon as a mere stylistic device serving decorative purposes only, it has now occupied a central place in the conceptualization of symbolic production and is widely believed to be the mode of all creative acts, including those leading to large-scale paradigmatic changes in discursive practices. This course will conduct a historical survey of what has been said about metaphor (and tropes in general) by major theorists on the subject, from Aristotle down to Richards and Davidson. It will try to account for the shift in the conception of metaphor and formulation of radically different perspectives on it in modern time by identifying the discursive or institutional interests and exigencies that have rendered the change and diversification meaningful. The relationship between metaphor and invention will be a major theme of the discussion. Special attention will also be given to the parallel between the newly acquired importance of metaphor on the one hand and the revitalization and expansion of rhetoric on the other.

76-497/897**
Pagan Rhetoric and Christian Literature **9 units**
Much that was associated with higher education the Roman Empire was viewed as "pagan" by early Church Leaders. Yet, these same prominent Christian leaders also recognized the benefits and advantages of pagan systems of learning, particularly in the study of rhetoric. The need to speak and write eloquently was an undeniable advantage in spreading the "good news" of Christian doctrine. To do so, however, required a modification and an assimilation of classical rhetoric. This course discusses the debate about pagan rhetoric and Christian literature. Students are introduced to the principles of rhetoric as understood in the early Roman Empire and examine the argument and response to this phenomenon as reflected in various forms of literature and oratory. Out of this course, students will acquire an understanding of rhetoric, Christian literature, and the social forces that shaped both.
Note: this course is also listed as part of the College's Religious Studies minor.

76-498/898**
Rhetorical Criticism **9 units**
This course is intended to complement, but not duplicate, work in literary and cultural criticism by stressing the analysis of discourse in social contexts. Students both study and apply various methods of rhetorical criticism in the examination of non-fictive discourse, such as the analysis of various social and political arguments. Some of the critical methods that students will both study and apply include: neo-Aristotelian criticism, Burkean Criticism, generic criticism, feminist criticism, metaphoric criticism, cluster criticism, and narrative criticism.

76-501
Senior Seminar: Theory and Methodology **9 units**
In the last semester of their senior year, English majors can investigate a significant topic in linguistic, cultural, literary, or rhetorical theory or methodology. Topics vary from year to year. Open to senior English majors and, with special permission, senior students in CIT choosing English studies for their H&SS depth sequence.

Independent Studies

Students may petition the Department Head for permission to undertake study outside the regular curriculum of the department. The Department Head will consult as appropriate with individual members and committees of the Department. On approval, students may take up to a maximum of 18 units of independent study (does not include internships). Students must have at least one year's standing in the program (two years for undergraduates) before making such a petition.

Internships and Projects

76-301
Internship **3-18 units**
Internships offer students who have maintained a B average in writing courses practical experience in research, writing, tutoring, or editing. Internships may be arranged on and off campus in public relations, advertising, publishing, business, or instructional activities. Prerequisites: junior or senior standing and approval of the Head or Associate Head of English; students may receive no more than 27 units of internship credit.

76-306
Editing and Publishing **9 units**
In this course students work closely with the editors of Carnegie Mellon University Press to learn many of the facets of producing books and magazines. These range from business management to the elements of editing and book-production. Prerequisites: enrollment limited to students having permission of the instructor.

76-509/510
Senior Thesis **9 units**
An honors thesis may be written by senior English majors. Prerequisites: By invitation, seniors with a 3.25 QPA and a 3.5 average in major courses, and participation in the College's Honors Program.

76-511
Senior Project **9 units**
Senior creative writing majors may work on a book-length manuscript in fiction or poetry by permission of the Creative Writing faculty. Creative writing majors doing their own fiction or poetry as an honor's thesis should register for Senior Project.

History
Undergraduate Courses

79-104
Introduction to World History **Fall and Spring: 9 units**
This course focuses on two leading aspects of world history: the formation of major traditional civilizations with their distinctive features, and the reactions of each to the challenge of Western dominance/industrialization during the past two centuries. Emphasis will be on leading themes of world history, rather than a detailed chronological narrative. Eight principal civilizations or cultural traditions will provide the basic units for analysis.

79-106
Race & Gender in the Western Tradition **Fall and Spring: 9 units**
What are the historical roots to the racial and sexual attitudes that pervade our civilization? This course seeks to answer that question. Starting with examples of Western attitudes toward women and outsiders in the medieval period, the course will trace the evolution of Western thinking about women and non-European peoples from the age of discovery (16th and 17th Centuries) to the 19th Century, and then on to the present day. Guiding the discussion will be a concern to establish the social and cultural forces that shape attitudes, how these forces change, and how in turn these changes give rise to new attitudes.

79-110
Dynamics of Cultural Change **Fall and Spring: 9 units**
The goal of this course is to introduce students to the study of culture as something which evolves over time. The desire is that students acquire both new intellectual skills and some appreciation of the historical background to ongoing debates about culture in contemporary America. Two topics are considered and two approaches are used. First we look at the formation of middle-class culture and its dissemination in western society. Our approach is chronological, starting with the European Middle Ages and ending in 20th Century America. The second topic is socialization as a cultural phenomenon. This topic is approached from the comparative perspective, the discussion emerging from the analysis of the way women are socialized into gender roles in different cultures.

79-111
Cultural and Cross-Cultural Perspectives on Environment **Offered Intermittently: 9 units**
Concerns over environmental degradation and debates about the proper actions to take to repair the damage and to prevent further harm are widespread throughout the world. This course is organized around the theme of the importance of cultural assumptions as well as economic pressures in shaping society's practical relationship to nature. This theme is explored both as a contemporary issue and as a problem in comparative cultural history.

79-112
Race, Nationality and the Development of Cultures **Offered Intermittently: 9 units**
This course examine the interplay of race, ethnicity, and nationality in the development of the United States. We explore socioeconomic, demographic and political factors in the shaping of the life course. Finally, we evaluate the comparative role of these factors as the groups interacted over time in American society.

79-113
Culture and Identity in American Social Life **Offered Intermittently: 9 units**
What ideas, values, and ways of thinking do Americans share and how do we understand the diversity of American culture? This course addresses these questions in terms of the "politics of identity" that seem to pervade many aspects of social life in the contemporary United States. We begin our investigation by considering a number of anthropological approaches to cultural analysis and interpretation and then we use the insights that we gain from this investigation to critically examine how factors such as class, gender, race, ethnicity, religion, and occupation shape Americans' views of themselves and others. Readings include ethnographic and historical description of Americans of African, Asian, European, Mexican, and Native American descent.

79-114
Causal Models and Historical Explanation **Offered Intermittently: 9 units**
In this course students are introduced to major types of explanations which are used to account for social, economic and political developments, including rational choice theory, Marxist and other materialist models, functionalism and structuralism, and interpretation theory (which calls for the investigator to read society "like a novel"). Students apply an understanding of these modes of explanation to the historical literature on some broad topic. Students learn how to characterize the causal and explanatory models explicitly or implicitly advanced by the authors of assigned books and articles, and to specify clearly why they find the arguments convincing or deficient. Prerequisite: one semester of statistics.

79-115
Education and Inequality **Offered Intermittently: 9 units**
Many Americans believe that education is a force for equality in our society, allowing those with talent to rise to the top regardless of their background. But there is also considerable evidence that indicates that in the United States (as in most societies) those who do best in school turn out to be the people from advantaged backgrounds, and that the educational system is as much a mechanism for transmitting and justifying inequality as it is one for producing equality. Important research in social science has produced a quantitative analytical scheme, commonly known as the status-attainment-process model, for getting at the ways inequality is transmitted and is modified as individuals move through their lives. This course will examine education in contemporary America and in one or more other societies from the vantage point of this model, placing the findings into the context of such related aspects of social structure as family organization, fertility patterns, the nature of "skills," the labor market, and, of course, schools. Prerequisite: one semester of statistics.

79-116
Debates and Controversies: Cultural Differences in Action **9 units**
This course introduces students to differences and diversity by focusing on an important current debate in American society. In the Spring of 1995, for example, the topic will be reproductive rights and family policy. The approach will be anthropological, introducing students to theories of kinship, family, and gender. In addition, by focusing on a debate, the course will show how "culture" is created by individuals in particular historical, economic, and social contexts. Why do particular issues become public problems, framed and argued in certain ways and do not others? How do "dominant" debates reflect or suppress divergent points of view? What bearing do social hierarchies have on the expression of cultural ideologies? These questions, and others, can be linked to students' experiences in other courses and on the campus as a whole. Readings will include anthropological texts, personal statements (biographies, autobiographies), and fictional accounts. Films will also be shown.

79-198
Research Training: History **Fall and Spring: 9 units**
This course is part of a set of 100-level courses offered by H&SS departments as independent studies for second-semester freshmen, and first- or second-semester sophomores, in the College. In general, these courses are designed to give students some real research experience through work on a faculty project or lab in ways that might stimulate and nurture subsequent interest in research participation. Faculty and students devise a personal and regularized meeting and task schedule. Each Research Training course is worth 9 units, which generally means a minimum for students of about 9 work-hours per week. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as "elective" units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. Prerequisites/restrictions: For H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

79-200
Society and the Arts **Spring: 9 units**
Art never exists in a vacuum, but exactly how does the creation and enjoyment of art relate to the rest of a society's life? Some answers will be gained by applying a variety of interpretive methods to works of art in several forms.

79-201
Global Security and Science **Offered Intermittently: 9 units**
This course deals with the history of nuclear weapons policies from the building of the atomic bomb to present-day issues. A major emphasis will be on a set of critical decisions and how they were made. Among these decisions are those involving the building of the H-bomb, ABM and MIRV, and arms control. Students will be divided into small groups to prepare position papers on policy issues of current importance.

79-202
Introduction to Anthropology **Fall: 9 units**
This course will introduce students to key issues in anthropology, to some of the classics in anthropological literature and to anthropological methods. Primary attention will be given to approaches in cultural anthropology, but other approaches will also be discussed. The course will also address important tensions in anthropology, notably the problem of generalizing from case studies and the relationship between anthropological study of modern, urban societies and research on traditional cultures.

79-204
Collapse and Renewal of Europe **Fall or Spring: 9 units**
This course will cover aspects of Western European history from 1914 to the 1980s. Its themes are the roots of the profound crisis of democracy and civil society and the parallel rise of radical intolerance in Europe between 1918 and 1945 and the causes behind the success of democratic republics since World War II. We will consider the social and economic impact of the two World Wars, the extraordinary artistic vitality of the 1920s, and the reasons why some countries produced large and successful fascist movements while others did not. We will also discuss the rise of Communist parties and the crisis of democratic socialism. In the post-war era we will focus on European responses to revolts against colonialism, the "economic miracle" of the 1950s, anti-Communism, and student radicalism of the 1960s. Readings will include primary sources, novels, reportage , and scholarly monographs.

79-206
Chinese Culture and Society **Fall or Spring: 9 units**
Few courses provide an opportunity to look at a civilization as a whole. If we examine the Chinese quarter of humanity in this way, we can better understand the interplay of ecology and history, of class and community, and of self and

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society in China—and in any other society. We may also gain a new perspective on the West, whose peculiarities we too readily take as normal. This introductory course focuses on Chinese solutions to Chinese problems, as reflected in the words of the literate (e.g., philosophers and soldiers, dramatists and novelists) or in the actions of the unlettered (e.g., peasants, women and religious cultists). We proceed by making explicit their values and ours, setting up a kind of discourse across cultures. Special attention is paid to the 17th and 18th Centuries.

79-207
History of Africa **Fall or Spring: 9 units**
Civil war in Uganda, troubles in oil-rich Nigeria, Ethiopia becomes a test case for United Nations action. A history course cannot keep pace with the day-to-day events of the modern world, but a history course can provide the background to understanding these events. In this course we will study the history of Africa in the colonial and independence periods, concentrating on the legacies those periods bequeathed to contemporary Africa. Readings for the course will come from literary, historical and journalistic sources.

79-208
History of South Africa **Offered Intermittently: 9 units**
South Africa stands today as a nation divided not only by race, but also by culture and language. The roots of these confrontations go back to the Seventeenth Century. In this course, we will trace the evolution of the ideas of social and cultural separatism as they developed over the course of South African history. First, our focus will be on the initial struggles between Africans and Afrikaners. Second, we will consider the impact of the arrival of the British on Afrikaner culture. Third, we will look at the Afrikaner triumph and the evolution of the doctrine of apartheid. Lastly, as we look at the contemporary situation, we will return to the theme of the struggles between Africans and Afrikaners for cultural and economic space.

79-209
City and Technology **Offered Intermittently: 9 units**
The modern city is the product of the interaction of technological and social forces. This course will focus on the interaction of technology and the urban environment in American cities in the 19th and 20th Centuries. It will examine the transition from the pedestrian city to the networked city to the post-industrial city of today. Among the topics to be considered are transportation innovation and its spatial effects; the formation of water and sewer networks; the evolution of the built environment; changing industrial patterns; the development of communications technologies; and energy shifts. This is a lecture/discussion course with a required research paper.

79-210
Women in Japan **Offered Intermittently: 9 units**
Through readings, films, discussion and lecture we will uncover the roles women have played in Japanese history. For comparative purposes, we will begin with a brief survey of women during the "feudal" era, 1600-1868; however, our primary emphasis will be on the modern period, 1868 to the present. Themes to be explored in this introductory study will include the role of the state in the social construction of Japanese women's lives; women in rebellion against social constraint and the state, women's sense of self and family, the development of a feminist consciousness, political and social activism before and after World War II, women's role in Japan's industrial "miracle"; women's creative expression. Our texts will include autobiography, fiction written by women about women, anthropological field studies, and articles by Japanese and American historians.

79-211
Festivals & Ceremonies **Offered Intermittently: 9 units**
This course blends the work of cultural anthropologists and historians in examining festivals and ceremonies as metaphors, mini-dramas, and sets of relationships that are tied to broader moral and social systems. By reading these "metaphorical" acts, we will try to unravel what a culture, what a society "is really all about." Specifically, we will be interested in trying to understand power relationships, social and political consciousness, economic "morality," and cultural expressions. The course will strive for an interdisciplinary approach and a cross-cultural perspective. We will consider festivals and ceremonies like carnivals, but also the royal processionals of early modern Europe, civic festivals of unity and purification, execution ceremonials, etc. and our discussion will range from royal spectacles and pageantry in modern Britain to 4th of July celebrations in the U.S., to the rites of charismatic kingship in Morocco and Java.

79-212
History of Modern Science **Offered Intermittently: 9 units**
What is the scientific outlook; what have been its applications and results; and how has it become the predominant, even characteristic, analytic approach in "Western" culture? This course surveys the origins, development, achievements, and influences of modern natural science. We will concentrate on major philosophical, methodological, and organizational features in the history of the physical and biological sciences from the Renaissance to the late 19th Century. Lecture, discussion, directed readings in secondary sources, exposure to primary sources (including copies of contemporary editions), and individually selected research and writing assignments.

79-213
Sociology as History **Spring: 9 units**
Students will investigate the intersection of the disciplines of sociology and history through readings and intensive class discussion. These will acquaint students with the history of the goals of the profession of sociology, the place of social change within its concerns, and how sociological materials may become the stuff of social historical analysis. Special topics include industrialization, race, social class, family, consumption, occupation, and crime. Readings include mainly case studies written over a century dealing with such topics as race, gender, the professions, wealth and poverty, and crime. Student writing will focus on the relationship of empirical investigation to chains of knowledge.

79-214
Modern Japan, 1868 To The Present **Fall or Spring: 9 units**
Japan as No. 1? Taking a historical look at Japan's rise to its present position of virtual world dominance in modern technology and foreign trade, this course presents a variety of perspectives on Japan—Japanese as well as foreign—paying chief attention to the political institutions and the distinctive cultural forms that have contributed to economic success. We shall not neglect the darker side of Japanese society, or the difficulties that have beset the Japanese in relations with the United States and other powers.

79-215
Dynamics of European Society **Fall: 9 units**
Dynamics of European Society concentrates on the major developments in the social, economic, and cultural history of Western Europe in the period from the French Revolution to the late Nineteenth Century. It focuses on the causes and consequences of two great revolutions, the French and the Industrial, while tracing key commonalities and differences in the evolution of English, French and German societies.

79-216
The Nature, Art, and
Science of Engineering in History **Fall or Spring: 9 units**
This is a lecture and discussion course designed for engineering students and students with a general interest in engineering innovation. No technical expertise is required, only a desire to explore the nature of engineering and its grand successes and spectacular failures. Historical case studies, such as the design and construction of the Brooklyn Bridge, the invention of the telephone, the collapse of the Tacoma Narrows Bridge, the development of the digital computer, and the Challenger disaster, provide the means for probing the perennial themes in engineering and the role of art, science, skill, imagination, and ambition in this human endeavor.

79-217
Great Ideas in the West and East **Offered Intermittently: 9 units**
What have men and women thought about their inner being, about the purposes of their lives, and about the nature of the world and the universe in which they exist? This course will explore the ways in which thinkers from ancient times to the present have addressed these issues.

79-218
Twentieth-Century America **Fall or Spring: 9 units**
This course will examine the history of the United States from World War I to the 1990s with emphasis on how economic, political and social changes during this time shaped the conditions, attitudes and values of present-day America. Subjects to be discussed in readings and in class will include the Great Depression, Franklin Roosevelt's "New Deal," World War II, the "Cold" War, the Civil Rights movement, the Vietnam war, Lyndon Johnson's "Great Society," the student protest or "counter-culture" movements and the rise of the New Right.

79-219
Picturing Others:
A Course on Ethnographic Film **Offered Intermittently: 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 will examine ethnographic films as descriptions of unfamiliar (and sometimes familiar) others. We will discuss the ways films interpret and portray material, examine the significance of changing techniques, and confront the problem of point of view. We will also evaluate the use of visual media for social analysis in general. Students will 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).

79-220
Contemporary America In Film **Offered Intermittently: 9 units**
This course makes use of feature films from the 1940s through the 1980s to explore key themes in recent American history. Among these themes are social mobility and social classes, the expansion of a consumer society, the images and realities of youth and the family and changing gender relationships. Emphasis is placed on what the films reveal about the social and cultural values of Americans, both past and present. Films used previously in the course have included The Best Years of Our Lives (1946), Rebel Without a Cause (1955), Medium Cool (1968), Shampoo (1975) and Lost in America (1985). There also are a number of required readings dealing with recent American History . Students will write approximately four essays on the films and readings.

79-221
A History of American Urban Life **Offered Intermittently: 9 units**
This course examines the development of urban America from the industrial city of the late 19th Century through the emerging post-industrial city of recent times. The course will analyze major economic, technological, demographic, political and social transformations in American urban life, with particular emphasis on questions of class, ethnicity, race and gender.

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79-222
Topics in American Business
History: History of Advertising **Offered Intermittently: 9 units**
Early in this century American advertising urged us to "reach for a Lucky (cigarette) instead of a sweet," then to "ask the man who owns one" (A Packard automobile), and more recently to "reach out and touch someone" with an AT&T phone call and to drink "the real thing" in the form of a Coca-Cola. What have such messages and the sounds and images accompanying them meant to the economy, society and culture? How did advertising become so important? Has it helped or hurt competition in the economy? How and when does it really sell products? Has it threatened or debased our morals, ethics and taste, or has it, in fact, enriched our society's stock of language, ideas and practices? What kinds of controls are needed? These and other issues will be explored through readings, graphic materials, and films as sources.

79-223
Modern Latin America **Fall or Spring: 9 units**
This course is an introduction to some of the most important issues in Latin American history from independence to the present. While also providing a general political chronology, the primary focus is on how historical forces transformed the lives of Latin Americans in the Nineteenth and Twentieth Centuries. A large portion of the course is dedicated to examining the life stories of ordinary people and certain members of the elites. The format consists of a combination of lectures and discussions; substantial reading will be required.

79-224
Technology and Values **Offered Intermittently: 9 units**
The purpose of this course is to consider the various cultural characteristics (values, beliefs, social arrangements) that encourage or discourage technological innovation and change. The course will also explore the effects of technology upon particular cultures.

79-225
Riots, Revolts and Revolutions **Offered Intermittently: 9 units**
This course will explore pivotal episodes in the past when ordinary people rebelled against established authority and in the process helped to shape the political culture of their societies. From the storming of the Bastille to the sit-down strikes of the 1930s, citizens have frequently stepped outside the usual political channels to defend themselves or advance a cause. This course will examine why people rebelled and what the consequences have been.

79-226
Technology in Western Civilization **Fall or Spring: 9 units**
This course will examine two interrelated themes: the relationship between scientific and technological progress, and the economic and social consequences of scientific and technological change. Emphasis will be placed upon the social relations of science—the values and resources upon which it depends—and on the economic and organizational implications of technology, rather than upon theoretical or hardware content.

79-227
Recent American Foreign Policy **Offered Intermittently: 9 units**
This course will focus on the major events in American foreign policy in the recent post World War II era. A general historical overview of the United States' foreign relations since 1945 will be presented. Issues concerning U.S. containment of the Soviet Union, arms control and war, and revolution in the developing world will be examined.

79-228
Religion and Society: The European Experience **Fall or Spring: 9 units**
In the Sixteenth and Seventeenth Centuries Europe underwent continuous religious upheaval. This course provides an introduction to the major events of the Reformation and Counter-Reformation and an assessment of the impact of these movements on the development of modern Christian life and values. The class will be presented in the discussion format, centered around the reading of contemporary texts such as the autobiography of St. Teresa of Avila and Bunyan's Pilgrim's Progress.

79-229
Religion and Society: The American Experience **Fall or Spring: 9 units**
Opinion polls taken from the 1940s through the 1980s report annually that over 90 percent of Americans believe in God. Our earliest institutions, when they were not churches themselves, reflected a strong religious influence. Americans have felt religious competition so keenly in various times in our history that they have rioted in support of one denomination over another. Why was (is) this so? How have Americans experienced, thought about, and manifested their various religious beliefs throughout our history, and how have Americans interacted with fellow citizens of differing beliefs? How has religion influenced the development of our current institutions, and why do Americans believe what they do? This course examines these and other issues connected to American religious development.

79-230
Population and History **Fall or Spring: 9 units**
Population and History introduces students to some of the basic methods of population analysis and to the history of human populations over the long-term, based on the work of Malthus. Using examples mainly from the European past, we study how population has been regulated by biological, social-economic and cultural influences. We also trace the importance of population policy using case studies from both the past and present. By the end of the course, we place what we have learned into perspective by comparing past trends with those now occurring in the developed and developing world.

79-231
Russian History from the First to the Last Tsar **Fall or Spring: 9 units**
This course covers a broad sweep of Russian history beginning with the first settlements of tribal nomads in the Ninth Century and ending with the fall of the 300-year-old Romanov dynasty in 1917. In our study of Russian colonization and state formation, we will make the acquaintance of Mongol marauders, greedy princes, and peasant rebels, as well as Ivan the Terrible, Peter the Great, and the long succession of genetically-inbred lunatics and idiots who occupied the Russian throne. We will explore the development of a working class, and the uprising of workers, peasants, and soldiers that ultimately brought down the Tsar.

79-232 **[mini-course]**
The Roles of Men in the Modern World **Spring: 6 units**
Men have undergone unusual stress in modern history. Being a father, for example, has moved from trainer-moralist, to provider, to...what? This course will deal with men's situation and self perception in such areas as work, emotion, sex, medical care and family life. The basic theme is the American image of masculinity in contact with the forces of modern society, and the ways contemporary men define their roles.

79-233 **[mini-course]**
The Making of the Modern Family **Fall or Spring: 6 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 diverse 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.

79-234
The Development of the Modern Mind **Offered Intermittently: 9 units**
This course examines the historical development of significant themes in modern thought, such as the glorification of emotion, the exaltation of reason, transformations in ideas about religion and nature, the elevation of artists and rebels as models for conduct. The reading consists of the actual works of important thinkers, not textbook summaries.

79-235 **[mini-course]**
Sex and Death **Offered Intermittently: 6/9 units**
This course will focus on basic human problems as they have evolved in the modern era, literally from cradle to grave. Why and how people had sex and how this changed as society became more modern; the development of birth control, which increasingly separated sex from childbirth (and death); and outlooks and practices toward disease and death will be the major topics. Basic questions include what sexual revolutions are about; how growing sexual conservatism today relates to the past; and whether we need to liberate death now that (maybe) we have figured sex out. Materials will be drawn from various countries, from the beginning of the modern era (about 1750) to the present, and from various kinds of reading and discussion.

79-236 **[mini-course]**
Work and Leisure **Offered Intermittently: 6/9 units**
This course focuses on current issues in work and leisure and how we got this way. The course will begin with a discussion of the traditional work ethic and a consideration of what people did with their spare time in the absence of a distinct leisure ethic. The course's principal focus will be on how both these aspects of people's lives changed and became modern and whether life got better or worse in the process. The classic middle-class work ethic will be sketched, along with divergent reactions depending on class, gender and age. We will also deal with the rise of a new leisure spirit, and how adequate it is, and on the problem of defining contemporary work values. Emphasis rests on leading interpretive issues and links to today's concerns.

