of the curriculum in architecture and will allow a degree of latitude for the student to plan toward concentrated study in the graduate program.

Humanities: nine credit hours are to be devoted to English literature courses, or to appropriate modern language courses at the 3000 level or above. Note that the architectural history sequence will satisfy the remaining nine credit hours of humanities requirements.

Social Sciences: 18 credit hours, including at least three hours in each of sociology, political science, psychology and history.

General Electives: 39 credit hours may be structured to best further the student's professional goals, but must include at least six credit hours of advanced architectural history and six credit hours in visual communication studio courses. Military training is an optional program of the institute, but in case basic ROTC and advanced military are elected, no more than 15 credit hours of general electives may be used for this purpose or will be credited toward the requirements for a degree.

2 See "Curricula and Degrees," Department of Physical Education and Recreation, for fresh majors in architecture from a school offering an accredited professional degree in architecture. Students having appropriate concentration in architecture in their undergraduate studies can expect to complete this program in two years.

The program has three major areas of study. They are: Theories, Methods and Architecture; Urban Studies and Architecture; and Behavioral Studies and Architecture. Conceptually, these can be seen as spanning a range of contexts from the regional and urban through the building specific to the personal.

There are a number of study topics related to each of the above. For example, within Theories, Methods and Architecture is included: design theories, methods and applications; architecture and development process; and construction management. Included in Urban Studies and Architecture are: urban form; urban development; transportation; environmental design; housing; and preservation and conservation. Behavioral Studies includes: studies in environment and behavior; health facility design; and institutional building design. The areas of study indicate only some of the choices available as topics of concentration. A minimum concentration study program has the following requirements:

Concentration course credits ........................................ 12
Concentration studio credits .......................................... 12
Thesis credits ............................................................. 18

Additional required courses ......................................... 12
Electives ......................................................................... 38

Total............................................................................... 90

### The One-Year Program

Persons holding a first professional degree in architecture (Bachelor of Architecture; Master of Architecture or equivalent) from an accredited school of architecture are normally expected to finish the program during one academic year (50 credit hours). As with the two-year program, the course work is developed within the major study areas outlined above.

### Building Construction

In tandem with the roles of the architect and engineer, the constructor assumes responsibility for bringing a building or group of buildings into physical reality. The Building Construction Program emphasizes habitable construction rather than bridges, dams or other civil work. Basic degree requirements encompass the areas of techniques, operations and management, from which the student may then expand in directions of individual interest through a series of professional electives.

Primary objectives of the Building Construction Program are: a) to provide a set of experiences through which technical and management skills can be obtained, along with a broad educational base, to equip the student for movement toward leadership roles in the construction industry; b) to
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Academic Calendar 1979–80

An official institute calendar is prepared and distributed each quarter by the Office of the Registrar. Dates, filing times, deadlines and other information included in the official calendar supersede previously published information such as that included in this catalog. Students are responsible for adhering to the requirements set by the official calendar.

Summer Quarter 1979

- June 18
- June 19
- August 27
- September 1

Registration
Classes begin
Final exams begin
End of term

Fall Quarter 1979

- September 17
- September 19
- November 22
- November 25
- December 3
- December 8
- December 9

Registration
Classes begin
Begin Thanksgiving recess
Last day of Thanksgiving recess
Final exams begin
End of term
Begin Christmas recess

Winter Quarter 1980

- January 3
- January 4
- March 17
- March 22
- March 23

Registration
Classes begin
Final exams begin
End of term
Begin spring recess

Spring Quarter 1980

- March 31
- April 1
- June 9
- June 14

Registration
Classes begin
Final exams begin
End of term

Summer Quarter 1980

- June 23
- June 24
- September 2
- September 6

Registration
Classes begin
Final exams begin
End of term

About this Catalog

The statements set forth in this catalog are for informational purposes only and should not be construed as the basis of a contract between a student and this institution.

While the provisions of this catalog will ordinarily be applied as stated, Georgia Tech reserves the right to change any provision listed in this catalog, including but not limited to academic requirements for graduation, without actual notice to individual students. Every effort will be made to keep students advised of any such changes. Information on changes will be available in the office of the registrar, dean of students and the major schools and colleges. It is especially important that each student note that it is his or her responsibility to keep himself or herself apprised of current graduation requirements for his or her particular degree program.
General Information

The Georgia Institute of Technology, founded in 1885, is a co-educational institution of higher learning located in Atlanta, Georgia. In 1888 the school opened its doors to the first class of future mechanical engineers. At that time the campus consisted of five acres of land and a physical plant of two buildings. One of these original buildings is still in daily use as part of today's 128-building physical plant which sprawls over 280 acres of land.

Tech's enrollment has paralleled the growth of the physical plant. The original class numbered only 129 students, all but one from Georgia. This year over 10,000 students from every state and from over 60 foreign countries are expected to pursue undergraduate or graduate degrees in the 20 engineering, architectural, scientific and management schools and colleges that make up Georgia Tech.

Nationally prominent in education and research, Georgia Tech is also famous for its colorful traditions—the Ramblin' Wreck parade and the school song of the same name, football and hard-working students who approach play with zest and ingenuity. Georgia Tech alumni support, from graduates scattered throughout the world, is consistently among the strongest in the nation.