79-237
The Psychological Interpretation of History **Offered Intermittently: 9 units**
How can historians use psychology in the solution of historical problems? Students will work on problems drawn both from the far past and from the yesterdays of personal experience. They will gain knowledge from various fields of psychology as they need it to tackle these problems.

79-238
Early Christianity **Offered Intermittently: 9 units**
In this course we examine the origins of Christianity. Although we deal with biblical, as well as other contemporary, materials, the approach is not theological but historical. We want to understand how and why Christianity assumed the form that it did by examining its background in the Jewish community of Palestine, its place in the classical world, its relationship to other mystery religions of the time and certain variant forms (now known as Gnosticism) which it assumed prior to the crystallization of orthodoxy.

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79-239
Child Welfare and Social Reform **Fall: 9 units**
Focusing equally on ideology and policy, this course will integrate the perspectives of social history and policy history in addressing such topics as: child care; children's health; child and family poverty; child abuse; juvenile employment and leisure; juvenile justice; adoption and foster care; and children's television. Class sessions will center on discussions of assigned historical and social science readings.

79-240
Development of American Society **Fall or Spring: 9 units**
This course is an introduction to American cultural and social history. It is not a survey of American history. Rather, it deals with selected themes: how Americans have defined their basic social-cultural values; the struggle among various groups to place these values into operation, and the impact of broader social forces, such as industrialization, on American values.

79-241
Crime and Punishment in American Society **Fall or Spring: 9 units**
This course offers an introduction to the historical study of crime in the United States, and highlights the different ways Americans have sought to deter, punish, and rehabilitate. Primary topics include the evolution of prisons for adults and juveniles, changing philosophies of punishment, and the role and organization of the police. Why and when did we turn to this system as our means of dealing with crime? The course will also take an in-depth look at the history of illegal drug use and drug law enforcement policies. Discussions of historical developments in the "war on drugs" will be linked to present day policy concerns.

79-242
Comparative Issues in U.S. &
Latin American History **Fall or Spring: 9 units**
This course examines some of the important issues in the history of the Western Hemisphere from a comparative perspective, which will aid in developing a deeper understanding of North American and Latin American societies. The course is designed around a number of questions, including the following: How did slavery differ between the pre-Civil War South and Brazil and what impact has this had on present-day race relations? How and why do relations between men and women differ in Argentina and the United States? Other issues which the course will address in a comparative focus are the insertion of each region into the world economy, migration patterns and frontier expansion. The course, in addition to written work, will include discussion based on readings and lectures, with emphasis on discussion.

79-243
Issues in American History **Offered intermittently: 9 units**
This course will examine certain issues, both important and long-lasting, that grew out of forces or circumstances that shaped American history. Such questions will include many of the following: how people treated the physical environment, and why; how people reacted to growing ethnic and racial diversity; what produced and what came out of economic growth and development; how free and how constrained individuals were by political, social, and economic institutions; how people treated differences in gender or age; what were considered norms for family life; what, in practical terms, constituted "communities"; and how power was distributed within society, and why. Some systematic comparisons with the experiences of other societies will be made.

79-245
Survey of Soviet History: from Lenin to Gorbachev **Fall or Spring: 9 units**
This course covers a broad sweep of Soviet history from the revolution in 1917 to the turmoil of the present. Spanning more than seventy years of upheaval and transformation, the course will examine 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 at political and economic reform in the 1970s and 1980s. The course will provide essential background for anyone interested in understanding the explosive, history-making events in the former Soviet Union.

79-247
History of the American Landscape **Fall or Spring: 9 units**
The pleasing and not-so-pleasing scenes we see from our car windows every day are the result of a complex history involving the interaction of many people with the natural environment. This course explores such interaction beginning with the way Indian peoples thought of and dealt with the land, through the "New World" vision of European settlers, and into the regional variations in settlement patterns during the Eighteenth and Nineteenth Centuries. The remainder of the course concentrates on an examination of the way the American landscape has been shaped by urban-industrial development and the demands of our suburban oriented, consumption-driven society. The course makes heavy use of visuals including slides, photographs and films, as well as readings drawn from autobiographies, journalistic accounts and scholarly studies.

79-248
America in Film: the 1940s-1960s **Offered intermittently: 9 units**
This course investigates the home front during World War Two and the subsequent event-filled decades that saw the emergence of what one social critic labeled the Affluent Society. Our emphasis will be on the complex web of beliefs and realities involved in the search for stability and order that dominated the 1940s, the concern over social mobility and a developing youth culture of central interest in the 1950s, and the changing relationship between men and women that had emerged by the mid-1960s. Course materials include fourteen feature films, a number of documentary films, lectures, and readings.

79-249
Power and Rights:
The American Constitution **Offered intermittently: 9 units**
The Constitution has taken its place as one of the most remarkable instruments of government in history. But it has been neither a monolithic monument nor an untouchable text. It emerged from struggle, survived through compromise. Contests over what it meant have ranged from arguing the shape of the nation (with civil war as an outcome) to deciding the rights of the individual in society (with the right to kill or to escape killing, as two examples). The course explores both the creation of the Constitution and the most crucial issues that have arisen in its history. It will use readings, films, written critiques, discussions and improvised court actions to discover the nature of controversies and the logic of choices that have kept the Constitution a living body of law.

79-250
Introduction to History and Policy **Fall: 9 units**
This course is required for majors in history and policy and is usually taken in the first semester of the junior year, although other students may enroll with the instructor's permission. Our purpose is to explore the ways in which historical methods and perspectives can illuminate contemporary policy issues and aid in decision making, on topics ranging from social welfare to foreign policy. Readings should be stimulating and class discussions lively.

79-251
Introduction to Social History **Fall: 9 units**
This seminar, designed for new history majors, provides a survey of the types and varieties of social history, with a focus on methodological considerations, i.e., how social history is researched and presented. Most of the texts will be either on U.S. or European history, but some attention will be given to African, Asian and Latin American history and interdisciplinary perspectives. The course will follow a discussion format.

79-252
The American Presidency **Offered intermittently: 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: How 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, use it, and perhaps lose it? In producing Presidential effectiveness, how crucial have individual character and personality been?

79-253
Development of the American Economy **Offered intermittently: 9 units**
This course focuses on key issues in the development of the American economy; the industrialization process; the rise of a consumer society and the institutions that supported it; the growing economic involvement of the state; and the position of the United States in the world economy.

79-254
Professions in Society **Offered intermittently: 9 units**
It is not hard to understand the appeal of the professions. Those who enter have many privileges. Among the most highly valued are status, income and the ability to shape the conditions and responsibilities of work. In return for these privileges, which set the professions apart from other occupations, members of the professions are expected to perform certain services for society and to conduct themselves in ethical and socially approved ways. One of our tasks will be to understand why so many occupations aspire to professional status and why attainment of this status is often not possible. A second focus will be the obligations of the professional. Finally, we will explore the likely future of the professions. Readings will be chosen from sociology, history and the knowledge domains of the professions.

79-255 **(mini course)**
Marriage, Divorce and Family **Offered intermittently: 6 units**
This course deals with issues of the contemporary American family. We examine the larger forces that hold the family together as well as the pressures that encourage its disintegration. Focusing on white and black working class families, we examine relations within the family—between parents and children, husbands and wives— and family relations with the outside world. We examine changing attitudes toward divorce, individual fulfillment, gender roles, and sexuality over the past forty years in an attempt to define the present and future prospects of the American family.

79-256
History of the Pittsburgh Region **Offered intermittently: 9 units**
This course examines the Pittsburgh region from its frontier origins, through its rise to America's industrial center in the 1890s, to the present period of adaptation to new social-technological realities. The class will emphasize the impact of the region's commercial/industrial development on the landscape, on class and ethnic relationships, and on work, recreational and family experiences during the last hundred years. We will make use of both visual (photographs, films) as well as written materials. In addition, we will carry out several field experiences using the Pittsburgh region as our "laboratory."

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79-257
African-American History I **Fall: 9 units**
This course examines a series of topics—economic, demographic, social, cultural and political—in African-American history from the slavery background to the present. The evolution of race relations is an important component of the course, but the major emphasis will be placed on the internal experiences of black people within the framework of larger socioeconomic and political processes in U.S. history. Although the course will include a general text, assigned readings will revolve around detailed studies of particular topics (e.g., work, family, and religion) or chronological periods (e.g., the colonial, revolutionary, and antebellum eras).

79-258
African-American History II **Spring: 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 will be placed on the internal experiences of black people, within the framework of larger socioeconomic and political processes in U.S. history. Although the course will include a general text, assigned readings will revolve around detailed studies of particular topics (e.g., work, family, and religion) or chronological periods (e.g., the Great Migration, the Great Depression, World War II, and the Civil Rights Era).

79-259
Europe after the Black Death **Offered Intermittently: 9 units**
The Black Death that ravaged Europe in 1347-50 was a watershed in history. This course is devoted to exploring early modern European society between 1350 and 1750. Special attention will be given to social and economic factors, to questions of mentalities, to forms of belief, and to cultural change. Some specific topics that will be covered include: the Renaissance and Reformation in their socioeconomic contexts; the decline of magic and the "rise" of religion; riot, revolts, and revolutions; changes in mortality and life expectancy; and the sources of crisis and stability in the early modern world.

79-260
Crime and Justice in Film **Fall or Spring: 6/9 units**
How have American films dealt with crime? What does Hollywood's treatment of crime tell us about American culture and society? How do the realities of crime and criminal justice systems differ from the film versions? Films have labeled murder, gambling, prostitution and fraud as immoral and/or criminal, but such film interpretations have differed widely over the past fifty years. We will explore these interpretations as an aspect of cultural history, linking them to changes in American society. This course will use documentary and feature length films as well as a wide range of readings in dealing with these related issues.

79-262
Women in the Western Tradition **Fall or Spring: 9 units**
This course will examine topics in women's history from the medieval to modern eras in Western Europe and the U. S. We will consider 1) women's changing self-perception as reflected in their behavior and writings; 2) men's perceptions of women as reflected in law and in literature, philosophy, and psychology; 3) women's roles in society and in the family. We will read a variety of sources: the writings of intellectuals such as Virginia Woolf and Sigmund Freud; diary excerpts of everyday women and men; scholarly articles about gender relations. The course will reach back into the Middle Ages and toward our time, but its focus will be on the 18th through early 20th Centuries.

79-263
Women in American History **Offered Intermittently: 9 units**
The course explores the history of women in America since the mid-Eighteenth Century. Although the main emphasis is on the experience of ordinary women, the rise and significance of feminism is also explored. Students are encouraged to think and write about themselves and their families in an effort to understand the impact of history on their own lives.

79-264
Gender Roles and Social Change **Fall or Spring: 9 units**
This course examines women's and men's roles, behaviors, and beliefs in a variety of societies, including our own. We will use an anthropological perspective to examine the relationships between gender and the distribution of power, ideologies and practices that incorporate a notion of "female" and "male" as well as other pertinent issues. The course will be comparative; the texts will be anthropological. Students will be responsible for learning theories and methods of anthropology, as well as familiarizing themselves with the societies/problems we focus on.

79-265
Immigration & Ethnicity in American History **Fall or Spring: 9 units**
The focus of this course is twofold: we will examine how historians analyze the past and what contributions have been made to understand the social process of immigration and the intellectual and social construction of ethnicity in American society. The intent of the course will be to illuminate how the immigration process has profoundly shaped American intellectual, social and cultural history from roughly 1870-1940.

79-266
Patterns in American Thought **Fall or Spring: 9 units**
This course explores developments in American thought and values, with an emphasis on the later 19th and 20th Centuries. Our emphasis is on the history of ideas, but we are also concerned with the relationship of ideas to the social situation of the time. One important area of concern is the way Americans have developed the idea of individualism, especially in its relationship to perceived demands of society. We use a variety of sources including scholarly interpretations, novels, autobiographies, poetry, and films.

79-271
Medicine and Society **Offered Intermittently: 9 units**
This course will focus on the relationship between medicine and society in the modern world. The emphasis will be 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 will 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 enmeshment of medicine in broader historical webs 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.

79-272
Industrial America, 1880-1945 **Fall or Spring: 9 units**
This course examines the transformation of America from an agrarian to an urban industrial society. It analyzes the major economic, demographic, political, and social consequences of industrialization with emphasis on conditions of race, class and gender as well as the impact of industrialization on the declining agricultural sector, the emergence of new middle and working classes, and the development of the welfare state.

79-273
Family and Population **Fall or Spring: 9 units**
This course will deal with major phases in the modern history of the family in Western Europe and the United States, and with corresponding stages in population behavior (birth and death rates, age structure). Changes in the functions and emotional relationships in the family will receive primary attention, as these relate to decisions about birth rates and the roles of family members. The past two centuries have seen major changes in the purpose of the family, as well as a host of new concerns about where the family is headed, and this course will trace these issues through historical perspective.

79-274
War and American Culture **Offered Intermittently: 9 units**
This course attempts to provide some answer s to the following sets of questions: What values do Americans carry with them in military service? How do those values influence the ways in which the nation and individual representatives (i.e. soldiers) fight? How do American attitudes towards government, technology, race, gender and ethnicity affect American preparation for and performance during wartime? Does the experience of war cause any changes in the American concerned with tactics, grand strategy or the careers of famous generals? Issues selected for examination are chosen for their potential in helping answer these questions.

79-275
History of Modern Warfare **Offered Intermittently: 9 units**
Broadly conceived, this course examines the role of war in society and history. 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 central are military leadership and the will to combat, both military and civilian. After an introduction to pre-modern warfare and to the initial development of modern armies in the Sixteenth and Seventeenth Centuries, interest will focus on the major conflicts of the Nineteenth and Twentieth Centuries, including the Napoleonic wars and the two World Wars.

79-276
Modern China **Fall or Spring: 9 units**
This is a survey of the century-long period of revolutionary change that culminated with the accession of the Communists to power in 1949. We shall examine three large themes: the strengths and weaknesses of the old order in and after the Opium Wars, the transplantation of foreign ideologies like nationalism, liberalism and communism into China, and the effort to create new national institutions as well as social movements at the grass-roots level. By using memoirs and analysis by Chinese and recent Western studies, the course should convey a sense of how life was lived in this violent period of transition, as well as why the Communists won. Lecture and discussion.

79-277
China Today **Offered Intermittently: 9 units**
Following a brief overview of China's history prior to 1949, this course will then focus on leadership techniques during the first decade of Communist control. We will also analyze the principal economic, social and intellectual policies of the new People's Republic of China. An understanding of the Cultural Revolution, 1966-1976, will be a major objective of the course. Why did Mao Zedong initiate this far-reaching movement? To what extent were its goals consistent with Marxist-Leninist ideology and/or Maoism? The last third of the course will concentrate on the pragmatic leadership of Deng Ziaoping, approximately 1978 to the present. We will analyze the latest scholarly reports concerning the changing living standards, the impact of capitalistic policies on China's economy, as well as he fluctuating climate for intellectual freedom. In addition to social science studies we will use eye-witness accounts of rural reform and the Cultural Revolution.

Course Descriptions

79-278 (mini course)
Gauchos and Indians in Latin America **Offered Intermittently: 6 units**
This course compares and contrasts the lives of the gauchos, or cowboys, of the Argentine pampas with the lives of the Indians ensconced in the high Andes. The Indians were able to maintain much of their culture well into the 20th Century, whereas the gauchos of Argentina have disappeared into legend. The course will examine why these different outcomes occurred and, in the process, show some of the diversity and cultural richness of Latin American rural society.

79-279
Origins of Conflict in Central America **Offered Intermittently: 9 units**
This course places the current political turmoil in Central America in its historical context. The main objective will be to evaluate the internal and external forces that have shaped Central American society and given rise to the present conflict. Particular emphasis will be given to the issues of economic development, the role of multinational companies, political culture and foreign intervention.

79-281
Irish History **Offered Intermittently: 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 will be to understand the sources of conflict in modern Ireland. In order to do that, however, we shall be looking 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.

79-282
East Asians in Film **Offered Intermittently: 9 units**
The 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 will be seen in relationship to the Confucian ethic, and under pressure of war, rapid economic change, crime and revolution. We shall also ask how East Asian filmmakers have made use of their medium and how political and other conditions have affected their work.

79-283
Foreign Policy Issues
in the Middle East **Offered Intermittently: 9 units**
Much in the news and of great concern to policy makers everywhere, the Middle East is a complex and daunting area. This course studies U.S. foreign policy towards the region and will consider several specific cases of American involvement in the Middle East. Attention is not confined to the American perspective, however. This course will sort out the Middle East players and examine their political behavior in light of broader historical and contemporary motivations and objectives. Readings and discussion will progress with a dual goal in mind: to understand American foreign policy interests and approaches in the Middle East, and to understand the historical forces and nuances endemic to the Middle East itself.

79-284
American Environmental History:
Critical Issues **Offered Intermittently: 9 units**
This course will explore critical issues in the history of the American environment during the last three centuries. Among the specific topics to be covered are changing attitudes towards 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. The class will follow a lecture/discussion format and will require a research paper.

79-285
Europe in International Affairs **Offered Intermittently: 9 units**
This course will examine the evolution of the United States relations with Europe during the Twentieth Century, both as a means of understanding the present American-European relationship and evaluating the prospects for change. Discussions of America's intervention in the First and Second World Wars will focus on the United States motives for intervention, and on the agreements and disagreements on war aims between the United States and its European allies. We will then see how the Cold War led to a much closer alliance between Europe and the United States, while paying close attention to how the alliance has changed and how it may continue to change. Important issues that will run through the course include the nature and influence of the economic relationship between the United States and Europe; the role of American domestic politics; and the clash of American and European interests in other parts of the world.

79-287
History of American Sports **Offered Intermittently: 6/9 units**
This course provides an introduction to the study of the business and the purpose of American sports from the early 19th Century to the present. After an introduction which briefly outlines the importation of European sports to America, the course will focus on the 19th-20th Centuries. We will examine how sports became the big business it is today through the study of sporting professionals. We will examine a variety of sports groups which fought to gain legitimacy both as professions and as businesses. We will also examine how the purpose of sports shifted from amateur play to professional activity and the rise of the governing bodies for both amateurs and professionals. Sources will include historical works, literary texts, and video presentations. Themes for the course, in addition to business, will be class, race, gender, and sexuality as expressed in a sporting life.

79-288 [mini-course]
The American West in Film **Offered Intermittently: 6 units**
Most of us think we know as much about the American West as we know about our hometowns. We know the West, however, largely from movies, television and novels. The West as myth, the West as a symbol of innocence, ambition and violence, has had a forceful grip on Americans for many years. This course will explore both the myths and the realities of the West, with emphasis on the late 19th and 20th Centuries. Representative films include The Virginian (1929), Red River (1948), and The Wild Bunch (1969). The course also includes documentary films and a wide range of contemporary and interpretive readings.

79-289
The 1920's & 30's in Film **Offered Intermittently: 9 units**
This course will concentrate on the way films over more than seventy years have depicted and interpreted the 1920s and 1930s, one of the most turbulent eras of American history. The era was an important one in the history of film (sound arrived in the middle of the period), and films were a major source of information and entertainment for a people racked by insecurity. We will explore the meaning of the society and culture of America through feature films, documentary films, lectures and allied readings.

79-290 [mini-course]
Family Law and Social Policy **Offered Intermittently: 6 units**
This course will focus on a variety of policies and legal practices that regulate marriage and divorce in American society. Changing ideas concerning such matters as division of marital property, spousal support, child custody, and child support will be examined from the dual perspectives of history and contemporary public policy. In addition, the course will introduce students to several other contentious areas in the current practice of family law, including adoption, the determination of paternity, and spousal abuse.

79-291
Vietnam: America's Lost War **Offered Intermittently: 6/9 units**
No event has had more effect on recent American history than the Vietnam War. The war began as an attempt to fulfill the United States' cold war mission: to save the "free nation" of South Vietnam from Communism. Within a few years it provoked enormous domestic protest, led to widespread resistance to and evasion of the draft and called the whole basis of our foreign policy into question. The war ended with the withdrawal of American troops in 1973 and the collapse of South Vietnam in 1975, but since then there has been no agreement on the "lessons" we should draw from the conflict.

79-292
Modern Germany
Offered Intermittently: 9 units
The role of Germany in history has been hotly debated but its significance is undeniable. This course will concentrate on Germany after the second World War but it will highlight in several sessions the salient features that contributed to Modern Germany—the tribal system, the medieval Empire, the Reformation, the rise of Prussia, the Nineteenth Century struggle between nationalism and liberalism culminating in the Bismarckian Reich, and finally, the rise to power of National Socialism. Succeeding sessions will deal with the creation of the German Federal Republic and examine its economic, social and cultural life. The course will conclude with a comparison of the two Germanies, West and East. The objective is to bring students a fuller understanding of the Germans than that provided by the media. Films and recordings will be included.

79-293
World War Two and the Cold War in Film **Offered Intermittently: 9 units**
World War Two ended in 1945, but people throughout the world are still trying to understand its meaning and cope with its consequences. The war reshaped the world's politics, economics, and cultures. Out of that reshaping came a 45 year period we call the Cold War, an era heavily influenced by rivalry between the Soviet Union and the United States. This course explores how world filmmakers since 1945 have depicted the social, cultural and military aspects of both World War Two and the Cold War. Sources include feature films and documentary films, as well as lectures and readings designed to place the films within their broader historical context.

79-294
Cultures of the Pacific **Offered Intermittently: 9 units**
This course will examine the peoples and cultures of the Pacific region. Focusing specifically on Polynesia, Melanesia and Micronesia, we will address historic and contemporary issues in the area such as peopling, colonization, and independence movements as well as major anthropological issues such as the ways in which Pacific people gain their livelihood, organize ideas about family and kinship and construct their social and spiritual worlds. Special attention will be given to the impact Pacific ethnography has had on anthropological theory in general.

79-295
Witchcraft and Dissent in the Middle Ages **Offered Intermittently: 9 units**
In the late medieval and early modern periods, Christian society in Europe felt itself threatened on all sides. Everywhere witches, heretics and dissidents were challenging the established traditions. It responded to these threats by the creation of the Inquisition and other repressive measures. This course surveys the different types of social and religious protests which developed in the medieval and early modern periods, and the means by which established society sought to cope with them.

Course Descriptions

80-221/621
Philosophy of Social Science **Alternate years (Fall): 9 units**
The course is about social norms. We look at sociological, psychological, and economic accounts of norms. We analyze how norms spontaneously emerge and evolve, and what makes people abide by them. We will use mathematical models to depict the emergence and evolution of norms, as well as to model what makes norms stable/unstable. Finally, we will contrast the predictions of formal models (in particular, game-theoretic ones) with the results of experimental studies.

80-222/622
Philosophy of Economics **Offered intermittently: 9 units**
Economists and philosophers have common interests in economic methodology, in theories of rational decision-making, and in theories of social or distributive justice. This course will explore problems in each of these three areas with a special emphasis on understanding the goals, structure, heuristics, and justification of standard neoclassical theory.

80-230
Ethical Theory **Spring: 9 units**
Ethics concerns the norms and principles by which we try to lead fulfilling and responsible lives, distinguishing right from wrong, good from bad, virtue from vice. Ethical theory tries to provide a systematic rationale and basis for those norms and principles. This course critically examines alternative theoretical accounts of ethical matters, such as utilitarian and social contract theory, and systematically explores questions like the following: How do we decide between competing theoretical alternatives? How do we decide ethical issues when we are undecided about the foundations of ethical decisions? Where do we stand when we are trying to decide where to stand? One aim of the course is to provide an account of ethical accountability.

80-235/635
Modern Political Philosophy **Alternate years (Spring): 9 units**
The course is given in a seminar-format and will cover in depth one or more of the following topics: neo-contractarianism, theories of justice, concepts of fairness, the tension between liberty and equality in modern democracies. Prerequisite: 80-135, Classical Political Philosophy

80-236
Philosophy & Law **Fall: 9 units**
While philosophy and human values may seem intractable realms of disagreement and conflict, philosophic concepts and human values infuse the most prosaic laws of the land. While the law is continually contested and subject to revision, it remains a relatively stable and consensual framework of rules and principles for regulating life and negotiating conflict in civil society. Thus, while the law is steeped in the intractabilities of conflicted human values, it must also be very practical and decisive. While the law must weigh and balance human values, it must also embody rigorous evidentiary standards for findings of fact. This course will explore the nature of law as an institution, rationales for limiting liberty and the justification of coercion, methods of legal reasoning, processes of legal decision-making, and crucial contested concepts such as our "rights" and "justice" under law. For depth of perspective on these general topics, we will focus on controversial cases and problematic "defenses" to charges of criminal homicide (such as "insanity", "duress", "self-defense", the "battered woman syndrome") underlying which are perennial philosophic issues of justifiability, culpability, and responsibility.

80-237
Philosophy, Politics, & Economics **Alternate years (Fall): 9 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.

80-240
Contemporary Ethical Issues **Offered intermittently: 9 units**
Various problems and quandaries in social ethics are examined in this course including: abortion, euthanasia, discrimination and reverse discrimination, pornography, free speech issues, capital punishment, privacy and animal rights. The course will emphasize the role that applied ethics can play in understanding controversial social issues and in resolving them.

80-241
Ethical Judgments in Professional Life **Fall & Spring: 9 units**
This is a self-paced course that examines the numerous ethical issues, problems and dilemmas that confront professionals in such areas as medicine, law, engineering, the media, government and the natural and social sciences. As a self-paced course, video and audio tapes and an electronic bulletin board are employed to create a virtual classroom for student discussions.

80-242
Conflict & Dispute Resolution **Fall & Spring: 9 units**
This course is about strategic choice, bases for choosing strategies for dealing with human conflict. The course has two dimensions: (1) methodology and (2) applications. (1) We will critically examine current models of conflict and conflict resolution, specific techniques and skills for negotiating conflict in principled ways, methods for addressing moral conflicts and disagreement, for identifying, weighing and balancing conflicting values and interests. (2) We will apply strategies for conflict resolution on societal, inter-group, inter-personal and intra-personal levels; in particular, we will use in-depth case studies to examine the application of conflict-resolution methods to social conflicts (like the Philadelphia MOVE crisis, the Waco disaster, and diversity issues on campus) and to intractable, polarizing social controversies (over abortion, euthanasia, gun control and violence in American society). We will make heavy use of video case studies and innovative multimedia technology developed at our Center for the Advancement of Applied Ethics.

80-243
Business Ethics **Offered intermittently: 9 units**
Various moral mazes that confront managers in the contemporary business organization will be the focus of this course. Topics treated will include: conflicts of interest, whistleblowing, confidentiality and privacy, environmental issues, sexual harassment, diversity in the workplace, international business ethics and corporate social responsibility. Codes of business ethics, ethics audits, recommendations from the U.S. Sentencing Guidelines Commission, 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, & Ethics **Alternate years (Spring): 9 units**
As environmental awareness grows, the role of organizational management is becoming a central focus. This course will examine the major issues in environmental ethics and the obligations of managers with respect to issues such as: management ethics, socially responsible management, conservation, ecological integrity, economic development and environmental sustainability, biological diversity, organizational responsibility for environmental damage and international issues of environmental exploitation. Emphasis will be placed upon both the role of collective management and the responsibilities of individual managers.

80-250
Presocratics **Alternate years (Fall): 9 units**
In this course we study the history of early Greek philosophy, starting with its sources and the first steps up to "the Socratic revolution". Our treatment is framed in the general (cultural and also partly political) history of the Greek world, and history of Philosophy is seen as an organic part of it. The link between philosophical, mathematical and scientific developments will be particularly stressed. We start by discussing the sources of Greek philosophy, like the Orphic cult and Greek mythology, and then continue with a systematic study of the Greek philosophers from the earliest ones: Thales, Anaximander and Anaximenes, all from the Milesian school. We discuss in detail the contributions of Pythagoras and his school, pointing out why he was one of the most influential men in the intellectual history of mankind. Other philosophers to be treated include Parmenides - the founder of metaphysics based on logic, atomists Democritus and Leucippus, Empedocles, Anaxagoras, sophists like Protagoras, and finally Socrates. We explain the Socratic revolution as a change of the main focus of philosophy, from the speculations about the outside world to the speculations about the inner human life, the nature and certainty of human knowledge and humanvalues. No prerequisites.

80-251
Ancient Philosophy **Alternate years (Spring): 9 units**
In this course we start with Socrates and explain why he represents a turning point in the history of Philosophy. After analyzing Socrates' philosophical method, we turn to Plato. We will pay special attention to his metaphysics, particularly to his solution of the problem of the universals. His political and moral thought will be seen in the context of the political events in Athens during his lifetime. We continue with Aristotle, giving special emphasis to his logic and his metaphysics. His solution of the problem of the universals will be compared in detail with Plato's. We analyze the impact of Plato and Aristotle on the subsequent developments in philosophy. We finish with Plotinus who stands at the end of the Greek era and the beginning of Christendom.

80-252
Medieval Philosophy **Offered intermittently: 9 units**
The philosophers of the middle ages were charged with the formidable task of making sense out of Catholic doctrine. If God is so good and omnipotent, and God created everything, then why is there evil? How can God be one and yet three? If God created me and knows just what I am going to do next, then how can I be responsible for my actions? Since God is good by nature, and therefore must create the best, then how is anything but the best even possible? If nothing but the best is possible, then whatever happens happens necessarily. So how can any feature of our world be contingent, including our actions? If God explains why the world is here, what explains why God is here? Despite the religious motivation of these questions, attempting to answer them forced the medieval philosophers to think very hard about the nature of possibility, time, and being. Their distinctions and theories are therefore still referred to in modern logical work. In this course, we examine some works of Augustine, Boethius, Aquinas, Scotus, and Ockham. Prerequisites: none.

80-253
Modern Philosophy **Alternate years (Spring): 9 units**
This course is a survey of seventeenth and eighteenth century philosophy. We explain what makes philosophical thought of this period "modern" and compare it with the medieval philosophy, both in terms of profound changes in some aspects and continuity in other aspects. The main philosophers to be discussed are "continental" thinkers Descartes, Spinoza and Leibniz, and British empiricists Locke, Berkeley and Hume. We explain the main differences and similarities of these two traditions and the impact they had on the development of science. Finally, we present Kant's philosophy as a synthesis which has elements of both traditions. We pay special attention to the accomplishments these great men achieved in metaphysics, epistemology, and logic.

Course Descriptions

80-254
20th Century Philosophy **Offered intermittently: 9 units**
In the early twentieth century, the advances in logic by Frege, Peano, and Russell, among others, contributed to a new standard of rigor in philosophical writing. Logic had an influence on views about mathematics, knowledge, language, natural science, and ethics. In this course, we examine movements early in the century such as logical atomism, logical positivism, and emotivism. Then we review the backlash against these views that continues today. Among the figures to be examined are Russell, Wittgenstein, Popper, Carnap, and Quine. Prerequisites: 80-210, or another course in mathematical logic is recommended.

80-255
Pragmatism **Alternate Years (Fall): 9 units**
This is intended as an introduction to a philosophic tradition, Pragmatism. What is Pragmatism and how does it differ, for example, from the rival philosophies associated with Descartes or Hume? We shall study selected writings of C. S. Peirce, William James, and John Dewey to see how these pioneers of Pragmatism addressed such diverse issues as justification of the "scientific method" and the status of ethical theories.

80-256
Continental Philosophy **Alternate years (Spring): 9 units**
This course provides students with an overview of key movements in 20th Century European Philosophy. The central tenets of phenomenology and existentialism (e.g., intentionality, Being-in-the-World, Bad Faith) will be discussed in the context of selected works from Husserl, Heidegger, Sartre and Merleau-Ponty. Other trends such as Structuralism and Hermeneutics will also be addressed.

80-260/760
Philosophy of Art **Fall: 9 units**
Philosophy of Art provides an excellent introduction to art history. It asks fundamental questions: What is the nature of art? Why do we value artworks? Why does art have a history?. This course will focus on painting, will use slides to present many visual examples. We will be concerned with both the activity of artmaking and the reflection on that process. Students will visit the local museums, the Frick and the Carnegie. To understand the value of art, we will explore theories of the social value of painting.

80-265
Philosophy of Religion **Offered intermittently: 9 units**
This course will cover classical and modern philosophic arguments about the existence and properties of God, and the relation of reason and evidence to faith. Other possible topics include the role of religious or theological views in the grounding of ethical theory and morality, the general problem of investigating so-called 'paranormal' phenomena, the freedom of the will, the meaning of life in a godless universe, creationism and science, and the rights and meaning of religious freedom.

80-272
Philosophy of Mind **Alternate years (Fall): 9 units**
Psychology is supposed to be about minds. What are they anyway? Brains? Machines executing programs? What is it for a brain to run a program? When are two computational models of mind synonymous? Do mental states refer to real objects in the world? Under what conditions? How do psychological theories differ from those in other sciences, if at all? What are "behaviorism", "physicalism" and "functionalism," and how do they differ, if they differ? Can I be wrong about having a pain in my arm? These are some questions in the philosophy of mind. To think about some of these questions, we turn to the work of Dennett, Chomsky, Quine, Skinner, Sellars, Wittgenstein, and others, as well as some papers in cognitive psychology and artificial intelligence. Prerequisites: none.

80-275
Metaphysics **Alternate years (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 philosophic texts will be studied.

80-280
Introduction to Linguistic Analysis **Offered intermittently: 9 units**
This course is designed as an intermediate course between "Nature of Language" (80-180) — which is a prerequisite — and more advanced, topical courses such as "Syntax" (80-380). The focus is on motivating and developing foundations in areas of linguistic analysis, such as phonology, syntax, and semantics.

80-300
Topics in Epistemology **Offered intermittently: 9 units**
A more careful examination of a narrower range of issues than is possible in the survey courses. Example topics would be developments in Bayesian epistemology, or reliability as a condition for knowledge.

80-305-306
Topics in Choice & Decision Theory **Offered intermittently: 9 units (each)**
These courses are intended to allow for specialized themes. For example, the instructor might focus on current disputes about Expected Utility theory by reviewing rival theories that purport to give better descriptive accounts of the way people actually choose. For another example, the instructor might emphasize issues in sequential decision making by reviewing such topics as extensive and normal form decisions, or the theory of multistage experimental design, or the principles of rational choice in the face of changing preferences. There is the opportunity, also, to examine differences between theories of choice for individual decision makers versus cooperative groups of several decision makers working together. — Appropriate prerequisites for these courses depend upon the specific thematic selections of the instructor. Students should examine the department's course descriptions for the particular term in question to get the relevant details.

80-307
Philosophical Issues in Game Theory **Alternate years (Spring): 9 units**
In this course, we apply results in game theory to philosophical issues in ethics and social and political philosophy. Topics covered will include 0-sum games, cooperative games, and applications of the "prisoner's dilemma" to utilitarian ethical theories.

80-310/710
Logic & Computability I **Fall: 9 units**
This is a first course in mathematical logic and computability. The course develops the syntax and elementary meta-theory of first order quantificational logic and uses it for several applications. The material covered emphasizes basic issues in formal languages, e.g., recursive definitions. Also, this course investigates the decision problem, introduces Turing-machines, and gives Turing's argument for the undecidability of quantificational logic. (Model theory and Gödel's incompleteness theorems are discussed in 80-410, Logic and Computability II.)

80-312 / 712
Probability & Artificial Intelligence **Spring: 9 units**
The course will consider two fundamental questions concerning probability and artificial intelligence: 1) How should artificial intelligence programs represent uncertainty, and how should they draw conclusions from uncertain information? 2) How can artificial intelligence techniques be used to help in the automatic construction of expert systems from statistical data? We will compare a number of different methods of representing uncertainty, including certainty factors, Dempster-Shafer theory, and Bayesian networks (that employ probability theory), and we will examine a number of expert systems such as Mycin, QMR, and Pathfinder that deal with uncertainty. We will also study recent advances in the automatic construction of expert systems from fragmentary background knowledge and statistical data.

80-313/713
Philosophy of Mathematics **Alternate years (Spring): 9 units**
Problems in the foundations of mathematical analysis prompted, around the turn of the century, renewed philosophical reflection on mathematics and related mathematical and logical work. Set theoretic and constructivist foundations for analysis are described; Hilbert's program is analyzed in detail. Finally, an attempt is made to defend a "structuralist" position, influenced by Bernays and Bourbaki, that incorporates important insights from the main foundational schools.

80-314/714
Philosophy of Logic **Alternate years (Spring): 9 units**
The first part of this course analyzes the work in and reflections on logic by Aristotle, Leibniz, and Frege. Tremendous progress in clarifying and (partially) resolving problems has been made in this century; most strikingly with respect to completeness and decidability questions. These results will be discussed in the second part. Finally, attention will be turned to theories of sets, classes, and properties.

80-320/720
Automated Discovery:
Model Search by Computer **Offered intermittently: 9 units**
This course will survey computational techniques for pattern recognition, concept learning, causal inference, and prediction. Emphasizing the limits of reliability and informativeness of each procedure, we will discuss linear regression, logistic regression, regression search procedures, neural net algorithms, automatic procedures for constructing Bayes networks, and modification indices for linear models. Students will gain hands on experience with a variety of computerized packages.

80-321
Topics in the Philosophy of Science **Offered intermittently: 9 units**
A more detailed examination of some issue in the philosophy of science, such as the nature of scientific progress, the nature of evidence, or the theory of explanation. The topic may also be an in-depth examination of some philosophical issues raised by a particular science (e.g., conventionalism in space-time physics or the role of adaptation in evolutionary theory). Prerequisites: specific to topic.

Course Descriptions

80-340
Environmental Issues **Fall or Spring: 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. A promising innovation, Alternative Dispute Resolution, involves the use of negotiation and mediation to resolve environmental disputes. Based on a series of environmental case studies, this course will explore the nature of ADR methods; the values implicit in the processes, the types of outcomes they produce, and the criticisms that have been raised. (Familiarity with basic conflict resolution skills, e.g., 80-242, is helpful but not required.)

80-342
Diversity Issues **Spring: 9 units**
This course examines issues germane to the substantial and increasing racial and cultural diversity of U.S. society. What are the realities and implications of this diversification? Can a society continuously incorporate different groups' values, styles, and other cultural features? Is it desirable to do so? Is racial intolerance partly a biological evolutionary vestige from more tribal times? How are businesses, schools and other institutions responding? Is the response effective, i.e., does "sensitivity training" actually reduce sexism, racism, homophobia, and/or ethnocentrism? This course examines these and other questions relevant to diversity by distinguishing the facts and values involved. Class work includes training exercises, videos, interactive multimedia, and a variety of hands-on multicultural experiences.

80-346
Value, Fact, & Policy **Fall or Spring: 9 units**
This seminar is about how appraisals of value and fact interact in the deliberation and evaluation of policy. Policy making and debate entail value judgments and evaluation (the weighing and balancing of competing values, interests and goals) as well as 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. 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 highly arguable and complex: we encounter political, sociological, cultural, psychological issues as well as legal and ethical questions. The seminar will focus on specific policy disputes regarding crime and violence, so that we can become well versed in the relevant factual as well as value controversies. A commonsense framework for deliberating and evaluating policy will be proposed and critiqued.

80-360
Advanced Aesthetics **Spring: 9 units**
This course builds upon Philosophy and Art, 80-260, which is a prerequisite. Recently philosophers have studied art history writing and art criticism. This class explores this recent research in aesthetics, with a special focus on visual art. We look at the various skills that traditional art historians use to analyze paintings, and at the rather different ways in which art critics have dealt with these philosophical problems. Using examples from traditional as well as contemporary art, we will be interested in the ways in which both the traditions of analytic philosophy and the theorizing associated with cultural studies are relevant to analyzing visual art. Recently art history has been interested in conceptual innovation. We will critically explore what is to be learned by art history from other disciplines. Topics will include: the nature of interpretation; the possibility of competing interpretations, and possible techniques for the resolution of such conflicts; and the philosophical analysis of the rhetorical strategies of art writing. The focus of this class will be changed from year to year.

80-370
Topics in Philosophy of Mind **Offered intermittently: 9 units**
This course discusses some of the conceptual issues that cognitive science has inherited from philosophy of mind, philosophy of science, and epistemology. The first part of the semester will be devoted to general questions in their historical context: What is the mind, i.e., the mind-body problem? How should we study it, e.g., physiological reductionism, behaviorism, cognitivism, contemporary critiques of cognitivism? The second part of the semester will be devoted to a series of specific research topics which touch on both empirical and philosophical issues. For example: Gibsonian direct perception versus internal rules and representations; the "imagery debate"; the relevance of artificial intelligence ("AI") o cognitive science; modularity versus unity of mind; parallel distributed processing versus symbol manipulation as models of perception and thought. Prerequisites: Introductory course work in cognitive science and philosophy, or advanced course work in either cognitive science or philosophy. This course is cross-listed in the Psychology department.

80-371/771
Psychoanalysis and Cognitive Psychology **Offered intermittently: 9 units**
Sigmund Freud is famous as the inventor of psychoanalysis, but he was trained in neuroanatomy and neurophysiology, and his early ambition was to develop a general, mechanistic and computational cognitive psychology. This background heavily influenced the development of his ideas, and provides an interesting comparison with the goals, methods, and theories of contemporary cognitive psychology. We will investigate the scientific context of Sigmund Freud's education and early work, and read his major writings on psychoanalysis and related topics through 1920. We will also read and make comparisons with works by psychologists associated with Carnegie Mellon, including John Anderson and Allen Newell.

80-375
Topics in Metaphysics **Offered intermittently: 9 units**
Some issues in metaphysics will be presented in more detail.

80-381/781
Philosophy of Language **Alternate years Fall: 9 units**
This course will examine contemporary theories of a number of linguistic concepts, including meaning, reference, and propositions. The relationships between these theories and other areas of philosophy will be examined through the works of such philosophers as Quine, Kripke, Putnam, and Donnellan. No prerequisites.

80-384
Pragmatics **Offered intermittently: 9 units**
This course will explore theories concerning ways in which context of utterance affects the content of what is said, and concerning relationships between language on the one hand, and human action and communication on the other. Presupposition, conversational implicature, nondeclarative sentences, deixis and anaphora, speech act theory, and the analysis of discourse units larger than sentences will be among the phenomena we will consider. The literature that we will examine belongs to linguistics, philosophy, cognitive psychology, artificial intelligence, and discourse analysis. This course may be of interest to students in linguistics, philosophy, psychology, information science, English, and language departments. If funds are available, the course will be integrated with a program of visiting speakers. Besides the prerequisite course(s), there are no specific requirements for this course. But some of the material will be technical, and it will be assumed that students enrolled in the course will have had experience with some theoretical approach to language.

80-385
Topics in Philosophy of Language **Offered intermittently: 9 units**
In this course, some issues in the philosophy of language will be developed in greater detail than is possible in 80-381.

80-407/707
Game Theory **Alternate years (Spring): 9 units**
The first part of course will be a standard introduction to noncooperative games. The second part will cover special topics such as signaling and reputation effects, evolution and learning, formal models of players' reasoning, and applications of game theory to artificial intelligence.

80-410/710
Logic & Computability II **Spring: 9 units**
This is a continuation of Logic and Computability I (80-310); but it can be taken independently by students who are familiar with the syntax of predicate logic. The first part of the course is concerned with the semantics of predicate logic and presents basic metamathematical results, such as Gödel's Completeness Theorems, Compactness Theorem, Löwenheim-Skolem Theorems, and Herbrand's Theorem. The second part focuses on Gödel's Incompleteness Theorems and presents in detail the requisite notions and results of computability theory, i.e., recursive functions and representability.

80-411/711
Recursion Theory **Fall: 9 units**
Recursion theory is the mathematical study of what algorithmic computations can and cannot do. In this course, we will examine the basic techniques for showing that a well-defined problem is or is not solvable. We will see, for example, that no non-trivial property of the input-output behavior of a program is effectively decidable. We will also see an easy approach to the proof of Gödel's incompleteness theorems. We will turn next to the theory of recursive operators. Kleene's fixed point theorems will be proved, with applications to programming language semantics. A special feature of the course will be the development of a close analogy between computation and empirical science. This analogy is reflected in formal learning theory, which makes extensive use of the techniques treated earlier in the course. Finally, we will turn from classical recursion theory to the theory of computational complexity, with a focus on the significance of NP-completeness and on the techniques for showing a problem to be NP-complete. NP-completeness theory applies to a vast array of practical scheduling and search problems. Prerequisites: 80-310, or some course in mathematical logic and some course involving machine-level programming.

80-415/715
Topics in Mathematical Logic **Spring: 9 units**
This class has Logic and Computability I and II as prerequisites. It will cover, building on the earlier courses, more advanced areas of model theory (mathematical semantics of formal languages), recursion theory (theory of computation), or set theory.

80-416/716
Proof Theory **Alternate years (Fall): 9 units**
Proof theory is the part of logic that joins most distinctively philosophical, mathematical, and computational concerns. The course explores these complementary aspects of proof theory and follows the historical development of the subject. We discuss the emergence of Hilbert's Program, the metamathematical investigations in the Hilbert School, the formulation of a generalized reductive program, and analyze the different proofs Gentzen gave for the consistency of number theory. The investigations will be extended, when time permits, to stronger theories (subsystems of analysis and set theory) and modified to obtain computational information from proofs. The latter themes are continued in the Seminar on the Foundations of Mathematics (80-813).

Course Descriptions

80—417/717
Intuitionism **Alternate years (Fall): 9 units**
The course first presents basic principles of "constructive" mathematics (as formulated e.g. by Kronecker, Hilbert, Bishop) and the distinctive features of Brouwer's intuitionistic analysis. Then intuitionistic logic and a variety of semantics are investigated. Finally, we discuss the fundamental difference between a "constructivist" and "realist" position in the foundations of mathematics.

80-480
Introduction to Computational Linguistics **Fall: 9 units**
This course is designed to introduce students to the techniques and problems of processing natural language computationally. Thus, it will focus both on issues related to the syntax of natural language — parsing — and on issues related to the semantics of natural language — representation. Under parsing, the course will deal with problems peculiar to the design of the lexicon, morphological analysis, and phrase and clause structure; and under representation, with problems of quantifiers, modality, and contexts for interpretation, including discourse representations. Students will be introduced to transition networks, chart parsers, and case-frame grammars, as well as implementations of "scripts" and "planning" devices. The lectures will be supplemented with extensive programming and problem-solving tasks, one goal of which will be to have students produce, in stepwise fashion, a modest natural language understanding system.

80-485
Language & Learning Theory **Offered intermittently: 9 units**
What classes of possibilities can be reliably discriminated on the basis of a certain kind of data? This is a question that applies equally well to scientific inquiry, to learning in humans and animals, to adaptive biological systems, and even to corporations, societies and computers. Formal learning theory provides a framework within which to prove both positive and negative possibility results about what is learnable. It also discriminates what learners with bounded computational resources can do from what less constrained systems can do. The theory is currently under development along a number of fronts, so it is likely that some unpublished material will be covered.

80-501/502
Honors Thesis I/II
Philosophy and Logic and Computation majors with outstanding academic records and intellectual promise will be given the opportunity to engage in original research under the direction of an individual faculty member. Research topics are selected by students and faculty. Prerequisites: senior standing, faculty sponsorship, and admission to the H&SS Senior Honors Program.

80-510 / 511/ 810/811
Seminar in Logic & Computation I/II **Fall & Spring: 9 units**
This, two semester course is part of the program for the Professional Major in Logic and Computation. In the Fall term, it is organized thematically and covers advanced and tightly related aspects of the following three topics: (1) models of human problem-solving that are empirically grounded and take into account feasibility constraints, e.g., models of decision-making and language acquisition; (2) computational models of problem-solving independent of human performability and their intrinsic complexity, e.g., theorem proving and computer chess-playing; and (3) reflection on methodological tools and their limits, e.g. investigating generalizations of expected utility theories, Church's Thesis and Mechanism, and concepts of feasible computation. In the Spring term, the seminar serves as a forum for reports by students on their research projects, and as a forum for discussion of moral and social issues raised by uses of computers.

80-581/781
Syntax I **Fall: 12 units**
This course is designed as a comprehensive introduction to the formal theory of natural language syntax. Approximately two thirds of the course will be devoted to introducing students to the most important features of syntax, including the notions of constituents, distance dependencies, control, agreement, islands, gaps, and embedding, all presented in a formal, though "theory-independent" framework. The balance of the course will be devoted to the examination of how several competing theories (Extended Standard Transformational Grammar, Lexical-Functional Grammar, and Generalized Phrase Structure Grammar) treat the syntactic phenomena of interest. In short, the course will identify the major problems uncovered by a generative grammatical approach to syntax and focus on the merits and difficulties of alternative solutions. The course will involve students actively in problem solving and theory building. It will thus be highly analytical and designed to familiarize students with the special dialectic of syntactic argumentation, grounded as it is both in empirical and intuitive data.

80-582/782
Syntax II **Spring: 12 units**
This course is an advanced course in syntax, designed to offer the student in-depth specialization in one of several contemporary theories in natural-language syntax. The class is conducted as a seminar. Prerequisite: 80-380 (Syntax I).

80-583/783
Semantics **pring: 12 units**
This course is designed to provide the student with a sound basis for intermediate and advanced work in the formal semantics of natural language. The first part of the course will review set theory, and propositional, predicate, and modal logic; and will introduce the student to intentional logic and categorical grammar. In parallel with the presentation of such formal systems, there will be a discussion of phenomena peculiar to the semantics of natural language, including the distinctions between sense and reference, direct and indirect quotation, propositional attitudes, generic and specific reference, quantifiers, and adverbials. The second part of the course will present one system for the semantics of English — Montague semantics — in great detail. Students should be comfortable with symbol manipulation and problem solving, and should have taken introductory logic courses before enrolling in this course.

80-585
Topics in Philosophy of Language **Offered intermittently: 9 units**
In this course, some issues in the philosophy of language will be developed in greater detail than is possible in 80-381.

80-680/880
Introduction to Computational Linguistics **Fall & Spring: 9 units**
This course is intended as a general introduction to the linguistic issues in computational techniques available for the mechanical processing of natural languages such as English. There are no formal prerequisites. The courses in linguistics (e.g. Nature of Language), computer science (e.g. Algorithms) and/or logic would be helpful. Four major topics will be covered: morphological processing, syntactic processing, semantic processing, and pragmatic processing.

80-681/881
Natural Language Processing I (Parsing) **Spring: 12 units**
This course is designed as an advanced, in-depth introduction to the techniques and problems of natural-language processing by machine, focusing especially on issues in parsing . Following a brief review of traditional parsing technology, including techniques associated with ATN's and chart parsers, the course will devote approximately equal time to the presentation of (1) parsing algorithms (including the Early and Timita algorithms), (2) knowledge-based parsing (including case-frame parsing), (3) large-scale knowledge representation for linguistic processing (including problems associated with lexical-semantic representation), and (4) selected applications taken from current research projects, highlighting the topics of the course.

80-682/882
Natural Language Processing II (Meaning) **Fall: 12 units**
This course is intended to be the final course in a sequence of three courses introducing the student to fundamental principles and applications in contemporary computational linguistics and natural-language processing theory. As such, it is designed to give the student an opportunity to apply the lessons of the first two courses in pursuing a semester-long research project under the supervision of a research scientist — in particular, to modify, design, or implement components in natural-language processing systems.

80-683/883
Natural Language Processing III **Spring: 12 units**
This is an advanced project course in natural language processing, with NLP I (80-481) and NLP II (80-482) as prerequisites. Students are expected to pursue a semester-long directed research project focusing on a contemporary problem in NLP.

80-812
Seminar on Philosophy & Artificial Intelligence **Fall or Spring: 9 units each**
Students will attend a faculty seminar on statistics, uncertainty and computation, emphasizing the relations between artificial intelligence problems and statistical theory.

80-813
Seminar on the
Foundations of Mathematics **Alternate years (Spring): 9 units**
The seminar will focus on mathematical and logical work, important for foundational issues. For example, in the context of Hilbert's program, fragments of first and second-order arithmetic are investigated. The main questions are: (1) which parts of mathematical analysis can be developed in weak subsystems of second order arithmetic, and (2) what computational information can be extracted from proofs? This involves a presentation of significant subclasses of recursive functions, the proof-theoretic analysis of fragments of arithmetic, and of combinatorial principles. This course is cross-listed with Mathematics and is open to undergraduates by permission of the instructor.

80-814
Seminar on Philosophy of Science **Fall or Spring: 9 units**
This seminar will focus on one topic in the philosophy of science, e.g. realism versus instrumentalism, theories of explanation, theories of scientific methodology, etc., and examine it in depth.

80-815
Seminar on the Foundations of Statistics **Fall or Spring: 9 units**
The seminar will focus on some important foundational work and investigate it and related research. For example, when Savage's Foundations of Statistics is to be read, the course goals will include understanding how Bayesian decision theory differs from its rivals, and understanding where Savage's position is located within the Bayesian program. This course is cross-listed with Statistics and is open to undergraduates by permission of the instructor.

80-816
Seminar on Philosophy of Social Science **Alternate years (Spring): 9 units**
The seminar will focus on foundational issues in the social sciences. Some of the topics addressed will be: intentionality, explaining and understanding human action, holism and reductionism, the nature of social concepts, invisible hand explanations.

80-817
Seminar on Proofs and Computations **Alternate years (Fall): 9 units**
This seminar consists of three parts. In the first part we present basics of computational complexity theory. Topics include: polynomial time Turing computability, NP-completeness, polynomial time hierarchy and Boolean circuits complexity classes. We also present various other topics, like the graph isomorphism problem. In the second part we develop proof theoretic tools, most notably Herbrand analysis of theories, which can be used to obtain proof-theoretic characterizations of various computational complexity classes. Finally, in the third part, we present known results whose proofs use Herbrand analysis, and then we present open problems in this field.

80-862
Poststructuralism **Offered intermittently: 9 units**
An introduction to the highly influential work of Barthes, Derrida and Foucault, this course is concerned both with the critics' theorizing and the practice of interpretation as they have influenced it. Studying in depth selected texts, we will relate those arguments to the concerns of the working critic.

80-884
Topics in Computational Linguistics **Fall or Spring**
See instructor.

80-886/887
Pro Seminar in Computational Linguistics **Fall & Spring: 6 units**

80-888/889
Comp. Ling. Dir Research Project I/II **Fall & Spring**

80-x90/x94
Special Topics Courses/Seminars **By arrangement: 9 units each**

80-990
Directed Reading **Fall & Spring: 9-12 units**

80-992
Directed Research **Fall & Spring: 9-12 units**

80-x95/x99
Supervised Research/Projects **By arrangement: 9 units each**

Course Descriptions

Modern Languages

Undergraduate Courses

Students who have never studied a foreign language are encouraged to enroll in elementary language courses. Those students with previous high school preparation in a foreign language are required to enroll in courses at the appropriate proficiency level as determined by the **Modern Language Placement Test**. Generally, students with two years of high school work will be placed by the test into the intermediate (200-level) courses. Four years of high school preparation should enable students to take advanced (300- or 400-level) courses. Credit will not be given for language courses students have previously taken in high school or at another university. The right is reserved to cancel any of the following courses for insufficient enrollment.

NOTE: Self-Paced Instruction (SPI) is a self-study method, including classroom instruction and/or individual consultation/tutoring, based on individual study materials that contain explanations, instructions, exercises, answer keys, tapes, computer exercises, films, video, and examinations. Students determine their own pace of study. Occasional attendance at specially scheduled sessions is mandatory. SPI is recommended only for highly-motivated students with schedule conflicts that would otherwise preclude enrollment in a regular language course. SPI is not available to freshmen students in their first semester of study; further, SPI may only be taken for one semester. It is available in French, German, Italian and Spanish and only at the elementary level. In addition, a small number of students may be able to study a number of less commonly taught languages. Information on these special courses is available in the Modern Languages Department office.

Modern Language courses are listed sequentially by language.

French

82-101/102
Elementary French I, II **Fall/Spring: 12 units**
A two-semester course sequence for beginning students emphasizing the development of communicative language proficiency: oral practice, aural comprehension, reading, writing, structural analysis and language laboratory work. Also a study of cultural aspects of French-speaking countries.

82-103
Self-Paced French **Fall/Spring: 12 units**
First-year study of French emphasizing oral comprehension, reading, writing, and speaking through guided self-study. Arranged meetings with instructors, language laboratory exercises, and periodic evaluations. (Note: SPI may only be taken for one semester.)

Note: All Elementary I, II and Self-Paced language students are required to attend three (3) additional 1 hour lectures as part of this course. These lectures are designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study.

82-107
Reflections of French Culture in Film **Offered Intermittently: 9 units**
One of the primary goals of the course will be to engage students in the process of cultural analysis by inviting them to reflect on questions of form and representation in the context of French cinema. Preliminary discussions will include an introduction to the concept of film as text, differences and similarities between written and cinematic texts and an exploration of the notion of genre and narrative analysis. In looking at examples ranging from early Surrealist experimentations to the latest Gerard Depardieu vehicle, students will acquire a number of critical tools that will help them better understand how a specifically French critical sensibility helped legitimize cinema as an art form, particularly through the development of film criticism as its own genre. The course will concern itself partly with an historical overview of French cinema but will also provide an introduction to technical and formal analysis. Students will be expected to write a number of analytical papers on specific films over the course of the semester and may have the option, at the instructor's discretion, of creating their own films that apply their newly acquired critical tools to a final creative project. (Taught in English)

82-201/202
Intermediate French I, II **Fall/Spring: 9 units**
A two-semester course sequence for intermediate-level students. An integrated approach to the study of French language and culture, consisting of grammar review, readings, and intensive practice in written and spoken French. Reading material on issues of continuing relevance and current interest in modern French society. Prerequisite: 82-102 or approved equivalent.

82-301
Advanced French Grammar and Stylistics **Fall/Spring: 9 units**
(To be replaced [along with 82-302] by 82-303 in Fall 1995)
This course stresses perfection of the linguistic and stylistic practices of advanced students. Focus will be on high frequency errors and on particularly problematic elements and structures which persist beyond the intermediate level. Special attention will be given to individual problems with the goal of improving accuracy of expression in both speaking and writing. Prerequisite: Completion of the intermediate level or the equivalent.

Course Descriptions

82-302
Advanced Writing as Communication - French **Fall/Spring: 9 units**
(To be replaced [along with 82-301] by 82-303 in Fall 1995)
This course focuses on the building of writing skills for students beyond the intermediate level of study. Students will develop linguistic and organizational skills necessary to achieve clear identification and expression of ideas in French. Writing will be practiced as a process of communication involving the generation, expression, evaluation, re-evaluation, and re-writing of ideas. After discussion of authentic texts in the foreign language from a variety of modes, students will engage in intensive practice of, for example, descriptive, narrative, journalistic, editorial, and expository writing. Prerequisite: Completion of the intermediate level or the equivalent.

82-303
Advanced Written French **9 units**
(previously offered as 82-301 and 82-302)
This course stresses the writing process through the examination of different discursive styles (expository, analytical, narrative) and the importance of multiple drafts as part of the clear and effective communication of ideas. It also emphasizes the mastery of advanced and idiomatic forms of written French. The content of the course is the writing process itself, with attention paid to both form and style. Prerequisite: Completion of the intermediate level or the equivalent.

82-304
Introduction to French and Francophone Culture **9 units**
Students will be exposed to the notion of "the text" as it appears in literary, visual and oral forms in France and the French-speaking world. Students will also be exposed to the notion of "genre" as expressed in forms such as poetry, song, film, play, short story, essay, television and print journalism, and historical narration. An important goal of the course is to develop higher-level critical skills such as inferencing, interpretation and argumentation that characterize the 400-level. Student assignments will include both oral and written analyses that demonstrate their ability to make critical judgments in extended-length discourse (short papers and presentations). Prerequisite: Completion of the intermediate level or the equivalent.

82-305
Contemporary Spoken French **9 units**
(Previously offered as 82-402)
This course is designed to promote the oral communicative competence and self-expression of advanced students of a foreign language. Attention will be given to helping students develop both the accuracy and the fluency which characterize the speech of native speakers of a language. Within the context of this course, students will work to refine and perfect speaking skills through special attention to stylistic variation, idiomatic expressions, colloquialisms, and regional and/or dialectal variations in contemporary spoken language. Students will further develop sensitivity to various registers of language use and develop a repertoire of linguistic usage, from the most formal to the most casual, that will permit them to deal effectively with the different types of communicative needs and demands that occur within a variety of cultural settings. In addition, the course will emphasize differences between spoken and written expression and require students to be able to both identify and produce texts appropriate for each. The structure of the course will be based upon a wide variety of authentic spoken and written texts including films, satellite broadcasts, documentaries, radio and television programs, recorded materials, and contemporary literary and non-literary texts. These materials will be used both to analyze differences in spoken discourse and as sources for oral interaction. Students will engage in intensive speaking practice through individual and group presentations, debates, panel discussions, special projects, dramatizations, and native speaker interviews in fieldwork segments of the course. Some written work will be required as preparation for a number of polished oral assignments. Prerequisite: Completion of at least one 300-level French course or consent of instructor.

82-402
Contemporary Spoken French **Fall: 9 units**
(To be replaced by 82-305 in Fall 1995)
This course is designed to promote the oral communicative competence and self-expression of advanced students of a foreign language. Attention will be given to helping students develop both the accuracy and the fluency which characterize the speech of native speakers of a language. Within the context of this course, students will work to refine and perfect speaking skills through special attention to stylistic variation, idiomatic expressions, colloquialisms, and regional and/or dialectal variations in contemporary spoken language. Students will further develop sensitivity to various registers of language use and develop a repertoire of linguistic usage, from the most formal to the most casual, that will permit them to deal effectively with the different types of communicative needs and demands that occur within a variety of cultural settings. In addition, the course will emphasize differences between spoken and written expression and require students to be able to both identify and produce texts appropriate for each. The structure of the course will be based upon a wide variety of authentic spoken and written texts including films, satellite broadcasts, documentaries, radio and television programs, recorded materials, and contemporary literary and non-literary texts. These materials will be used both to analyze differences in spoken discourse and as sources for oral interaction. Students will engage in intensive speaking practice through individual and group presentations, debates, panel discussions, special projects, dramatizations, and native speaker interviews in fieldwork segments of the course. Some written work will be required as preparation for a number of polished oral assignments. Prerequisite: Completion of at least one 300-level French course.

82-409
French Literature of the Nineteenth Century **Offered intermittently: 9 units**
Readings in prose, poetry, and drama from Romanticism through Naturalism and Symbolism. Prerequisite: 82-303 and 82-304 or approved equivalents.

82-410; 79-320
Issues in Contemporary European Civilization **Spring: 9 units**
This course will examine contemporary issues in Modern Europe and will develop a comparative perspective on problems that relate to major European themes of 20th century European society. It will deal with social experience as reflected in language, literature, political and cultural movements as expressed by different ethnic, religious, sexual, scientific, artistic, and/or political groups. Discussions in the course will exemplify the similarities and differences in the historical expression of these issues in Germany, France, and Spain.
Issues to be examined might include local versus common markets, particular and common political and legal structures, homogeneous and heterogeneous populations, ideological and philosophical currents, regional versus national and international languages, and the evolution of educational systems. The course will focus on both comparative and national issues and in the language-specific sections will deal with developments particular to contemporary France, Germany, and Spain. In German, this will include the evolution of "the new Germany", Germany's role in a more closely integrated EC and in the former Eastern bloc nations. With respect to France, topics will include the impact of interwar experience on subsequent French political and social development and the France of the Mitterand era. Issues in Spain might include the Franco era and the evolution of Spain in the post-Franco period, and Spain's relationship to the EC. Prerequisite: 82-303 and 82-304 or approved equivalents.

82-412
Contemporary French Theatre **Offered intermittently: 9 units**
Main trends and representative authors of the French theatre since the 1930s. Prerequisite: 82-303 and 82-304 or approved equivalents.

82-413
Contemporary French Novel **Offered intermittently: 9 units**
An examination of narrative trends of the twentieth century examining novels by Proust, Breton, Aragon, Leiris, Camus, Duras, Laye, Ben Jalloun and Yourcenar, among others (titles and authors may vary). Students will also explore some of the major trends in literary analysis including structuralist and semiotic criticism, Marxist, Psychoanalytic and post-structuralist models as well as feminist and deconstructionist criticism. Prerequisite: 82-303 and 82-304 or approved equivalents.

82-415/416
Studies in French Literary and Cultural Studies: **9 units**
A series of inquiries into one or more aspects of French culture as expressed through written texts. Topics may include close readings of a particular author, movement, genre or period (for example, the novels of Simone de Beauvoir, the Nouveau Roman, the epistolary novel or the *extre-deux-guerres* period), or may take a thematic approach (e.g. Imperial and Occupied France, Text and Society in the Eighteenth Century, or Parisian World's Fairs and French Cultural Life from 1855 to 1937; Poetic Revolutions; Introduction to French Theater: Performance, Power, and the Art of Illusion; France and America: Cross-Cultural Community). Prerequisite: 82-303 and 82-304 or approved equivalents.

82-465/466
Surrealism in France and Spain **Offered intermittently: 6 units**
Section A3, French and Spanish Surrealism
This course examines the Surrealist movement in works by French and Spanish writers, painters, photographers and filmmakers including Dali, Buneal, Breton, Aragon, Lorca and Tzara. Readings and lectures will be in English. Films will be in French or Spanish with English subtitles. Prerequisite: 82-303 or approved equivalent.
Section B3, "El Surrealismo en España" **6 units**
Meets for the second half of the semester and is conducted entirely in Spanish. A continuation of section A3, this mini-course will be an in-depth study of several Spanish Surrealist writers, painters, photographers and film-makers. Readings, class discussions, student presentations and a final paper will all be in Spanish. Prerequisite: Completion of 300-level in Spanish.
Section B4, "Le Surrealisme en France" **6 units**
Meets for the second half of the semester. A continuation of section A3, this mini-course will be an in-depth study of several French Surrealist writers, painters, photographers and filmmakers. Readings, class discussions, student presentations and a final paper will all be in French. Prerequisite: 82-303 and 82-304 or approved equivalents.

82-501/509
Special Topics: French **Offered intermittently: 9 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: Consent of the instructor and a 400-level course.

82-701
French for Graduate Reading Knowledge **Offered intermittently: 9 units**
This course offers an introduction to the written French language for graduate students in the humanities. Students will be introduced to the structure of the French language in order to prepare them for their own research needs that will require consultation of sources in French. The course is not intended to develop writing, listening and speaking skills, nor is it intended to prepare students for further study in the regular undergraduate French program. It is intended to help them meet specific needs in their research in areas such as history, art and music history, literature, and literary and cultural studies.

Course Descriptions

German

82-121/122
Elementary German I, II **Fall/Spring: 12 units**
A two-semester course sequence for beginning students emphasizing the development of communicative language proficiency: oral practice, aural comprehension, reading, writing, structural analysis, and language laboratory work. Also a study of cultural aspects of German-speaking countries.

82-123
Self-Paced German **Fall/Spring: 12 units**
First-year study of German emphasizing oral comprehension, reading, writing, and speaking through guided self-study. Language laboratory exercises, periodic achievement tests, individual consultation. (Note: SPI may only be taken for one semester.)

Note: All Elementary I, II and Self-Paced language students are required to attend three (3) additional 1 hour lectures as part of this course. These lectures are designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study.

82-221/222
Intermediate German I, II **Fall/Spring: 9 units**
A two-semester course sequence for intermediate-level students. An integrated approach to the study of German language and culture, consisting of grammar review, readings, and intensive practice in written and spoken German. Reading material on issues of continuing relevance and current interests in modern German society. Prerequisite: 82-122 or approved equivalent.

82-321
Advanced German Grammar and Stylistics **Fall: 9 units**
(To be replaced [along with 82-322] by 82-323 in Fall 1995)
This course stresses perfection of the linguistic and stylistic practices of advanced students. Focus will be on high frequency errors and on particularly problematic elements and structures which persist beyond the intermediate level. Special attention will be given to individual problems with the goal of improving accuracy of expression in both speaking and writing. Prerequisite: Completion of the intermediate level or the equivalent.

82-322
Advanced Writing as Communication - German **Spring: 9 units**
(To be replaced [along with 82-321] by 82-323 in Fall 1995)
This course focuses on the building of writing skills for students beyond the intermediate level of study. Students will develop linguistic and organizational skills necessary to achieve clear identification and expression of ideas in German. Writing will be practiced as a process of communication involving the generation, expression, evaluation, re-evaluation, and re-writing of ideas. After discussion of authentic texts in the foreign language from a variety of modes, students will engage in intensive practice of, for example, descriptive, narrative, journalistic, editorial, and expository writing. Prerequisite: Completion of the intermediate level or the equivalent.

82-323
Advanced German Grammar, Stylistics and Writing **Fall: 9 units**
(Previously offered as 82-321 and 82-322)
This course stresses perfection of the linguistic and stylistic practices of advanced students. Focus will be on high frequency errors and on particularly problematic elements and structures which persist beyond the intermediate level. Special attention will be given to individual problems with the goal of improving accuracy of expression in both speaking and writing. Students will also develop linguistic and organizational skills necessary to achieve clear identification and expression of ideas in German. Writing will be practiced as a process of communication involving the generation, expression, evaluation, re-evaluation, and re-writing of ideas. After discussion of authentic texts in the foreign language from a variety of modes, students will engage in intensive practice of, for example, descriptive, narrative, journalistic, editorial, and expository writing. Prerequisite: Completion of the intermediate level or the equivalent.

82-324
Contemporary Spoken German **9 units**
(Previously offered as 82-422)
This course is designed to promote the oral communicative competence and self-expression of advanced students of German. Attention will be given to helping students develop both the accuracy and the fluency which characterize the speech of native speakers. Within the context of this course, students will work to refine and perfect speaking skills through special attention to stylistic variation, idiomatic expressions, colloquialisms, and regional and/or dialectal variations in contemporary spoken language. Students will further develop sensitivity to various registers of language use and develop a repertoire of linguistic usage, from the most formal to the most casual, that will permit them to deal effectively with the different types of communicative needs and demands that occur within a variety of cultural settings. In addition, the course will emphasize differences between spoken and written expression and require students to be able to both identify and produce texts appropriate for each. The structure of the course will be based upon a wide variety of authentic spoken and written texts including films, satellite broadcasts, documentaries, radio and television programs, recorded materials, and contemporary literary and non-literary texts. These materials will be used both to analyze differences in spoken discourse and as sources for oral interaction. Students will engage in intensive speaking practice through individual and group presentations, debates, panel discussions, special projects, dramatizations, and native speaker interviews in fieldwork segments of the course. Some written work will be required as preparation for a number of polished oral assignments. Prerequisite: Completion of 82-323.

82-325
Introduction to German Studies **9 units**
The Italian literary theorist Franco Moretti has written that Germany "is a sort of Magic Stage, where the symbolic antagonisms of European culture achieve a metaphysical intractability, and clash irreconcilably. It is the centre and catalyst of the integrated historical system we call Europe." This course is a general introduction to German culture, German history, and German society, with a focus on Germany's role as "centre and catalyst" of the European system. The course is conducted entirely in German. Its goal is to provide students with a basic level of "cultural literacy" about the German-speaking world. In the course, we will study major trends in German society since the end of the eighteenth century, 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, as well as of the problems facing the reunited Germany of today. In addition to broadening students' cultural knowledge about the German-speaking world, this course will continue to emphasize the improvement of students' ability to speak, read, write, and listen to German. Prerequisite: Completion of the intermediate level or the equivalent.

82-410; 79-320
Issues in Contemporary European Civilization **Spring: 9 units**
This course will examine contemporary issues in Modern Europe and will develop a comparative perspective on problems that relate to major European themes of 20th century European society. It will deal with social experience as reflected in language, literature, political and cultural movements as expressed by different ethnic, religious, sexual, scientific, artistic, and/or political groups. Collaborative discussions in the course will exemplify the similarities and differences in the historical expression of these issues in Germany, France, and Spain. Issues to be examined might include local versus common markets, particular and common political and legal structures, homogeneous and heterogeneous populations, ideological and philosophical currents, regional versus national and international languages, and the evolution of educational systems. The course will focus on both comparative and national issues and in the language-specific sections will deal with developments particular to contemporary France, Germany, and Spain. In German, this will include the evolution of "the new Germany", Germany's role in a more closely integrated EC and in the former Eastern bloc nations. With respect to France, topics will include the impact of interwar experience on subsequent French political and social development and the France of the Mitterand era. Issues in Spain might include the Franco era and the evolution of Spain in the post-Franco period, and Spain's relationship to the EC.

82-422
Contemporary Spoken German **Fall: 9 units**
(To be replaced by 82-325 in Fall 1995)
This course is designed to promote the oral communicative competence and self-expression of advanced students of a foreign language. Attention will be given to helping students develop both the accuracy and the fluency which characterize the speech of native speakers of a language. Within the context of this course, students will work to refine and perfect speaking skills through special attention to stylistic variation, idiomatic expressions, colloquialisms, and regional and/or dialectal variations in contemporary spoken language. Students will further develop sensitivity to various registers of language use and develop a repertoire of linguistic usage, from the most formal to the most casual, that will permit them to deal effectively with the different types of communicative needs and demands that occur within a variety of cultural settings. In addition, the course will emphasize differences between spoken and written expression and require students to be able to both identify and produce texts appropriate for each. The structure of the course will be based upon a wide variety of authentic spoken and written texts including films, satellite broadcasts, documentaries, radio and television programs, recorded materials, and contemporary literary and non-literary texts. These materials will be used both to analyze differences in spoken discourse and as sources for oral interaction. Students will engage in intensive speaking practice through individual and group presentations, debates, panel discussions, special projects, dramatizations, and native speaker interviews in fieldwork segments of the course. Some written work will be required as preparation for a number of polished oral assignments. Prerequisite: Completion of at least one 300-level German course.

82-427
The New Germany **Offered intermittently:**
This course, conducted in German, will explore the problems and promise of contemporary Germany. Starting with the end of World War II, it will move on to analyze the division of Germany and the establishment of capitalist and communist German states. After exploring Germany's central role in the cold war system which dominated Europe for half a century, the course will then analyze Germany's role in the breakup-up of that system, which occurred in the fall of 1989 and led to the reunification of Germany on October 3, 1990. The final weeks of the course will be devoted to the current, highly problematic situation in Germany as the former West and East Germany's attempt to achieve cultural, economic, and political integration. In addition to literary works, the course will also include film, political speeches, the visual arts, music, and journalistic articles. Prerequisite: Completion of 82-323 and 82-324 or approved equivalents.

Course Descriptions

82-428
German Classical Literature **Offered intermittently: 9 units**
Main trends from the Enlightenment through Classicism, with special attention to Lessing, Goethe, and Schiller. Prerequisite: 82-323 and 82-324 or approved equivalents.

82-429
German Literature of the Nineteenth Century **Offered intermittently: 9 units**
Readings from Romanticism through Realism. Prerequisite: 82-323 and 82-324 or approved equivalents.

82-430
German Literature of the Early Twentieth Century **Offered intermittently: 9 units**
Readings from major authors such as Hauptmann, Kafka, Mann, Rilke and Brecht. Prerequisite: 82-323 and 82-324 or approved equivalents.

82-431
Postwar German Literature **Offered intermittently: 9 units**
Readings from major authors such as Boll, Borchert, Gross and Walser. Prerequisite: 82-323 and 82-324 or approved equivalents.

82-435/436
Studies in German Literature **Offered intermittently: 6-9 units**
A series of inquiries into major aspects of German literature, from the formation and development of the German literary tradition and its importance as an expression and creator of German national consciousness to specific periods of literary history (classical, Romantic, modern, etc.) or particular literary genres (the short story, the novel, the poem). Prerequisite: 82-323 and 82-324 or approved equivalents.

82-437
Studies in German Culture: (1933-1945): Nazi and Resistance Culture **Offered Intermittently: 6-12 units**
This course will explore what happened to German culture from 1933- to 1945. In particular, it will examine the Nazi assault on modern (or "degenerate") art and the artistic response of the German resistance to Nazi tyranny. Arts explored will include literature, film, music, and the visual arts. Students will be required to view at least five films from the period. The last several weeks of the course will deal with the continuing implications of 1933-1945 for German culture today. Prerequisite: 82-323 and 82-324 or approved equivalents.

82-438
History of German Film **9-12 units**
From the beginning of the twentieth century and the classics of silent film to the 1970s masterpieces of Fassbinder and Syberberg, the history of German film is extraordinarily rich. It provides crucial insights into the development of the German nation in the modern era. This course offers a general introduction to German film studies. It includes both readings and required weekly film screenings. Prerequisite: 82-323 and 82-324 or approved equivalents.

82-521/529
Special Topics: German **Offered intermittently: units variable**
Restricted to language majors who wish to go beyond the regular offering in German. Group or individual study in a subject area approved by the instructor. Prerequisite: Consent of the instructor and a 400-level course.

82-582
Theory & Practice of Translation (w/emphasis on technical texts) **9 units**
This course will introduce students to the world of scientific-technical translation and the special linguistic and cultural difficulties found in scientific-technical German texts. This introductory course is divided in two sections of equal length: a) historic and linguistic background to translation studies, with an emphasis on scientific-technical aspects of German translation (theory & practice), common translation mistakes and traps, and overview of terminology-related questions in scientific-technical translations; and b) practice in translating scientific-technical texts from German into English. There is no perfect translation and no translation is ever finished. Keeping these two important aspects about translation in mind, the work in class will focus on discussing the various translations and working constantly on improving our own translations as well as those of others. In order to accomplish these tasks, a major portion of class time will be spent on developing and building translation strategies (incl. students' ability to read, analyze and translate scientific-technical texts). Prerequisites: Successful completion of German 82-321 and/or 82-322 (or approved equivalent; instructor's approval required); scientific-technical background not required, but may be helpful.

82-583
German Scientific-Technical Translatio **9 units**
This course is a continuation of German 82-583. Whereas the previous course offered an introduction to translation studies, this course concentrates on building and refining students' translation and language skills. In addition, students will be introduced to the world of machine translation, the differences between human and machine translation, and to some of the MT research projects at the Center for Machine Translation (CMT). Students will also be introduced to CMT's Translator's WorkStation (TWS) and begin working with TWS tools for translating, editing, building vocabulary and glossary banks, and applying desktop-publishing skills in actual translation projects. Prerequisites: Successful completion of German 82-321 and/or 82-322 (or approved equivalent; instructor's approval required); ideally, students should have completed German 82-582, enrolling in 82-583 without having taken 82-582 requires instructor's approval; scientific-technical background not required, but may be helpful.

Chinese

82-131
Elementary Chinese I **Fall: 12 units**
A two-semester course sequence for beginning students. The goal of this course is for students to acquire the basic skills of listening, speaking, reading, and writing the standard Chinese language (Mandarin Chinese) that is used by one-fourth of the world's population, and to expose the students to the social and cultural settings in which the language is used. Emphasis will be placed on the development of communicative skills through the learning of the sound system, basic vocabulary and language used in everyday life. Approximately 30% of the time will be devoted to the learning of the Chinese characters, in both the orthodox and the simplified styles. Students will also be exposed to social and cultural aspects of life in China.

82-132
Elementary Chinese II **Spring: 12 units**
This is the second semester of a two-semester course sequence for beginning students. The goal of this course is for students to continue to acquire the basic skills of speaking, listening, reading and writing the Chinese language, with emphasis on the speaking and listening, reading, and writing the Chinese language. The course emphasis will continue to focus on the use of basic vocabulary, sentence patterns and idiomatic usages for communication in everyday life. About 30% of the time will be devoted to the development of reading and writing skills. Lectures will also be given to expose the students to Chinese culture.

Note: All Elementary I, II and Self-Paced language students are required to attend three (3) additional 1 hour lectures as part of this course. These lectures are designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study.

82-231
Intermediate Mandarin Chinese I **Fall: 9 units**
This course is the continuation of Elementary Chinese II. 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. Approximately 40% of the total class hours will be devoted to reading and writing Chinese characters.

82-232
Intermediate Mandarin Chinese II **Spring: 9 units**
A Continuation of Intermediate Chinese I. Students will be taught more complicated word and sentence pattern to be able to carry on daily conversations in a more normal environment. Reading and writing Chinese characters will be given more emphasis and students will learn to write short compositions using characters. Additional lectures on Chinese culture and society will also be given.

Spanish

82-141/142
Elementary Spanish I, II **Fall/Spring: 12 units**
A two-semester course sequence for beginning students emphasizing the development of communicative language proficiency: oral practice, aural comprehension, reading, writing, structural analysis, and language laboratory work. Also a study of cultural aspects of Spanish-speaking countries.

82-143
Self-Paced Spanish **Fall/Spring: 12 units**
First-year study of Spanish for oral comprehension, reading and writing skills through a guided self-study. Language laboratory work and periodic tests. Individual consultation. For highly-motivated students, capable of working independently. (Note: SPI may only be taken for one semester.)

Note: All Elementary I, II and Self-Paced language students are required to attend three (3) additional 1 hour lectures as part of this course. These lectures are designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study.

82-241/242
Intermediate Spanish I, II **Fall/Spring: 9 units**
A two-semester course sequence for intermediate-level students. An integrated approach to the study of Spanish language and culture, consisting of grammar review, readings, and intensive practice in written and spoken Spanish. Reading material on issues of continuing relevance and current interests in modern Spanish or Latin American society. Prerequisite: 82-142 or approved equivalent.

82-341
Advanced Spanish Grammar and Stylistics **Fall: 9 units**
(To be replaced [along with 82-342] with 82-343/344 in Fall 1995)
This course stresses perfection of the linguistic and stylistic practices of advanced students. Focus will be on high frequency errors and on particularly problematic elements and structures which persist beyond the intermediate level. Special attention will be given to individual problems with the goal of improving accuracy of expression in both speaking and writing. Prerequisite: Completion of the intermediate level or the equivalent.

Course Descriptions

82-342
Advanced Writing as Communication - Spanish **Spring: 9 units**
(To be replaced [along with 82-341] with 82-343/344 in Fall 1995)
This course focuses on the building of writing skills for students beyond the intermediate level of study. Students will develop linguistic and organizational skills necessary to achieve clear identification and expression of ideas in Spanish. Writing will be practiced as a process of communication involving the generation, expression, evaluation, re-evaluation, and re-writing of ideas. After discussion of authentic texts in the foreign language from a variety of modes, students will engage in intensive practice of, for example, descriptive, narrative, journalistic, editorial, and expository writing.
Prerequisite: Completion of the intermediate level or the equivalent.

82-343/344
Hispanic Language and Culture A and B **9 units**
(Previously offered as 82-341 and 82-342)
This course is a non-sequential, two-semester, post-intermediate program (Language and Culture A and B). It advances grammatical, communicative, and cultural proficiency through study of important aspects of Hispanic culture. While the focus is on content matter in written and oral forms such as 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. Treatment of literary and cultural reading selections is designed to increase students' general familiarity with a variety of genres, devices, and discourses and to build a foundation for the department's more advanced courses in literature and culture. Writing assignments will direct students to synthesize text-based comprehension and personal perspective and will involve the generation, expression, evaluation, re-evaluation, and re-writing of ideas.
Prerequisite: Completion of the intermediate level or the equivalent.

82-345
Introduction to Hispanic Literary and Cultural Studies: **9 units**
Gazing in the 'Buried Mirror'- Reflections of Spain and Latin America
This course is an introduction to the social, political, and economic forces that have shaped the more than two thousand-year old history and cultures of Spain and Latin America. The clash between Spaniards and the indigenous inhabitants of the lands Spain claimed for itself, combine with the advent of the African slave trade and other European and Asian immigration, has resulted in a 500-year experiment in transculturation with a wide variety of political-economic, linguistic, literary, musical, artistic, dietary, and religious implications. In this course, we shall examine examples of both Spanish and Latin American literary and cultural production from the above mentioned sociohistorical periods. Materials will include but not be limited to historical chronicles, poetry, dramas, essays, and critical readings, narratives, films, music, art, and architecture. Student evaluations, will be based on participation in class activities and discussions, exams, and writing assignments. Prerequisite: Completion of 82-343 or 82-344.

82-410; 79-320
Issues in Contemporary European Civilization **Spring: 9 units**
This course will examine contemporary issues in Modern Europe and will develop a comparative perspective on problems that relate to major European themes of 20th century European society. It will deal with social experience as reflected in language, literature, political and cultural movements as expressed by different ethnic, religious, sexual, scientific, artistic, and/or political groups. Collaborative discussions in the course will exemplify the similarities and differences in the historical expression of these issues in Germany, France, and Spain. Issues to be examined might include local versus common markets, particular and common political and legal structures, homogeneous and heterogeneous populations, ideological and philosophical currents, regional versus national and international languages, and the evolution of educational systems. The course will focus on both comparative and national issues and in the language-specific sections will deal with developments particular to contemporary France, Germany, and Spain. In German, this will include the evolution of "the new Germany", Germany's role in a more closely integrated EC and in the former Eastern bloc nations. With respect to France, topics will include the impact of interwar experience on subsequent French political and social development and the France of the Mitterand era. Issues in Spain might include the Franco era and the evolution of Spain in the post-Franco period, and Spain's relationship to the EC.

82-441
Survey of Spanish Literature and Culture **Offered intermittently: 9 units**
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 82-300-level or approved equivalent.

82-442
Analysis of Spoken Spanish **9 units**
This course will study variations of spoken Spanish in diverse regional and social contexts. Students will conduct recorded personal interviews with Spanish speakers, and then analyze phonological, syntactic and discourse patterns. A goal of the course is to reach a better understanding of the rich diversity of Spanish speaking societies through analysis of their speech patterns. The course will include a review of Spanish phonetics and syntax.
Prerequisite: Advanced course work in Spanish, 80-280 or 82-383 or permission of instructor.

82-442
Contemporary Spoken Spanish (See 82-345) **Fall: 9 units**
This course is designed to promote the oral communicative competence and self-expression of advanced students of a foreign language. Attention will be given to helping students develop both the accuracy and the fluency which characterize the speech of native speakers of a language. Within the context of this course, students will work to refine and perfect speaking skills through special attention to stylistic variation, idiomatic expressions, colloquialisms, and regional and/or dialectal variations in contemporary spoken language. Students will further develop sensitivity to various registers of language use and develop a repertoire of linguistic usage, from the most formal to the most casual, that will permit them to deal effectively with the different types of communicative needs and demands that occur within a variety of cultural settings. In addition, the course will emphasize differences between spoken and written expression and require students to be able to both identify and produce texts appropriate for each. The structure of the course will be based upon a wide variety of authentic spoken and written texts including films, satellite broadcasts, documentaries, radio and television programs, recorded materials, and contemporary literary and non-literary texts. These materials will be used both to analyze differences in spoken discourse and as sources for oral interaction. Students will engage in intensive speaking practice through individual and group presentations, debates, panel discussions, special projects, dramatizations, and native speaker interviews in fieldwork segments of the course. Some written work will be required as preparation for a number of polished oral assignments. Prerequisite: Completion of at least one 300-level Spanish course.

82-443
Introduction to Spanish Translation **Offered intermittently: 9 units**
This course will introduce the students to the process of translating Spanish texts into English and vice versa. The texts will be chosen from a variety of genres and fields, and will include samples of children's literature, short stories, poetry and journalistic texts. Broad issues related to the craft of translation will be addressed and students will be asked to reflect on the different skills and techniques required for the translation of each type of text. The course will emphasize the practical aspects of translation, although some supporting theoretical material will be introduced. Prerequisite: Completion of 82-300-level or approved equivalent.

82-444
The Structure of Spanish **9 units**
We will study the basics of the morphology and syntax of Spanish, to understand how the language works as a system. The student will learn to use descriptive models to analyze Spanish, through assigned readings and problem solving. Segments of the course will cover features that differentiate Spanish from other Romance languages as well as from English. We will also cover important dialectal and historical variations. This course should interest students who might teach or are who are curious about language from an analytical viewpoint.
Prerequisite: Advanced course work in Spanish, 80-280 or 82-383, or permission of instructor.

82-451
Introduction to Latin American Literature and Culture **Offered intermittently: 9 units**
A sociocritical approach to the study of Latin American literature and a survey of representative authors considered in the context of the cultural heritage of Latin American. Prerequisite: 82-345 or approved equivalent.

82-455/456
Studies in Spanish and Latin American Literature **Offered intermittently: 9 units**
A series of inquiries into an aspect of Spanish or Latin American literature, such as a literary movement, a genre, a theme, or the work of a single author (e.g., Visions of Business in the Spanish Speaking World; Political Drama of the 20th Century in Spain and Latin America; Contemporary Novels of Spain and Latin America; Portrait of Family in Contemporary Spanish Drama; Gazing in the 'Buried Mirror': Reflections of Spain and Latin America). Prerequisite: Completion of 82-300-level or approved equivalent.

82-457
Contemporary Latin American Texts: "Back to the Future" - "Revision, Rewriting and Representation" **Spring: 9 units**
An overview of contemporary Latin American texts dealing with issues of historical representation, autochtonous heritage, popular culture and gender roles. The course will explore literary texts and films, their formal and "rhetorical" problematics, as well as the relationship between fiction and imaginary solutions to real cultural and political conflicts. Other materials for consideration will include artwork and critical articles. Prerequisite: Completion of 82-300-level or approved equivalent.

82-465/466
Surrealism in France and Spain
Section A3, French and Spanish Surrealism **Offered intermittently: 6 units**
This course examines the Surrealist movement in works by French and Spanish writers, painters, photographers and filmmakers including Dali, Buneal, Breton, Aragon, Lorca and Tzara. Readings and lectures will be in English. Films will be in French or Spanish with English subtitles. Prerequisites: 82-302 or approved

Course Descriptions

Section B3, "El Surrealismo en España" **6 units**
Meets for the second half of the semester and is conducted entirely in Spanish. A continuation of section A3, this mini-course will be an in-depth study of several Spanish Surrealist writers, painters, photographers and film-makers. Readings, class discussions, student presentations and a final paper will all be in Spanish. Prerequisite: Completion of 300-level in Spanish.

Section B4, "Le Surrealisme en France **6 units**
Meets for the second half of the semester. A continuation of section A3, this mini-course will be an in-depth study of several French Surrealist writers, painters, photographers and filmmakers. Readings, class discussions, student presentations and a final paper will all be in French. Prerequisite: Completion of 302 or approved equivalent.

82-541/549
Special Topics: Spanish **Offered intermittently: units variable**
Restricted to language majors who wish to go beyond the regular offering in Spanish. Group or individual study in a subject area approved by the instructor. Prerequisite: Consent of the instructor and a 400-level course.

Italian

82-161/162
Elementary Italian I, II **Fall/Spring: 12 units**
A two-semester course sequence for beginning students emphasizing the development of communicative language proficiency: oral practice, aural comprehension, reading, writing, structural analysis, and language laboratory work. Also a study of cultural aspects of Italy. Language laboratory work.

82-163
Self-Paced Italian **Fall/Spring: 12 units**
A self-paced version of 82-161/162, for highly-motivated students, capable of working independently. Language laboratory work and periodic achievement tests. Individual consultation. (Note: SPI may only be taken one semester.)

Note: All Elementary I, II and Self-Paced language students are required to attend three (3) additional 1 hour lectures as part of this course. These lectures are designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study.

82-261/262
Intermediate Italian I, II **Fall/Spring: 9 units**
A two-semester course sequence for intermediate-level students. An integrated approach to the study of Italian language and culture, consisting of grammar review, readings, and intensive practice in written and spoken Italian. Prerequisite: 82-162 or approved equivalent.

82-561
Special Topics: Italian **Offered intermittently: units variable**
Restricted to language majors who wish to go beyond the regular offerings in Italian. Group or individual study in a subject area approved by the instructor. Prerequisite: Consent of the instructor .

Japanese

82-171/172
Elementary Japanese I, II **Fall/Spring: 12 units**
A two-semester course sequence for beginning students This course emphasizes the development of oral-aural skills and introduces basic reading and writing Japanese and the socio-linguistic setting needed for students to enhance their language acquisition. Class attendance is mandatory and all conversation in the recitation sessions is conducted in Japanese.

Note: All Elementary I, II and Self-Paced language students are required to attend three (3) additional 1 hour lectures as part of this course. These lectures are designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study.

82-271/272
Intermediate Japanese I, II **Fall/Spring: 12 units**
A two-semester course sequence for intermediate-level students. A Continuation of 82-171-172, this course introduces more complex grammatical structures and different speech levels. Study of the Japanese syllabaries continues with further integration of Chinese characters. Class attendance is mandatory and all conversation in the recitation sessions is conducted in Japanese. Prerequisite: 82-171/172 or approved equivalent.

82-273
Introduction to the Japanese Language & Culture **Fall: 9 units**
This course is an introduction to modern Japanese and the role the language plays in contemporary Japanese society. It provides an overview of the language from cultural, social psychological and linguistic perspectives, and is intended for individuals with interest in Japan or the Japanese language, as well as for students of the Japanese language. Topics covered include the distinctive features of Japanese as a linguistic system, spoken and written; gender- and status-based differences in language use; the role of the language in Japanese interpersonal communication; and its role in Japanese cultural identity. The course is taught in English with no previous knowledge of Japanese assumed.

82-371/372
Advanced Japanese Conversation and Composition II **Fall/Spring: 9 units**
Course designed to help advanced students master the Japanese spoken language and further develop their reading and writing skills. Study of appropriate speech levels required in different situations (formal vs. informal; polite vs. plain; male vs. female speech). Selection of reading materials covering most of the Chinese characters in the Kyooiku Kanju (881). Prerequisite: 82-272 or approved equivalent.

82-471/472
4th Year Japanese I, II **Fall/Spring: 9 units**
This course is designed for the students to develop the reading and writing skills and Chinese character acquisition, while continuing to refine oral communication skills through class discussions and role-play exercises. Course materials include Japanese newspapers, magazines, short stories, videotapes of TV shows, movies and news programs. Prerequisite: 3 years of college Japanese or approved equivalent.

82-572
Special Topics: Japanese **Offered intermittently: variable units**
Designed for students of Japanese who wish to go beyond the regular offerings in Japanese. The emphasis is on the development of advanced reading and writing skills. Course materials include Japanese newspapers, literary texts and some technical documents. Prerequisite: Consent of the instructor and a 400-level course.

Russian

82-191/192
Elementary Russian I, II **Fall/Spring: 12 units**
This two-semester course sequence (which begins in the Fall only) takes a proficiency-based approach to teaching basic skills in listening, speaking, reading and writing. Language is presented in communicative contexts illustrating cultural aspects of daily Russian life. Special emphasis is given to developing oral competency. Attendance is required at four hourly meetings per week. One to two hours per day outside of class must be devoted to practice in the language laboratory and to other oral and written homework assignments.

Note: All Elementary I, II and Self-Paced language students are required to attend three (3) additional 1 hour lectures as part of this course. These lectures are designed to help students learn to reflect upon and draw upon strategies used by good language learners in their second language study.

82-193
The Faust Legend in Europe and Russia **Offered intermittently: 9 units**
Since the sixteenth century, the name of Faust has nurtured a vigorous strain of legend and literature that has flourished not only in Europe but in Russia, too. 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 films of Germany, France, Hungary, Czechoslovakia and Russia. On the assumption that cultures reveal something distinctive about themselves by the particular way in which they adapt the legend, this course aims to discover how and why these Faustian works of art respond and contribute to the social, political and historical context in which they are produced. On what is the persistent appeal of the Faust legend based? To what needs does it speak? How does the history of its own, continual reemergence affect the meanings it communicates? These questions are entertained as works including the following are studied: Christopher Marlowe's "The Tragical Life of Doctor Faustus", Johann Wolfgang von Goethe's "Faust", Charles Gounod's "Faust", George Sand's "The Seven Strings of the Lyre", Ivan Turgenev's "Faust", Klaus Mann's "Mephisto", Mikhail Bulgakov's "Master and Margarita", Vaclav Havel's "Temptation", F. W. Murnau's "Faust" and Istvan Szabo's "Mephisto". Written papers, oral presentations, and participation in class discussions are required, as are reading assignments of approximately 200 pages per week and viewing of films outside of class hours.

82-291/292
Intermediate Russian I, II **Fall/Spring: 9 units.**
A continuation of 82-191/192, this two-semester course sequence (which begins in the Fall only) further develops communicative proficiency through intensive practice in written and spoken Russian, involving more complex grammatical structures and stylistic variations, as well as more extensive vocabulary acquisition. Through reading materials, both fictional and non-fictional, acquaintance is made with the basic components of Russian cultural literacy. Four hours of in-class instruction plus language laboratory work outside of class are mandatory, as are written homework assignments.

82-391
Advanced Russian **Fall: 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. Language laboratory practice, additional to three class hours per week, is mandatory for the evolution of aural/oral fluency. Written compositions and translations, assigned for homework, are required for the development of grammatical accuracy and stylistic appropriateness. All class discussions are conducted in Russian. Prerequisite: high level of competence at the 200-level.

Course Descriptions

82-399A
Special Topics-Russian: Contemporary Russian Writing and Speech **Offered intermittently: units variable**
This course takes a proficiency approach to speaking and writing Russian, and is designed especially for those who intend to study in Russia. The goal is to achieve precision and accuracy of expression, in order to prepare the student for rapid advancement in a Russian academic setting. In addition to developing the required linguistic skills, special attention is paid to the cultural differences between Russian and American systems of education. Prerequisite: high level of competence at the 200-level.

82-399/B
Special Topics-Russian: "The Russian Press" **Offered intermittently: units variable**
A reading course concentrating on the particular syntax and vocabulary that characterizes the contemporary Russian press. Designed for those who seek to acquaint themselves with current issues in Russian society and to improve their grasp of the discourse particular to Russian journalism. Satisfactory completion of two years' college Russian or the equivalent is required. Background in Russian history and political science is recommended, but not required. Prerequisite: 82-292 or permission of the instructor.

82-399/C **Special Topics-Russian: The New Russian Text-Type** **Offered intermittently: units variable**
This course seeks to characterize current trends in the Russian publishing industry at large. A range of texts (newspapers, short stories, poems, children's literature) are sampled from a variety of temporal frames of reference (current, perestroika, Cold War, Revolution, Monarchy). Comparisons are made in vocabulary and syntax in order to reveal the attitudes of writers toward readers that characterize the institutions governing the printing press. The course is open to those with four or more semesters of college Russian (or the equivalent), and is structured to accommodate a range of Russian language capabilities.

82-491
Literature, Politics and Film in East Europe and Russia Today **Offered intermittently: 9 or 12 units (see below)**
This course aims to familiarize the student with the cultural geography of contemporary East Europe and Russia, including, to some extent, the territories of the former the Soviet Union. Visual texts serve to outline the power politics that have shaped East European and Russian/Soviet cultures from World War II to the present, dramatic day, while verbal texts reveal a range of personal responses to current crises affecting national identity, human rights, gender roles, and the natural environment. While the first of these is the predominant concern of the course, the other three attract a good deal of attention as they take shape in the modes of cultural discourse by which national identities are formulated. The course seeks to sample this discourse mainly in fictional literature and feature film; however, a small number of nonfiction essays and documentary films are seen to demonstrate the breakdown of traditional genres that characterizes intellectual production in times of political flux. Alexander Solzhenitsyn, Valentin Rasputin, Yevgeny Yevtushenko, Vaclav Havel, Milan Kundera, Elie Wiesel and Christa Wolf are among the writers considered in their attitudes toward their nations' political and cultural institutions as well as in the intertextual relationships of their works to one another. Films to be examined for the means by which they magnify these writers' social concerns include "Repentance," "Requiem for Dominic," "Little Vera," "Nasty Girl," and "Sideburns" Lecture and discussion formats 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 and viewing of films outside of class hours. The course is offered in English, three times per week, for 9 units. For 12 units, a fourth weekly meeting in Russian is added.

82-492
The Historical Imagination in Nineteenth Century Russian Literature **Offered intermittently: 9 or 12 units (see below)**
Pushkin, Gogol, Turgenev, Chekhov, Dostoevsky and Tolstoy all ruminated upon their nation's historical destiny. This course aims to describe the role played by imagination in these authors' efforts to wreak from Russia's past a vision of her future. Emphasis is placed upon the figurative operations of language that allow narrative to function as a guidepost to a collective mission and a map of the individual's location within the projected historical scheme. Seminar format: 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 times per week, for 9 units. For 12 units, a fourth weekly meeting in Russian is added.

Modern Language Courses(not language-specific)

82-110
Self-Study in Less Commonly Taught Languages **Fall/Spring: 12 units**
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., Hebrew, Korean, Swahili). The course will provide individualized language instruction for students working at their own pace in consultation with a tutor using materials identified by the National Association of Self Instructional Language Programs. Courses emphasize the development of oral-aural skills and introduce basic reading and writing. Students must be prepared to devote at least 15 hours per week to individual study in addition to the time spent each week in consultation with their tutor. Enrollment in the course is limited, and permission from the Modern Languages Department is required.

82-180
Freshman Seminar in Modern Languages **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 begin by contrasting worldwide multilingual contexts such as India, Africa and parts of Europe with the language situation in the U.S. 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 second language proficiency; and the societal repercussions of encouraging or discouraging second language learning or teaching programs. Examples, reading, and assignments will be selected to permit consideration of a range of issues from both monolingual and bilingual countries.

82-198
Modern Languages Research Training Course **Fall/Spring: 9 units**
This one-semester research internship is open to second semester freshmen and to 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 Department secretary maintains a listing of participating faculty and the current projects on which they are willing to supervise student interns. The general interests of Modern Languages faculty include four broad categories: second language acquisition, cultural studies, the development of innovative multi-media applications to language teaching, and the use of machine translation tools for enhancing the quality and speed of scientific translation. It is intended that students carry out a finite piece of research which will require about 10 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 on only one occasion.

82-280
Learning about Language Learning **Fall: 9 units**
This course is designed for students majoring or co-majoring in a Modern Language, or for students seriously contemplating undertaking the study of a foreign language at some 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 learning. Co-requisite: Study of a foreign language.

82-381
Issues and Trends in Second Language Learning and Teaching **Offered intermittently: 9/12 units**
This course is directed toward those who intend to teach foreign or second languages, primarily English. The course will focus on the relationship between theories of second language learning and approaches to second language teaching. The course will begin by introducing students to the concept of language needs assessment, and will then provide a broad introduction to the major approaches, methods, and techniques currently used with a view toward helping students understand the major strengths and weaknesses of the various methods. It will address such issues as the difference between tutored (classroom-based) second language learning and natural second language acquisition, second language learning that takes place in the native language environment (e.g., English as a second language in the U.S.) as contrasted with language learning that takes place out of the host country (e.g., learning French in the U.S.). Relevant topics include literacy, bilingual education, current methods of teaching, language assessment and policy issues in language education. In addition to classroom discussion, students will spend time observing classes or tutorial sessions in which the target language is being taught as a second language by experienced teachers. Students who take this course as part of the minor in TESOL will be required to add 3 units of practice teaching in ICC as part of the course. The practicum will offer students an opportunity to put into practice some of the methods and techniques that are being discussed and observed as part of their participation in Issues and Trends in Second Language Learning and Teaching.

82-382
Structure of English **9 units**
This course will provide a description of the lexical and syntactic structures of English. Students will be introduced to linguistic analysis as well as analysis of grammatical relations within sentences and rhetorical relations among sentences. The class is designed to prepare teachers of English as a second or foreign language who will be working either in an American school setting or teaching abroad

82-383
Second Language Acquisition **9 units**
This course provides an introduction to research in Second Language Acquisition (SLA). The processes that underlie the learning and use of second language(s) are approached from three perspectives: 1) as linguistic knowledge 2) as a cognitive skill, and 3) as a socially and personality-meditated process. Factors examined include: age-related differences, the influence of the first language, the role played by innate (universal) principles, the role of memory processes, attitudes, motivation, personality and cognitive styles, and formal versus naturalistic learning contexts. Prerequisites: None, however, 82-280 Learning about Language Learning is strongly recommended.

82-480
Social and Cognitive Aspects of Bilingualism — **Offered intermittently: 9 Units**
This seminar will examine the differential course and consequences of learning two languages for individuals who study a second or foreign language in a formal classroom setting and for others who have an opportunity or need to acquire a second language in non-formal setting. With the changing demography of the American population, and the increasing internationalization of markets, more and more "students" and adult learners will be seeking ways to develop foreign language skills. In addition, we will examine the ways in which a variety of affective, cognitive, and personal factors influence the process of learning. The implications of these finding for the formulation of educational policy for the United States will be discussed.

82-481
Research Methods in SLA — **9 units**
Introduces students to research methodology as it applies to language learning and language teaching. An examination of different approaches currently used in SLA research ranging from experimental studies to case studies. The goal is to develop an ability to critically evaluate and to design and implement sound SLA research.

82-482
Language Assessment — **9 units**
Theoretical and practical study of aspects of language testing. Purposes and types of language tests are examined in relation to theories of language use and language teaching goals. Testing practices and procedures related to language research and language teaching are also discussed. The course also includes the planning, writing, and administration of tests, and basic test analysis.

82-505
Undergraduate Internship — **Fall/Spring: 9 to 18 units**
Approved upper-class language majors may receive limited credit in connection with work experience related to language learning and language use. As a rule, this experience takes the form of work abroad that involves language use or research related to language study at national sites off campus. Students must obtain prior approval for proposed work and must be evaluated by a university-approved on-site supervisor as well as a departmental faculty member. Prerequisite: At least one 300-level course or consent of a faculty member. plus permission of the Department Head.

82-580
Senior Seminar in Modern Languages — **Spring: 3 units**
This mini seminar for majors in Modern Languages, will focus on general issues in second language learning. It will provide an integrative and culminating experience for students as they complete their studies. The course will include questions 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 will be for students to reflect upon their language learning experience and to discuss the role that a second language plays in their own lives and in American society today. Students will be asked to relate their study of a foreign language with another content area in the undergraduate curriculum.

82-591/592
Honors Thesis — **Fall and 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. Research topics are selected by students and faculty. Prerequisites: Senior standing; a 3.5 QPA in one's language major; a 3.25 QPA overall; permission of the Department's faculty; and approved entry into the College's Honors Program.

Summer Language Programs Abroad

Carnegie Mellon offers intensive summer programs on campus and abroad for college students who wish to acquire or improve communication skills in French, German, and Spanish and become acquainted with the countries in which these languages are spoken. Participants in the four- or six-week intensive sessions at the language institutes in Europe will have 20 - 24 hours of classroom instruction per week as well as supplemental tours and excursions. Weekends are free for sight-seeing and travel. This portion of the program is offered for 18 units (6 credit hours) and is open to students at all levels. The cost includes tuition, lodging (with families, in Germany and Spain), all meals, the supplemental excursions and tours, and ground transportation to the institute from the nearest airport.

French:	Carnegie Mellon in Southern France
German:	Goethe Institut in Rothenburg
Spanish:	Estudio Internacional Sampere in Madrid and Puerto de Santa Maria.

82-101/201/301
Carnegie Mellon in Aix-en-Provence and Avignon: Summer Program — **Summer: 18 units**

82-126/226/326
Carnegie Mellon in Germany: German Language and Culture — **Summer: 18 units**

82-146/246/346
Carnegie Mellon in Spain: Spanish Language and Culture — **Summer: 18 units**

Psychology

Undergraduate Courses

** Courses with a second 3-digit course number suffix, preceded by a double asterisk (e.g., 85-414/**714), are courses offered simultaneously as undergraduate and graduate courses. Courses thus marked and taken for graduate credit may have different prerequisites, requirements, or unit value. Check with the Department for details.

85-100
Cognitive Processes: Theory and Practice — **Fall: 9 units**
A practical as well as theoretical introductory course aimed at increasing the student's problem-solving skills. Topics covered will include representing problems, searching for solutions, making decisions, learning, creating, and self-monitoring. A special feature of the course involves the acquisition of skills which can be transferred to the student's own areas of interest.

85-101
General Psychology (self-paced) — **Fall and Spring: 9 units**
This course introduces both the biological and social science aspects of psychology. It covers development, personality, brain mechanisms, perception, motivation, social processes, learning, cognitive processes, and mental health. Beyond a minimum rate of progress, students can work at their own pace. Approximately fourteen chapters in the text are assigned, along with an accompanying film, with a short test given on each. Within each major section of the course students may take a particular chapter test whenever they are ready, and can be tested up to three times on the same material until they achieve the grade level they choose. Only the highest grade on any test counts. There is also a comprehensive examination on each major section of the course that accounts for approximately 1/3 of the grade.

85-102
Introduction to Psychology — **Spring: 9 units**
This course examines major areas of scientific psychology in some depth. The primary focus is on the areas of neural and motivational control of behavior, memory and thought, social interaction, and psychological development. Specific topics within these areas include brain function, motivational control systems, learning, cognitive and perceptual information processing, problem solving, obedience and conformity, social interaction, emotion, attitude consistency and change, how our social, cognitive and language functions develop, the importance of childhood to adult functioning, and psychopathology. In addition to the lecture, the course includes a weekly recitation section meeting and a small number of computerized laboratory experiences in which the student gets to perform actual experiments and analyze real data.

85-120
General Programming — **Fall and Spring: 9 units**
This is a course focused on the general concept of computer programming. It strives to teach the core ideas behind writing a computer program. Two programming languages (Prolog and LISP) will be used to show how these ideas are realized in different programming languages. Students will write programs in the two languages and emerge with the ability to program on the Macintosh. This course is appropriate for H&SS undergraduates who want a broad appreciation of the nature of computer programming. It is not a sufficient preparation for students who will be going on to other computer science courses. Students who want to take other computer science courses but who lack preparation might take this course before the introductory computer science course. This course is largely taught from computers and involves only occasional class work. The course is a modified self-paced course based on the concept of mastery learning. This course makes use of intelligent computer-based tutors to provide individualized instruction on each of the topics. After reaching mastery level with the tutors on a topic students take a quiz on the Macintosh.

85-150
Introduction to Social Problems — **Fall: 9 units**
This course applies social-psychological models to understanding contemporary social problems including homelessness, urban crowding, victimization, drug abuse, and natural or technological disasters. Social psychologists assume that individuals are, to varying degrees, embedded in formal and informal networks. Individuals' social webs have a variety of forms and functions. By studying models of the structures and functions of social ties, students will learn how social psychologists explain individuals' responses to and the social courses of a variety of social problems. Particular emphasis will be given to understanding social problems from the perspectives of social control, social modeling and social support theorists.

85-198
Research Training: Psychology — **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. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as "elective" units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. Prerequisites/restrictions: For H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

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, 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.

85-219
Biological Foundations of Behavior **Fall or Spring: 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 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, 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 traces the development of the child from the prenatal period to the end of adolescence. First, we will examine the genetic underpinnings of human nature and the ways in which these underpinnings set limits on later development. Next, we will study the development of the emotional system, visual perception, and early vocalizations in the infant. During the preschool years, the main topics we will consider are language development and cognitive development. Finally, we will trace the development of the school-aged child in both the cognitive and the social realms in the areas of moral development, sex-role formation, peer group formation, problem-solving, numerical reasoning, and logical operations. For each of the topics examined, we will consider theoretical accounts from social psychology, learning theory, biology, Piagetian psychology, and information-processing psychology.

85-241
Social Psychology **Fall: 9 units**
The focus of this course will be on how people's behavior, feelings and thoughts are influenced or determined by their social environment. The course will begin with lectures and readings on how social psychologists go about studying social behavior. Next, various topics on which social psychologists have done research will be covered. These topics will include: person perception, prejudice and discrimination, the nature of attitudes and how attitudes are formed and changed, interpersonal attraction, conformity, compliance, altruism, aggression, group behavior, and applications of psychology to problems in health care, law, politics, and the environment. Through readings and lectures on these topics, students will also be exposed to social psychological theories.

85-251
Introduction to 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 from a slightly different vantage point. Included among these approaches are the dispositional, psychoanalytic, learning, phenomenological, and cognitive self regulation perspectives. This is a survey course and is intended to provide students with a broad background of theory and research in the area. Class meetings will include a mixture of lecture and discussion.

85-261
Abnormal Psychology **Fall and Spring: 9 units**
People do not always act in the ways we expect, be they roommates, recluses, parents, or even people on the street. In the extreme, some people are even labeled psychologically "abnormal." This course will look at theoretical, experimental and applied issues for understanding "abnormal" psychological functioning. The course will survey etiologic, diagnostic, theoretical, therapeutic and political aspects of "abnormal" psychological functioning. Readings and lectures will be supplemented by films and opportunities for more direct experience so that students may leave the course with a sense of its relevance for their own lives.

Course Descriptions

85-281
Introduction to Clinical Psychology **Spring: 9 units**
This course is designed to introduce students to a wide variety of concepts in the area of clinical psychology. Different approaches to psychological assessment and various theories of psychotherapy will be explored including psychoanalytic, Gestalt, Jungian, cognitive, client centered, behavioral, and phenomenological psychology. Issues that arise in treatment will be discussed such as depression, gender, sexuality, stress, and substance abuse. Prerequisites: either 85-251 Introduction to Personality, 85-261 Abnormal Psychology, or 85-241 Social Psychology.

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 experimental methods in cognitive psychology. Students learn how to design experiments and analyze and interpret data by conducting experiments. The course covers experimental design, including factorial design, and a variety of research methodologies, including the analysis of response times, the analysis of qualitative data, and signal detection analysis. The topics include mental imagery, memory, and language processing The class format consists of lecture, discussions and student presentations. Prerequisites: 85-211 Cognitive Psychology and 36-202 Statistics.

85-320
Research Methods in Child Development **Fall and Spring: 9 units**
This is a laboratory course, in which the student will have direct experience working with children, as well as writing research reports and designing and critiquing research in child development. The purpose of the course is to develop research expertise that will assist the student both in carrying out research and in evaluating the research of others. Special emphasis will be given to the unique methodological problems associated with the study of development. Prerequisites: 85-221 Principles of Child Development and 36-202 Statistics.

85-340
Research Methods in Social Psychology **Fall and Spring: 9 units**
This course is designed to provide students with the necessary knowledge to evaluate research, make transitions between theory and the operations that test the theory, and to design and carry out original research. Topics will include the nature of proof and causal inference, manipulation of independent variables, measurement of dependent variables, questionnaire design, experimental ,and quasi-experimental, design and ethical issues involved in doing research. Survey, observational and experimental techniques as applied in both field and laboratory settings will be covered. Students will be expected to criticize completed research. They are also expected to design measures and complete their own original studies. During the course of the semester students will also be expected to design and carry out an original research project as well. Prerequisites: 85-241 Social Psychology or 85-251 Introduction to Personality and 36-202 Statistics.

85-350
Research Methods in Cognitive Neuroscience **Spring: 9 units**
This course is designed to introduce students to the various research skills and approaches associated with cognitive neuroscience. A wide range of methods such as brain imaging, the cognitive assessment of brain damage in patients, and neuroanatomy, will be introduced. An emphasis will be placed on the use of multiple techniques to address questions. The course will also cover the constraints on experimental design related to these techniques. The class format will consist of lectures, discussions, student presentations, and some direct "hands on" experience. Prerequisites: 85-211 Cognitive Psychology, or 85-219 Biological Foundations, and 36-202 Statistics, or permission of instructor.

85-380
The Historical Development of Experimental Psychology **Fall: 9 units**
This course will focus on three aspects of the origin and growth of experimental psychology. The first is the "prehistory" of psychology, where the connection of the discipline to the development of modern science, and in particular, its origins in philosophy and physiology, is examined. The second focus of the course is on the different approaches and attempts to define the field that have contested for dominance during much of the life of the discipline. The final major focus of the course is on the modern period (roughly the last forty years) where the influences that brought about the modern "counter-revolution" in psychology will be examined, and where some conjecture about likely future directions will occur. Prerequisite: at least two prior Psychology courses.

85-390
Human Learning and Memory **Offered intermittently: 9 units**
Without memory, people would barely be able to function: we could not communicate because we would not remember meanings of words, nor what anyone said to us; we could have no friends because everyone would be a stranger (no memory of meeting anyone); we could have no sense of self because we could not remember anything about ourselves either; we could not predict anything about the future because we would have no recollections of the past; we would not know how to get around, because we would have no knowledge of the environment. This course will discuss issues related to memory at all levels: the sensory registers, i.e., how we perceive things; working or short-term memory; long-term memory or our knowledge base. We will discuss the differences between procedural/skill knowledge, and declarative/fact knowledge. The topics of memory monitoring, feeling and knowing, spread of activation within memory (priming), implicit memory, and amnesia will also be covered. Prerequisite: 85-211 Cognitive Psychology or equivalent.

Course Descriptions

85-393
Human Factors **Offered intermittently: 9 units**
Human factors is the field that concerns the relationship between humans and their environment, most typically the work environment. It draws from research in psychology, physiology, and engineering. The course goals are to provide a general overview of the field and to introduce students to basic tools used by human factors researchers. Topics may include a brief introduction to experimental design and statistics; basic human factors, comprising anthropometry (measuring the human body), biomechanics (the study of movement), and ergonomics (the study of work, with emphasis on biological constraints); psychological foundations, including perception, motor control, cognitive processing, and human information processing; methods of human factors; and applications of human factors. Prerequisites: junior or senior class standing, or permission of the instructor.

85-408/708**
Visual Cognition **Spring: 9 units**
Recognizing an object, face or word is a complex process which is mastered with little effort by humans. This course adopts a three-pronged approach, drawing on psychological, neural and computational models to explore a range of topics including early vision, visual attention, face recognition, reading, object recognition, and visual imagery. The course will take a seminar format. Prerequisite: Permission of the instructor.

85-409/709**
Cognition and Instructional Design **Offered intermittently: 9 units**
This course examines the use of cognitive analyses to design and assess practical instruction which can, in turn, serve as an experimental arena for refining the analyses and improving basic understanding of human cognition. A central focus will be instruction facilitating the learning of conceptual and problem-solving skills needed to deal with scientific or technical subjects. Work in this seminar course will involve moderate amounts of reading, active student participation in discussions of important issues, and design and implementation of a small instructional project. The course is open to graduate students and to interested undergraduates if they have adequate preparation (such as 85-211, or 85-411) and permission of instructor.

85-411/711**
Cognitive Processes and Problem Solving **Fall: 9 units**
This course will focus on psychological processes in thinking and problem solving; relation of language to thinking; relation of perception and imagery to problem solving; semantics and internal representations; development of information processing capacity. Methods for studying thinking empirically; constructing and testing computer simulation models of adult's and children's thinking. Prerequisite: 85-211 Cognitive Psychology or permission of the instructor.

85-412/712**
Production System Models of Thought **Offered intermittently: 9 units**
The goals of this course are three: To review the evidence for production system models of human cognition, particularly as model of skill acquisition. To teach the skills involved in developing a production system model of a particular cognitive skill. Show how production system models can be deployed in the development of intelligent tutoring systems. The course grade will be determined by a series of assignments involving developing production system models and by two written exams. Prerequisites: At least one course in cognitive psychology and an ability to program in LISP.

85-413/713**
Psychology of Reading **Offered intermittently: 9 units**
Reading is a composite of very complex cognitive skills. It is also an area in which there has been rapid progress in understanding the process, its acquisition, and the sources of difficulty and disability. This course examines research and theories on sentence and text comprehension, word recognition, individual differences in reading ability, dyslexia, writing systems, eye fixations, perception, instructional methods, and speed reading. Prerequisite: 85-211 Cognitive Psychology or permission of the instructor.

85-414/714**
Cognitive Neuropsychology **Fall or Spring: 9 units**
This course will review what has been learned of the neural bases of cognition through studies of brain-damaged patients as well as newer techniques such as brain stimulation mapping, regional metabolic and blood flow imaging, and attempt to relate these clinical and physiological data to theories of the mind cast in information-processing terms. The course will be organized into units corresponding to the traditionally-defined subfields of cognitive psychology such as perception, memory and language. In each area, we will ask: To what extent do the neurological phenomena make contact with the available cognitive theories? When they do, what are their implications for these theories (i.e., Can we confirm or disconfirm particular cognitive theories using neurological data?)? When they do not, what does this tell us about the "parses" of the mind imposed by the theories and methodologies of cognitive psychology and neuropsychology? Prerequisites: 85-211, Cognitive Psychology and either 85-310, Research Methods in Cognitive Psychology, or 85-350, Research Methods in Cognitive Neuroscience.

85-417/717**
Intelligent Computer-Assisted Instruction **Offered intermittently: 9 units**
This course will focus on the combination of cognitive psychology and artificial intelligence required to develop intelligent computer-assisted instruction. A background in artificial intelligence (minimally LISP) and cognitive psychology is required. Half of the course will be project-oriented. We will learn the production system GRAPES and work up to producing an expert system and a tutor for a fragment of calculus. Prerequisite: permission of the instructor.

85-418/718**
Development of Mathematical Thinking **Offered intermittently: 9 units**
This course will focus on how children come to understand mathematics. We will examine a number of different facets of mathematics, including counting, understanding of numerical magnitudes, number conservation, arithmetic, estimation, and algebra. We will follow the development of these mathematical concepts and reasoning skills from the earliest days of life until adulthood. The goal throughout the course will be to understand how children think mathematically at particular points in development and to understand the mechanisms that produce changes in these ways of thinking.

85-419/719**
Introduction to Parallel Distributed Processing **Spring: 9 units**
This course will provide an overview of parallel-distributed processing models of aspects of perception, memory, language, knowledge representation, and learning. The course will consist of lectures describing the theory behind the models as well as their implementation, and students will get hands-on experience running existing simulation models on workstations. Prerequisites: 85-211 Cognitive Psychology, extensive experience using computers, and 21-122 Calculus 2 or permission of the instructor.

85-420/720**
Perception and Perceptual Development **Offered intermittently: 9 units**
This course examines how people perceive the world around them. The course will cover a number of topics including the major theories of perception, the empirical data on human vision and other senses, the neural substrates of perception, and perceptual development.

85-421/721**
Language and Thought **Fall: 9 units**
This course allows the student to explore ways in which the mind shapes language and language shapes the mind. Why are humans the only species with a full linguistic system? Some of the questions to be explored are: What kinds of mental abilities allow the child to learn language? What are the cognitive abilities needed to support the production and comprehension of sentences in real time? How do these abilities differ between people? Are there universal limits on the ways in which languages differ? Where do these limitations come from — cognition in general or the specific language facility? Why is it so hard to learn a second language? Are there important links between language change and cultural change that point to links between language and culture? Prerequisite: either 85-211 Cognitive Psychology, 80-180 The Nature of Language, or equivalent background.

85-422/722**
Infancy **Offered intermittently: 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 which characterize research in that field. The course will be discussion-oriented and every student will be required to participate actively in both preparing for and contributing to the discussions. Specific content areas to be covered include attachment, perception, memory, conceptual development, and the origins of language. Prerequisite: 85-221 Principles of Child Development.

85-423/723**
Cognitive Development **Fall or Spring: 9 units**
The general goals of this course are that students become familiar with the basic phenomena and the leading theories of cognitive development, and that they learn to critically evaluate research in the area. Piagetian and information processing approaches will be discussed and contrasted. The focus will be upon the development of children's information processing capacity and the effect that differences in capacities have upon the child's ability to interact with the environment in problem solving and learning situations. Prerequisite: 85-221 Principles of Child Development or permission of the instructor.

85-426/726**
Development of Individual Differences in Cognition **Offered intermittently: 9 units**
The goal of this course is to acquaint students with the contemporary literature on theories of (a) how and why individuals differ in cognitive abilities and (b) how these differences develop. By the end of this course, students will have a thorough acquaintance with this literature, as well as with its historical antecedents. The requirements for the course are (a) regular attendance, (b) doing all of the required reading, and (c) a term paper or project. Grading will take into account all three requirements.

85-428/728**
Brain Development and Cognition **Offered intermittently: 9 units**
This course is centered around the interface between the fields of cognitive neuroscience and cognitive development. Taking a developmental approach to cognitive neuroscience allows one to study how the maturation of particular neural pathways and structures gives rise to developments in cognitive, perceptual and motor abilities. The emphasis will be firmly on the computational consequences of underlying developmental events. Students will be required to have attended previous courses in at least one of the following: 85-219,

Biological Foundations of Behavior, 85-420, Perception and Perceptual Development, or 85-423, Cognitive Development.

85-441/**741
Social Psychology of Social Problems **Fall: 9 units**
This course will take an in-depth look at social problems with an eye toward understanding their nature, contributing causes, and human consequences. Various contemporary issues of interest to social psychologists will be covered, including homelessness, discrimination, crowding, bereavement, victimization, health care and stress at work and in the family. Readings and discussions will focus on methods and theories social psychologists use to identify, explain and solve social problems. Prerequisites: 85-241 Social Psychology

85-442/**742
Social Psychology of Health **Offered intermittently: 9 units**
This course evaluates the role of cognition and behavior in the etiology of and recovery from disease. We discuss evidence suggesting the importance of psychosocial factors in illness, and review select primary sources on a number of relevant topics. Topics discussed in the past include stress and illness, helplessness and illness, the health enhancing effects of social support systems, personality and health, relationship between mental and physical health, symptom perception, influencing patients and others to conform to health promoting behavioral regimes, and the effectiveness of massive behavioral interventions on health and well-being. We may also look at psychosocial determinants of specific disorders, e.g., obesity, cancer, depression, and infectious diseases. This is a small seminar for advanced (junior and senior) undergraduates and graduate students. The class requires considerable preparation time. Prerequisite: permission of the instructor.

85-444/**744
Interpersonal Relationships **Fall or Spring: 9 units**
The focus of this class will be on social psychological and sociological studies of attraction and relationships. Readings and class discussions will be organized in terms of theories of and approaches to understanding attraction and relationships which researchers from these two disciplines have taken. Some of the theories and approaches to be included are classical conditioning, attribution theory, attitude theories, and theories of social justice. In the course of covering these approaches some of the topics which will be discussed include: a definition of attraction, how attraction can be measured, impression formation, ingratiation, attraction in short term relationships and attraction in long term relationships. Research techniques will also be discussed. Prerequisites: 85-241 Social Psychology or 85-251 Introduction to Personality

85-446/**746
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. Readings will consist of theoretical, and empirical articles for psychological, sociological, and medical journals.

85-451/**751
Psychology of Purpose **Fall: 9 units**
Psychologists have had a long-standing interest in understanding human motivation — knowing what it is that makes people work as hard as they do for the things that they want, and knowing what it is that determines a person's response to problems that arise that interface with the achievement of goals. The primary purpose of this course is to consider the topic of human motivation, broadly defined. As an organizational tool, we will rely on one recent theory of human motivation, which usually goes by the name of behavioral self-regulation theory. We will consider first how people identify and work towards goals when things are going smoothly. An even larger part of the course, however, will be devoted to examining the causes and consequences of problems in self-management, as well as to understanding the role of affect in coping with life problems. As part of our consideration of the coping process, we will focus attention on several personality characteristics that seem to influence success in coping. Two of these personality characteristics are dispositional optimism and pessimistic explanatory style. This is a small, advanced seminar. Active participation in classroom discussion is mandatory. Prerequisites: 85-251 Introduction to Personality or 85-241 Social Psychology. It is also recommended that you have taken, or are taking concurrently, Research Methods in Social Psychology 85-340.

85-460/**760
Functional Neural Circuits **Offered intermittently: 9 units**
This course will examine brain function from an information processing and computational perspective. Primate and non-primate brain systems will be studies with a focus on the function of these systems, and their relationship to behavior. The course will begin with a brief examination of two simple vertebrate brain systems (toad and chick) which demonstrate general principles of neural organization. The remainder of the course will focus on the organization of mammalian brains. A series of classes will be devoted to general principles of organization (cortical columns; cortical layers; cortical development). This will be followed by classes dedicated to particular brain systems (visual cortex, basal ganglia and striatum, hippocampus, temporal and parietal cortex, frontal cortex and neuromodulatory systems). The course will be run in seminar format: students will be expected to present readings to the class. Assessments will be based on performance in class (both quality of presentations and participation in discussion).

Course Descriptions

Prerequisites: This course will assume an introductory-level working knowledge of basic concepts in neurobiology (e.g., what neurons synapses, action potentials and neurotransmitters are and how they function) as well as basic concepts in cognitive psychology (e.g., the distinction between automatic and controlled processes, standard models/theories of memory and attention, etc.). Therefore at least two of the following courses are prerequisites, one from list A and one from List B.

List A
85-211 Cognitive Psychology
85-219 Biological Foundations of Behavior
85-414 Cognitive Neuropsychology
85-428 Brain Development & Cognition

List B
85-428 Brain Development & Cognition
03-360 The Biology of the Brain
Any other neurobiology/neuroscience course

85-480
Internship in Clinical Psychology **Fall and Spring: 5 units**
This course is a cooperative effort by Carnegie Mellon University and Western Psychiatric Institute and Clinic to expose students to the techniques of therapy and treatment of patients at WPIC. It is an opportunity for students to learn about clinical psychology through direct contact with patients under the supervision of WPIC staff. It can also be an opportunity for undergraduates to participate in a clinical research project. This unique undergraduate opportunity can be as varied as the individuals who participate. It is geared to the serious psychology major, junior or senior, who is planning a graduate career. After an interview with WPIC staff you may have the opportunity to either enter an existing research project or work in a clinical situation coordinated to both your interests and the institute's needs. In the second semester you may elect to work in another institutional or agency setting chosen in conjunction with the course instructor. The course will be graded on a pass-fail basis. Prerequisite: 85-251 Introduction to Personality or 85-261 Abnormal Psychology or 85-281 Introduction to Clinical Psychology.

85-481
Seminar in Intervention **Fall or Spring: 9 units**
This course is an introduction to the helping process. It gives the student the opportunity to develop the skills needed to be a helping person. The primary vehicle of instruction in the course is through practice of these skills, which is accomplished in role-playing situations.

85-501/502
Seminar in Special Topics **Offered intermittently: 9 units**
Various topics are covered, drawing on selected areas of the department's research expertise. Size is generally limited to preserve the "seminar" format. Prerequisites are likely, and vary from topic to topic.

85-505/506
Independent Reading in Psychology **Fall and Spring: Units variable**
As the name implies, the emphasis in the "Reading" course is on reading articles and books in some specified area. The student's work in the course must lead to the production of a written paper which will be read by the instructor directing the readings. Often the reading is related to a research project which the student may wish to conduct. Readings courses have also been used to give students an opportunity to receive instruction in areas which are not included elsewhere in our course listing. The course may be taken for any number of units up to 9, depending upon the amount of work to be done. In the Fall, the course number is 85-505 and in the Spring it is 85-506. Prerequisite: permission of the instructor.

85-507/508
Independent Research in Psychology **Fall and Spring: Units variable**
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 student's 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. In the Fall, the course number is 85-507 and in the Spring it is 85-508. Prerequisite: permission of the instructor.

85-611/612
Honors Thesis **Fall and Spring: 18 units**
Psychology or Cognitive Science majors who qualify for the H&SS Senior Honors Program are given the opportunity to conduct original research under the direction of a faculty member. Research topics are selected jointly by the student and faculty advisor. Prerequisite: Senior standing, department permission, and admission to the H&SS Honors Program. Students double majoring in Psychology whose home department is elsewhere, are also eligible to perform honors work in psychology.

Course Descriptions

Social and Decision Sciences

Undergraduate Courses

88-104
Decision Processes in American Government **Fall: 9 units**
This course familiarizes the student with the basic structures of American government and various models of political decision-making. It examines a number of central questions about American government, including the nature of power and influence, the motives of voters, special interest groups and public officials, and how institutional structures shape political conflicts and decisions. To develop these topics, the course examines case studies in foreign and domestic policy-making (e.g., the Persian Gulf War, federal budget deficit, election reform).

88-104
Decision Processes in American Foreign Policy **pring: 9 units**
This class will discuss major foreign policy issues and decisions made by different U.S. administrations from WW II to the present day. The course will begin with a discussion of the institutional setting focusing on presidential power, Congress, the defense establishment and the public. Later we will discuss the basic concepts and models that will allow us to analyze the policy making process, as well as the content of the policies. The bulk of the course will focus on issues, such as the Cold War, and major foreign policy decisions ranging from Truman's creation of NATO, to JFK's decision to intervene in Vietnam, to Bush's decision to send troops to the Persian Gulf. The course will end with a discussion of current issues and decisions affecting the U.S. political, military and economic interests in the world.

88-108
Introduction to Intelligence: Norms and Heuristics **Spring: 9 units**
This course will introduce students to issues raised in understanding, creating, and interacting with natural and artificial intelligent systems. The course will be team-taught by faculty from the Departments of Philosophy, Psychology, and Social and Decision Sciences. It will emphasize both the common roots and the unique characteristics of the study of intelligence as approached by these three disciplines. Students will be taught some basic skills and concepts about intelligence, formal computations, decision making, and adaptive behavior in human and non-human organisms in natural and artificial systems.

88-109
Institutions and Individuals **Spring: 9 units**
The aggregation of independent behavior of individual actors can create social structures. Some of these social structures are simply the unanticipated outcome of individual motivations. Some of these social structures are transformed into social institutions that are functional for and valued by the individuals involved. Individuals become embedded in these social institutions, individual preferences and behavior change because of the social institutions, and the social institutions persist. This course examines the relationship between individual preferences, the emergence and persistence of social institutions, and the effect of social institutions on individual preferences and behaviors.

88-110
Social Decision Making: A Laboratory Approach **Fall: 9 units**
Students in the course participate in weekly in-class experiments that cover topics of interest to social scientists, ranging from economics to political science. Included in these topics are examples of when voting systems can imply undesirable outcomes, how markets both work and fail, and various ways to make good strategic decisions. Students will develop models to help explain what happens during the experiments. Classes not devoted to experiments will be used to develop basic analytic techniques for exploring the data generated in the laboratory, and to discuss models — those of the students and those typically found in textbooks — of the phenomena examined throughout the semester.

88-198
Research Training: Social & Decision Sciences **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. These courses are offered only as electives; i.e., they cannot be applied toward a college or major requirement, although the units do count toward graduation as "elective" units. Additional details (including a roster and descriptions of Research Training Courses available in any given semester) are available in the H&SS Academic Advisory Center. Prerequisites/restrictions: For H&SS students only; only for second-semester freshmen, or first- or second-semester sophomores; minimum cumulative QPA of 3.0 (at the time of registration) required for approved entry; additional prerequisites (e.g., language proficiency) may arise out of the particular demands of the research project in question.

88-200
Structured Analysis & Design **Fall: 9 units**
This course provides a basic understanding of computer-based information systems and the factors determining the successful analysis, development, and administration of such systems. Students are introduced to the methodology of structured analysis and design, and the associated computer aided design tools. Such tools include: data flow diagrams, data dictionaries, functional decomposition, logical models, project management techniques, interviewing and presentation techniques. Topics to be covered include project management, user oriented design, the system life cycle, user interface design, decision support systems and expert systems. Prerequisite: 15-200 or 15-211 or permission of instructor. (IDS majors are to take this course concurrently with 88-204.)

88-201
Data Base Management Systems **Spring: 12 units**
This course is an in-depth study of the application of information systems concepts and technology. Major topics include systems development and data base management. Specific topics include feasibility studies, cost-benefit analysis, requirements analysis, systems design, project management, management of change, testing of systems, structured design techniques, user-controlled design concepts, physical data structures and storage, file organization techniques, data dictionaries and data definition languages, data manipulation language, query languages, relation data base systems, and network data base systems. Case studies are used to illustrate the systems development issues in actual organizational settings. The data base topics involve the use of commercial data base management systems software. Prerequisites: 15-200 or 15-211, 88-200, 88-204 or permission of instructor.

88-202
Information Systems Applications (Project Course) **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 Carnegie Mellon University faculty and, when possible, by project clients. Prerequisites: 15-200 or 15-211, 88-200, 88-201, 88-204.

88-204
Structured Analysis & Design Lab **Fall: 9 units**
This is a lab course providing experience in 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. Information and Decision Systems majors must take this course concurrently with 88-200. Seniors who are not IDS majors do not have to register for 88-200 in order to take this course, but should have 15-200 or 15-211 or permission of instructor.

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 and partial 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," when private markets are not efficient. The strengths and weaknesses of markets are then examined in a broader framework encompassing concerns with information decentralization, incentive compatibility, transactions costs, and non-efficiency criteria such as equity and fairness. Markets are compared in this light with organizational, governmental, and other modes of resource allocation.

88-221
Policy Analysis II **Spring: 9 units**
This course is an extension of Policy Analysis I and focuses on a normative analysis of government action. The course begins by considering justifications for government action drawing on work in political philosophy. It then compares different institutional approaches governments may adopt in attempting to correct market failures and in pursuing objectives other than efficiency. The basic concepts and tools of cost benefit analysis are then presented. Students are involved in individual and group projects applying the class material to specific policy issues. Prerequisite: 88-220.

88-222
Policy Analysis III: Workshop in Policy Analysis **Fall and Spring: 12 units**
Students in this course apply analytical methods to real problems. Teams of students, guided by a faculty adviser, locate a public institution facing real problems. Each team tries to find a good solution to the problems confronting its client. Prerequisite: 88-221.

88-223
Decision Analysis and Decision Support Systems **Spring: 9 units**
This course emphasizes explicit procedures for analyzing complex decisions. The topics covered include: decision trees and other models of decisions involving uncertainty; methods for quantifying preferences and expert opinion; risk analysis; and the development and use of computerized decision aids ranging from spread sheet programs to highly specialized decision support models. Prerequisite: 36-201, 36-211 or 36-225.

Course Descriptions

88-240/241
Empirical Research Methods I, II **Fall and Spring: 9 units**
The subject of the social sciences is human behavior in all of its variety. With such a broad and varied domain it is not surprising that the methods of social science research reflect the variety of social phenomena. This two semester sequence will introduce students to the existing research techniques. This course will not, however, be a simple enumeration of available technologies. Research technologies are intended to answer theoretical and empirical questions about social phenomena. An important emphasis of this course will be on the relationship between problems and appropriate research techniques. Thus the central theme of this course will be strategies of inquiry in the context of theories of social phenomena. Prerequisites: 36-201/202 or 36-211/212 or 36-225/226.

88-260
Organizations **Fall: 9 units**
Organizations are people acting upon a particular context. The context is shaped by a structure, technology, procedures, history, and environment. This course considers alternative theories of organizations that shed light on these elements. The course is divided into several parts. The first two parts examine individuals in organizations. We discuss such questions as how individuals make decisions and how these can influence organizational success or failure. In the third section, we examine various models of organizational behavior. Here, we emphasize the influence of the nature of information processing on organizational behavior and performance. The fourth part presents economic approaches to understanding organizations. The fifth part of the course considers the importance of the environment for organizational behavior.

88-302
Behavioral Decision Making **Fall: 9 units**
This course discusses behavioral theories of probabilistic inference, intuitive prediction, preference and decision making. Topics covered include heuristics and biases in inference and prediction, risk perception and attitudes toward risk, strategies for combining conflicting information from different sources, strategies for dealing with conflicting objectives, and ambiguity effects in inference and decision. Applications to economics, management science, and public policy analysis will be discussed.

88-309
Altruism and Selfishness **Fall or Spring: 9 units**
The course covers theorizing and research in the past two decades concerning basic questions about the nature of human altruism. These questions have arisen in Western culture at least since the Old Testament and the philosophies of the Sophists and Plato, and undoubtedly for centuries in many other cultures as well. The unique focus of this course will be on the current views of leading economists, political scientists, psychologists, sociobiologists, and sociologists. The course will end with an examination of cultures in which altruism appears to have become nonexistent. Questions include whether acts we term "altruistic" can be best explained within a biological or evolutionary framework, or in terms of a conflict between social structures and training versus biologically based desires for reproduction and self-enhancement. Do these acts exist only in so far as they provide egoistic "side-payments" to the person performing them, or can they occur out of concern for group welfare — or commitment to conceptions of justice and fairness — independent of such payoffs? (and if so, how they then could have evolved, if indeed performing them has a genetic basis.)

88-311
Applied Social & Political Theory: The Case of AIDS **Spring: 9 units**
Each week will begin with an exploration and discussion of a specific theory of action and/or knowledge. During the second class each week, the relevancy of the previous days theory will be applied to various factors associated with AIDS/HIV. We will be examining such factors as the political environment (with specific reference to funding research; legislation of mandatory testing and/or mandatory disclosure of seropositivity), the scientific environment (e.g. the American vs. French battle over the discovery of HIV), the health environment (Should doctors, dentists, nurses, or paramedics be forced to have AIDS/HIV infected patients as clients? What are the risks to medical practitioners? etc.), the social environment (What are the stigmas associated with AIDS/HIV?), the economic environment (How is the insurance industry affected by AIDS?), and the cultural environment (What is the effect of specific cultures being disproportionately affected by AIDS/HIV?). This course will force students to examine the hidden theoretical assumptions of various stances regarding AIDS and HIV.

88-312
Political Psychology and Sociology **Fall or Spring: 9 units**
The study of political psychology and sociology focuses on theoretical and empirical descriptions of individual and group-level political phenomena. As part of this course, you'll (1) consider the empirical basis of contemporary government, (2) develop an understanding of the psychology and sociological theories which help us understand politics, and (3) examine the origins of various political phenomena, including the deterioration of trust in government, widespread ignorance and apathy about government, public reactions to health and environmental risks, intolerance of out-groups, political unrest and violence, and crisis decision-making by political elites. Overall, the course emphasizes the historical, philosophical and practical interpretation of the theories and empirical models which characterize the study of political psychology and sociology.

88-313
Introduction to Models of Political Science **Fall: 9 units**
This course studies several theoretical results from mathematical models of politics. They include Black's Median Voter Theorem, McKelvey's Chaos Result, bribing models, and veto models. Part of the course will be devoted to applying the models to current events in American politics. A course in calculus and microeconomics are not prerequisites, but are strongly suggested.

88-316
Social Theory and Analysis **Fall or Spring: 9 units**
The purpose of this course is to examine the processes by which societies and groups are organized and change over time. Topics include status and stratification, family and work relationships, deviancy, occupations, mobility, emotions and social action, norms, and culture. The course is designed to introduce perspectives from sociology, anthropology, and communications. Students will gain experience collecting and analyzing information on the social and cultural organization and change of groups.

88-317
Social Structure & Human Development **Fall: 9 units**
Everyone's biography is different, but the ways people organize and accomplish the major transitions in their lives depend in part on characteristics of the society of which they are members and on features of the culture which make their worlds meaningful to them. Just as there are important commonalities in the structuring of lives within a given society and culture, so also there are national and even subnational differences at a given time in the way lives are structured. No less, the characteristic life course within a given nation changes in historical time. This course will introduce students to the notion of the life course, and acquaint them with some of the biological, social, and cultural mechanisms that explain how biographies are structured. Major topics to be treated will include: the organization of childhood, adolescence, and old age; age-specific institutions like formal education; the career; the stratification of society by age; cross-cultural differences in the life course; and historical change in the life course.

88-318
Contemporary Latin American Politics **Spring: 9 units**
This course will examine some of the salient issues which continue to affect Latin American politics. We will emphasize, from a policy perspective, five interlocking issues: U.S.-Latin American relations, the role of the military in Latin American society, guerrilla insurgencies, the effect of drug trafficking, and the imposition throughout the region of "neoliberal" economic policies. Each issue will be examined from its historical perspective as well as analyzed within its present context. In addition to these topics, students will be expected to remain abreast of current developments in Latin America during the duration of the course; these developments will be discussed and integrated into the course. The purpose of the course is to provide empirical information and analytical tools so that the student can understand more profoundly the impact of current and past events on Latin America itself as well as on the world at large.

88-320
U.S.-Soviet Relations: From Confrontation to Cooperation **Spring: 9 units**
The course will provide an analysis of U.S.-Soviet relations in the post World War II period. The course will be divided into two major sections and a short concluding section. In the first section we will discuss the confrontational period (1946-1985) focusing on: a) the ideological dimensions of the conflict, b) the arms race, c) the competition for power and influence in the 3rd World. The second section will deal with the period of cooperation and it will emphasize: a) the decline of Soviet power, b) the new policies of Gorbachev and the disappearance of Communism, c) the end of conflicts in the 3rd World and the U.S.-Soviet cooperation during the Gulf War and the Middle East Peace Conference. In the concluding section we will discuss the appearance of a New World Order in which the USSR is in total disarray and very dependent on Western economic aid as well as the replacement of the bipolar world of the Cold War by a unipolar world led by the U.S.

88-321
Campaigns and Elections **Fall or Spring: 9 units**
This course surveys the techniques and efforts made by political campaigns to influence voters. Subtopics include various theories of voter decision-making and behavior (e.g. voter turnout and candidate evaluation), as well as organizational and strategic aspects of running campaigns. As part of the course, students will study voting behavior and political campaigns in the Pittsburgh area.

88-322
Elections, Interest Groups, and Public Policy **Fall or Spring: 9 units**
This course examines the processes by which candidates for elected government offices (e.g., the U.S. Presidency, the U.S. Congress, the British House of Commons) are recruited, nominated and elected. The objective of the course is to understand the ways in which choosing people to fill government offices by popular election enables citizens to influence the policy decisions of the office holder. The investigation proceeds in two stages. The first is to examine the nature and the extent of the participation of citizens, both as individuals and as members of interest groups, in the recruitment and election of candidates to government office. The next stage is to consider how citizen and interest group participation in elections affects the elected candidate's policy decisions once she/he assumes office. The course focuses primarily on the extensive body of research on the American experience, although some cross-national comparisons will be considered.

Course Descriptions

88-323
Legislative Processes **Fall or Spring: 9 units**
This course examines the processes of decision making and influence within legislatures, especially the United States Congress. Two kinds of processes are investigated. The first part of the course analyzes the decision processes in the committees and chambers of the legislatures. The second part of the course examines the processes by which individuals who are not members of the legislature (e.g., constituents, lobbyists, bureaucrats, and Presidents) may influence the decisions of legislators. Throughout the course, the implications of these processes for the development of public policies are discussed extensively.

88-324
Comparative Politics **Spring: 9 units**
This course looks at how nations and various political systems differ in several political processes, such as the organization of government, elections, mass political behavior and socio-economic policy. Emphasis will be placed on various theoretical approaches to comparative politics and on how comparative politics can shed light on our understanding of the American political system.

88-326
Issues in International Affairs **Fall: 9 units**
This course examines several conceptual designs intended to make order out of the essential anarchy in international relations. We will begin with a theoretical assessment of the nation-state and the nature of national power and proceed to an exploration of behavior among nation-states, including the ultimate problem of war and peace and an appraisal of the factors that give an age its particular characteristics.

88-328
Stalin and Stalinism **Fall: 9 units**
This seminar will explore in depth the many facets of Stalinism, an era that has left a lasting imprint on Russian political and social life. We will read about Stalin himself, his background and his rise to power. We will study the astounding changes of the 1930s: the collectivization of agriculture, the construction of huge new industrial complexes and cities, the political repression, the struggles within the Soviet leadership, the purges, and the mass terror.

88-329
Recent American Foreign Policy **Fall: 9 units**
This course attempts to foster a transnational approach to the study of conflicts and crises. We will investigate selected crises which occurred during the Eisenhower Administration and integrate traditional U.S. scholarship on the role of U.S. decision makers with recent foreign scholarship on the role of East European, Soviet, Chinese, British, and Egyptian leaders. Conflicts analyzed include Korea, Indochina, Taiwan Straits crisis, Polish and Hungarian uprisings, Suez Canal, and the Berlin Wall. We will then try to determine what lessons have been learned, and which remain to be mastered.

88-331
Europe in Transition: The Cold War & Alternative Systems for Conflict Management **Fall or Spring: 9 units**
The end of the Cold War has totally transformed the nature of the international political system and it is also transforming the domestic political institutions in Western and Eastern Europe and the former Soviet Union. The course will compare and contrast international and domestic politics in Europe and the former USSR during and after the Cold War, focusing on the themes that have dominated European politics such as containment, NATO, the division of Germany, the European community, as well as on current issues such as the end of Communism, the end of the Soviet Union, and of Soviet control of Eastern Europe, the growth of the European community, and the appearance of nationalism as a major force in domestic and international politics.

88-332
Global Security and Science **Fall: 9 units**
This course is concerned with the uses of force, the limits to the use of force, and alternatives to the use of force in international relations. The implications of modern science and technology for the development of new weapons and the control of their spread will be considered. Subjects that may be covered include the history and evaluation of nuclear deterrence, arms races, offense-defense balance, arms control, collective security, peaceful change and theories concerning the use of force. Students will be expected to carry out a case study on a major issue of the post-Cold War era such as proliferation of chemical, biological, and nuclear weapons and delivery systems; the use of force in Yugoslavia; nuclear weapons in the FSU, and START agreements; U.S. forces and defense budget; and the role of the United Nations and other international organizations.

88-333
The Cold War in Historical Perspective **Fall or Spring: 9 units**
This course will address major issues in international security, beginning with a discussion of how international security can be defined. Traditional and non-traditional threats to international security will be examined, ranging from nuclear weapons and regional security issues to terrorism and the environment. The purpose will be first to analyze why a particular issue is important to international security and then to explore policy responses to the problem, including the decision-making processes necessary to establish national and international policies.

88-334
Foreign Policy Issues in the Middle East **Spring: 9 units**
Much in the news and of great concern to policy makers everywhere, the Middle East is a complex and daunting area. This course studies U.S. foreign policy towards the region and will consider several specific cases of American involvement in the Middle East. Attention is not confined to the American perspective, however. This course sorts out the Middle East players and examines their political behavior in light of broader historical and contemporary motivations and objectives. Readings and discussions progress with a dual goal in mind: to understand American foreign policy interests and approaches in the Middle East, and to understand the historical forces and nuances endemic to the Middle East itself.

88-336
Educational Policy: Historical Perspectives **Fall: 9 units**
Educational policy is at the center of efforts to make our workplaces more competitive, our civic order more humane, and our schools more effective. Debates over educational policy have revealed the tension between public and private space, centralization and federalism, wealthy communities and poor. The special features of American educational policy and institutions will be examined in light of our historical experience and the institutional patterns and finances of other nations. Special attention will be given to the move for higher standards and the effort to build better bridges between schools and the workplace.

88-337
Health Policy Reform: Historical Perspectives **Fall: 9 units**
This course provides a comparative look at health policy in the U.S., Great Britain and Germany from approximately 1870 to the present. It examines the rising authority of physicians against the background of the bacteriological revolution and analyzes the expanding range of conditions considered disease subject to public health or other medical intervention. Several key questions will be explored against the social and economic background of each of the three countries: What are the interests of the state in the health of the population and what is the corresponding role of the state in funding or providing health care? What role should physicians or public health bodies play in addressing social and environmental causes of disease? What are the rights, responsibilities and options of patients seeking health care? In exploring these questions, movements to create national health programs, changes in the private health insurance industry, and the changing nature of hospitals and other venues of health care service delivery will be analyzed.

88-338
Health Care Policy **Spring: 9 units**
An introduction to health care delivery systems in the United States which examines the role of government and private enterprise in the development and operation of health institutions. Topics covered include health care financing (e.g., insurance, Medicare, Medicaid), health care organization (e.g., hospitals, traditional physician practice arrangements, Health Maintenance Organizations), and usage of regulation and markets to contain health care costs, and national health insurance proposals.

88-340
Law and Public Policy **Spring: 9 units**
This course will explore various laws and the public policy behind such laws, with an emphasis on the implementation and interpretation of such laws. Substantive areas of the law will include constitutional issues (such as first amendment issues and an individual's right to privacy), the protection of intellectual property rights (such as whether the current method of software protection is sensible public policy), environmental issues, litigation and taxation (e.g. is the tax code an appropriate means by which to develop public policy). The course will also teach skills necessary to participate in the legal process, such as reading and drafting statutes and regulation, interpreting court decisions, legal reasoning, advocacy writing and negotiating.

88-341
Comparative Perspectives on Public Policy in the United States **Fall or Spring: 9 units**
This course will explore the history of public policy in Western Europe and the U.S. since the late nineteenth century. The main purpose will be to use systematic comparisons between America and a small number of European countries in order to illuminate what has been distinctive about policy-making in the U.S. Students with a primary interest in Europe may also use the course to investigate European policy-making in a comparative context. We will focus on several areas of economic and social policy, including health, welfare, social security, industrial policy, criminal justice, and immigration. After working through the series of case studies in comparative policy history, students will be encouraged to draw larger conclusions about how the traditions, structures and circumstances peculiar to a country helped to shape policies and the way people made them. By the same token, the course will also suggest ways that the history of public policy can shed light on the broader history of societies on both sides of the Atlantic.

88-342
Market Organization and Business Behavior **Fall or Spring: 9 units**
This course examines the relationship between business behavior and the market and regulatory environment. It develops theories of business behavior and industry development from a number of perspectives, including institutional, behavioral, and evolutionary approaches. The development of the modern corporation, industry analysis, internal decision processes, innovation, and investment behavior will be emphasized. Prerequisites: 88-220 or 73-250 or permission of the instructor.

Course Descriptions

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 economics of the adoption and diffusion of innovation. In addition to drawing on economic theory, the course will emphasize empirical studies of innovation and technological change, and will selectively exploit case study and institutional studies. Prerequisites are 88-220 or 73-250 or 88-342.

88-344
Strategic Games & Decisions — **Fall or Spring: 9 units**
Strategic considerations are a common feature of all types of economic, political, and social decisions. What conditions are needed to get individuals to cooperate with one another, even when it is not in their direct interest to do so? How should politicians design their campaigns so that they can get elected? When will nations abide by an arms treaty? These are just a small sample of the many questions which have important strategic elements. The course explores strategic decision making from a variety of perspectives, including approaches originated by biologists, computer scientists (artificial intelligence and machine learning), economists, and experimental psychologists. Learning in the course will be facilitated through the use of actual experiments and computer-based tournaments.

88-345
The Rise of Industrial Research and Development — **Spring: 9 units**
The electric light, nylon, the atomic bomb, the transistor and integrated circuits, Post-it notes, Teflon, and Silly Putty are all products that emerged from organized research and development (R&D) programs. What factors gave rise to modern R&D? When 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 institutionalization of R&D affected the work of the individual inventory and scientist? Does Big Business now dominate R&D in the U.S., or do "the little guys" still play an important role in technological innovation? How has R&D been "managed"? These are some of the questions that will be explored in this reading seminar, which is open to students from all colleges. Through several case studies, students will have an opportunity to manage real R&D projects themselves.

88-347 A3 (Mini)
Marriage, Divorce, and Family — **Spring: 6 units**
This course will deal with issues of the contemporary American family. We will examine the larger forces that hold the family together as well as the pressures that encourage its disintegration. Focusing on white and black working class families, we will examine relations within the family — between parents and children, husbands and wives — and family relations with the outside world. We will examine changing attitudes toward divorce, individual fulfillment, gender roles, and sexuality over the past forty years in an attempt to define the present and future prospects of the American family.

88-348 A4 (Mini)
Family Law and Social Policy — **Spring: 6 units**
This course focuses on a variety of policies and legal practices that regulate marriage and divorce in American society. Changing ideas concerning such matters as division of marital property, spousal support, child custody and child support are examined from the dual perspectives of history and contemporary public policy. In addition, the course introduces students to several other contentious areas in the current practice of family law, including adoption, the determination of paternity and spousal abuse.

88-361
Technology & Social Change — **Fall or Spring: 9 units**
This course examines theories of social change and ways that technologies have influenced social change. Specific technologies examined include steel axes, snowmobiles, oral contraceptives, and computers. Prerequisite: Junior standing or permission of instructor.

88-366
Social Issues in Computing — **Fall or Spring: 9 units**
Traditionally, machine-based technologies have been studied as a problem in automation and its impact on the individual industrial worker. While this problem is important, the new computer-based technologies reaching business and industry, public organizations, and homes have much broader implications. The main topic of this course is the organizational and social implications of computerization. Its purpose is to highlight both the (re)definition of problems associated with technology in society and new research approaches for understanding the social aspects of computers. The approach will be multidisciplinary, reflecting the wide significance of the issues and the range of research.

88-367
Computers in Organizations — **Spring: 9 units**
This course examines the introduction, diffusion, and use of computers and telecommunications in organizations from a social perspective. Information technology is assessed in terms of its interaction with human behavior, organizational characteristics, and organizational procedures. Both historical and contemporary examples will be used. By the end of the course, students should have a good understanding of the range of uses to which information technologies are put in organizations and the complexities involved in the predicting their effects.

88-368
User Interface Design — **Spring or Fall: 9 units**
As the complexity & scope of information systems has grown over the past decade, the importance of a system's user interface & the impact of that interface on a project's overall success has become painfully clear. It is simply not enough to produce a system that "works", such systems must also be "usable" by the target audience. Software vendors & information systems firms are now investing an increasing portion of their resources to address the design issues of windowing environments, alternate input devices, & dialog-interaction techniques. This course will provide an overview of the current state of the field of User Interface Design while introducing the student to the student to the language & tools of the domain. The course will provide the foundations for approaching user interface design with a user-centered focus as a multi-disciplinary activity. Building the translation between a user's functional requirements and a systems underlying software will be investigated and students will be asked to solve real world interface issues. The course will survey readings & directions from the entire Human Computer Interaction spectrum from graphic artists to cognitive psychologists. Students will leave the course with a common vocabulary that will facilitate working with both designers and programmers. Prerequisites: Students should have had formal exposure to a Systems Analysis & Design course, either through an Information and Decision Systems course or a Software Engineering course.

88-398 A-Z
Independent Study — **Fall or Spring: var. units**
Students conduct research under the supervision of a Social & Decision Sciences faculty member. Students who wish to engage in research should seek out a faculty member whose interests are appropriate to the topic. Prerequisite: Permission of a faculty sponsor.

88-425
Regulatory Processes — **Spring: 9 units**
This course examines selected issues related to the manner in which governments (Federal, State and Local) in the U.S. profess and practice the regulation of economic activity. The course attempts to develop a broad overview of the theory of regulation. The normative justification for regulation, the processes through which regulations are adopted or discarded (de- regulation), the operation of the regulatory agencies, and regulatory outcomes are considered. The course develops regulatory problems associated with agencies such as public utility commissions, the Environmental Protection Agency, etc. Emphasis is on processes. Relevant economic, organizational and political materials are developed as needed by both the instructor and by students in the course. Prerequisites: 73-250 or 88-220 or permission of the instructor.

88-470
Advanced Projects in Information and Decision Systems — **Fall or Spring: 9 units**
This course enables the student to apply analytical techniques and system analysis tools to the design, development or evaluation of a complex real system. Students work either individually or in small groups. Prerequisites: 88-201, 88-204, and by permission of instructor.

88-471
Industrial Applications in Information and Decision Systems — **Spring: 6 units**
This course provides students with an in-depth understanding of how advanced issues in the information and decision systems area are handled in industry. Topics include: networking, expert system applications, management techniques, law and information systems, and massive data base systems. Prerequisite: 88-202.

88-501/502
Honors Thesis I, II — **Fall and Spring: 9 units**
Majors in the Social and Decision Sciences Department with outstanding academic records and intellectual promise will be given the opportunity to undertake original research under the direction of individual faculty members. Research topics are selected by students and faculty. Prerequisites: Senior standing; a 3.5 QPA in one of the Department's majors; a 3.25 QPA overall; permission of the Department's faculty; and approved entry into the College's Honors Program.

Appendix

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Key to Buildings and Services

Academic Buildings

1. Alumni House
2. Baker Hall
3. Bellefield Towers
4. Bramer House
5. College of Fine Arts
6. Cyert Hall
7. Doherty Hall -
8. Field and Mobile Robotics Building
9. Graduate School of Industrial Administration
10. Gymnasium
11. Hamburg Hall
12. Hamerschlag Hall
13. Hunt Library
14. Margaret Morrison Carnegie Hall
15. Mellon Institute
16. Mine Safety Laboratory Building
17. Physical Plant Building
18. Planetary Robotics Building
19. Porter Hall
20. Publications and Printing Building
21. Scaife Hall
22. Skibo Hall (University Center, Constr. 5/94-Fall '96)
23. Smith Hall
24. Software Engineering Institute
25. Studio Theatre
26. University Technology Development Center
27. Warner Hall
28. Wean Hall
29. West Garages
30. Whitfield Hall
31. 407 South Craig Street
32. 4616 Henry Street
33. The Student Center
34. 6555 Penn Avenue

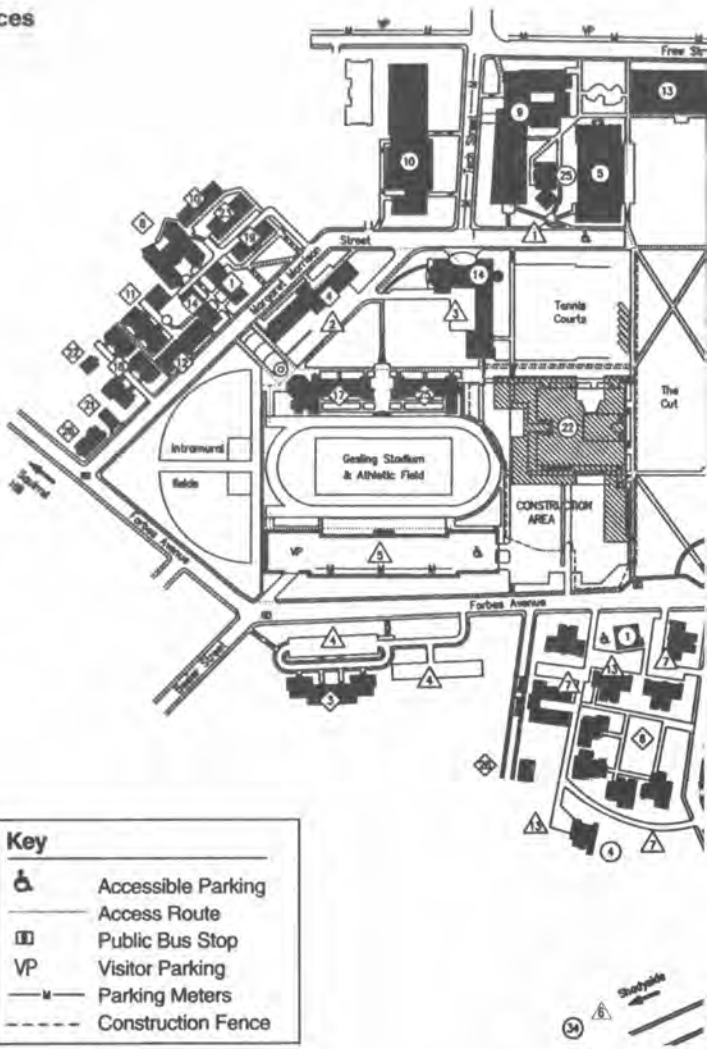
Residence Buildings

1. Boss Hall
2. Cathedral Mansions
3. Doherty Apartments
4. Donner Hall
5. Fairfax Apartments
6. Fraternity Quadrangle
8. Hamerschlag House
10. Henderson Hall
11. Margaret Morrison Apartments
12. Margaret Morrison Sorority Houses
13. Marybelle Apartments
14. McGill Hall
15. Morewood Gardens
16. Mudge House
17. Resnik House
18. Roselawn Terrace
19. Scobell Hall
20. Shirley Apartments
21. Tech House
22. Spirit House
23. Welch Hall
25. West Wing
26. Woodlawn Apartments

Parking Areas

1. Fine Arts
2. Sororities
3. Children's School
4. Doherty
5. East Campus Garage
6. 6555 Penn Avenue
7. Fraternities
8. Morewood
9. Warner
10. Dithridge Street Garage
11. Porter-Hamerschlag-Wean
12. Baker
13. Bramer House and Alumni House
14. Whitfield Hall
15. Hamburg Hall
16. Lower Bureau of Mines
17. Upper Bureau of Mines

VP Visitor Parking



Key

- Accessible Parking
- Access Route
- Public Bus Stop
- VP Visitor Parking
- Parking Meters
- Construction Fence

Colleges

Carnegie Institute of Technology (CIT) – Scaife Hall
Mellon College of Science (MCS) – Scaife Hall
College of Humanities and Social Sciences (H&SS) – Baker Hall
College of Fine Arts (CFA) – Fine Arts
Graduate School of Industrial Administration (GSIA)
H. John Heinz III School of Public Policy and Management – Hamburg Hall
School of Computer Science (SCS) – Wean Hall

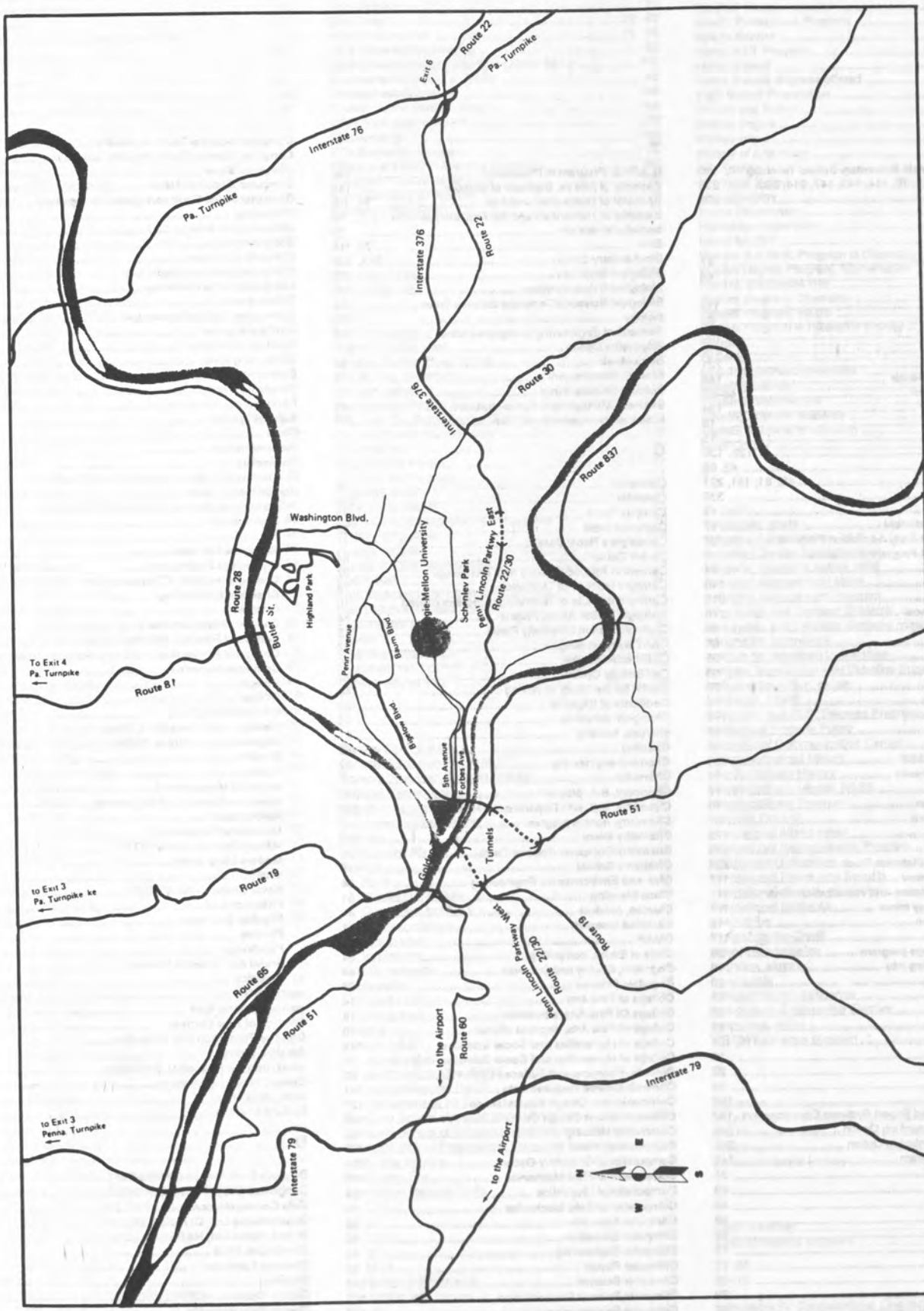
Services

Office of Admission – Warner Hall
Housing Office – Morewood Gardens
Security – Baker Hall

Information is available in the Office of Student Affairs, Warner Hall and at four campus Kiosks: Warner Hall lobby, the Student Center, Morewood Gardens lobby and Hunt Institute.

This map is provided by the Office of Facilities Planning and Construction.

Carnegie Mellon University
Campus Map 1994


Route 22
Pa. Turnpike
Exit 6
Interstate 76
Pa. Turnpike
Interstate 376
Route 22
Interstate 376
Route 30
Route 837
Washington Blvd.
Route 28
Butler St.
Highland Park
Penn Avenue
Baum Blvd
Carnegie-Mellon University
Schenley Park
Penn Lincoln Parkway East
Route 22/30
To Exit 4
Pa. Turnpike
Route 8 1
Bigelow Blvd
5th Avenue
Forbes Ave
Route 51
Tunnels
to Exit 3
Pa. Turnpike ke
Route 19
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Penn Lincoln Parkway West
Route 22/30
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to the Airport
Route 60
Interstate 79
to Exit 3
Penna. Turnpike
Interstate 79
to the Airport

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Addendum

The addendum to this catalog will be published in the summer of 1995 and bound in the back of books distributed after August of that year. Separate copies of the addendum will be distributed to undergraduate students who have already obtained this catalog during enrollment in August 1994 and to faculty and administrators during the fall by way of campus mail. Additional copies of the catalog may be purchased at the bookstore.

Printed in the United States of America
on recycled paper containing 10%
recovered post-consumer fiber

Academic Calendar

1994-95 Official Academic Calendar

1994 Fall Semester

Days: M- 13; T- 15; W- 14; Th- 14; F- 14; Total= 70

Freshman Enrollment Week	August 23-26 (T-F)
Enrollment Week	August 29 - Sept 8 (M-W)
Classes begin	August 29 (M)
Add/Drop period	August 29 - September 12
Labor Day (no classes)	September 5 (M)
Classes resume	September 6 (T)
Mid-semester break	October 17 (M)
Mid-semester grades due	October 18 (T)
Last day to drop a course in CFA, CIT, H&SS, IM, MCS and SCS	November 1 (T)
Thanksgiving holiday	November 23-25 (W,R,F)
Last Day of Classes [See note below]	December 9 (F)
Reading Day	December 14 (W)
Final Examinations	December 12,13,15,16 (M,T,R,F)
Final Examinations	December 19,20 (M,T)
Final Fall Semester grades due by 9:00AM	December 22 (R)

1995 Spring Semester

Days: M - 14; T - 15; W - 15; Th - 15; F - 14 Total = 73

Enrollment Week	January 16-20 (M-F)
Classes begin	January 16 (M)
Add/Drop period	January 16-27
Mid-semester break	March 6 (M)
Mid-semester grades due	March 7 (T)
Spring Vacation	March 20-24 (M-F)
Last day to drop a course in CFA, CIT, H&SS, IM, MCS and SCS	March 28 (T)
Spring Carnival	April 7,8 (F-S)
Lastday of classes [See note below]	May 5 (F)
Reading days	May 9,11 (T,R)
Final Examinations	May 8,10,12 (M,W,F)
Final Examinations	May 15-17 (M-W)
Senior Grades due by 9:00AM	May 18 (R)
Commencement	May 21 (Su)
Final Spring Semester grades due by 9:00AM	May 23 (T)

NOTE: The last day of classes for Heinz and GSIA may vary.

1995-96 Academic Calendar (Tentative)

1995 Fall Semester (Tentative)

Days: M- 13; T- 15; W- 14; Th- 14; F- 14; Total= 70

Freshmen Enrollment Week	August 22-25 (T-F)
Enrollment Week	August 28-Sept 6 (M-W)
Classes begin	August 28(M)
Add/Drop period	August 28-September 11
Labor Day (no classes)	September 4 (M)
Classes resume	September 5 (T)
Mid-semester break	October 16 (M)
Mid-semester grades due	October 17 (T)
Last day to drop a course in CFA, CIT, H&SS, IM, MCS, and SCS	October 31 (T)
Thanksgiving holiday	November 22-24 (W-F)
Last day of classes [see note below]	December 8 (F)
Final Examinations	December 11-12 (M-T)
Reading day	December13 (W)
Final Examinations	December 14-15 (Th-F)
Final Examinations	December 18-19 (M-T)
Final Fall Semester grades due by 9:00 am	December 21 (Th)

1996 Spring Semester (Tentative)

Days: M-14; T-15; W-15; Th-15; F-14; Total=73

Enrollment Week	January 15-19 (M-F)
Classes begin	January 15(M)
Add/Drop period	January 15-26
Mid-semester break	March 4 (M)
Mid-semester grades due	March 5 (T)
Last day to drop a course in CFA, CIT, H&SS, IM, MCS, and SCS	March 19 (T)
Spring Vacation	March 18-22 (M-F)
Spring Carnival	April 19-20 (F-Sa)
Last day of classes [see note below]	May 3 (F)
Final Examinations	May 6 (M)F
Reading day	May 7 (T)
Final Examinations	May 8 (W)
Reading day	May 9 (Th)
Final Examinations	May 10 (F)
Final Examinations	May 13-15 (M-W)
Senior grades due by 9:00 am	May 16 (Th)
Commencement	May 19 (Su)
Final Spring Semester grades due by 9:00 am	May 21 (T)

NOTE: The last day of classes for Heinz and GSIA may vary

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