Assistance for the Handicapped

Georgia Tech has a committee for handicapped assistance and planning. The chairman is a handicapped person who can be reached at 894-3844. The committee is looking at the long range requirements in order to be in compliance with the federal law and also to the mid-range plans.

The purpose of this notice is to publicize the fact that we do take care of handicaps today on a case by case basis. Handicapped persons who may have problems with access to buildings and in parking should contact the director of campus safety at 894-4588 for resolution. If you know of any handicapped persons in need of assistance, please do not hesitate to notify either the committee chairman or the director of campus safety.

For more information concerning handicapped contact the coordinator of programs for the handicapped, Carnegie Building, Georgia Tech, Atlanta, Georgia 30332.
Annual Notice of Privacy Rights

This institution is covered by the Family Educational Rights and Privacy Act of 1974 (FERPA), which is designed to protect student rights with regard to educational records maintained by the institution. Under this Act, students have the following rights: (1) the right to inspect and review educational records maintained by the institution that pertain to them; (2) the right to challenge the content of records on the ground that they are inaccurate, misleading or a violation of their privacy or other rights; and (3) the right to control disclosures from their educational records with certain exceptions.

A written policy detailing how Georgia Tech will comply with the provisions of the Act is printed in the Student Handbook and a copy can be obtained in the Office of the Dean of Students. The registrar has the institutional responsibility for interpreting (a) the Family Educational Rights and Privacy Act of 1974, as amended, (b) rules and regulations issued by the Department of Health, Education and Welfare to enforce this Act and (c) the written policy of the institution.

Students who believe the institution has violated the written policy and/or the provisions of the Family Educational Rights and Privacy Act should send a written complaint to the registrar, specifying the nature of the possible violation. The registrar shall investigate the complaint and initiate corrective action if it appears the institution is in violation. The registrar shall notify the complainant of the results of the review within a reasonable period of time, not to exceed 30 calendar days. Students also have the right to file complaints with the FERPA Office of the Department of Health, Education and Welfare, Washington, D.C. 20201 regarding alleged violations of the Act.

Academic Offerings

Through the College of Engineering, College of Sciences and Liberal Studies, College of Industrial Management and College of Architecture, Georgia Tech offers programs of study leading to 27 undergraduate and 28 graduate degrees. General information about these programs is contained in the "Information for Undergraduate Students" and the "Information for Graduate Students" sections of this book. More specific information can be found in the "Curricula and Degrees" section.

Academic Calendar

Georgia Tech operates on the quarter plan with the fall, winter and spring quarters normally constituting the academic year. A full summer quarter is also offered and many students accelerate their program by attending four quarters per year. A program of study may be entered in any one of the four quarters. The requirements for a degree may be completed at the end of any quarter and a commencement ceremony is held at the end of each quarter.

See page iv for the academic calendar for 1979–80.

Special Supporting Facilities

Computer Facilities

The Office of Computing Services provides a wide range of computing services for education, research and administration. Since 1955 this centralized service facility has operated a variety of systems. In 1974 a Control Data Corporation CYBER 70 Model 74–28/CDC 6400 replaced UNIVAC 1108 and IBM 360/30 computing systems on the campus. The hardware configuration, the NOS operating system, a broad variety of programming languages, applications programs and library subroutines all combine to provide an impressive amount of computer power to both time-sharing, remote batch and on-site batch users. Data preparation equipment, time-sharing terminals, CALCOMP and Versatec plotters and an optical scanner are also available. Many schools, departments and administrative offices have interactive and remote batch terminals to access the central facility in addition to their own minicomputers.

Continuing Education

This department annually conducts many educational programs designed to help professionals in technology keep pace with their field, advance in their profession or retrain in related areas. Special technical and management short courses, as well as conferences and institutes, train key industry personnel by providing information and instruction on new developments and best methods. The department cooperates closely with industry, trade associations and professional organizations in planning and presenting these special educational programs.

Engineering Experiment Station

The Engineering Experiment Station (EES) operates extensive research programs and specialized research facilities. Many of their activities are colocated with instructional programs on the Atlanta campus. They also operate extensive programs at the Cobb County Research Facility located 14 miles northwest and at numerous other foreign and domestic locations. The Georgia Tech Area Offices, which provide educational, governmental, industrial and general services to all regions of the state of Georgia, are administered by the Engineering Experiment Station. These offices are located in Albany, Augusta, Carrollton, Douglas, Gainesville, Macon, Rome and Savannah, in addition to the central office in Atlanta. Several hundred undergraduate students, graduate students and instructional faculty as well as several hundred full-time research faculty and staff participate in a wide variety of programs for noncredit education, research and services. A large number of advanced technological research facilities are operated in most areas of science, engineering and industrial extension. Undergraduate and graduate students may be appointed as part-time employees or cooperative plan students. Many graduate students are appointed as research fellows and graduate research assistants. Programs are often suitable for project or thesis topics.
Additional information can be obtained from the Office of the Director, Engineering Experiment Station, Main Lobby, Hinman Building, 894-3411.

**Health Systems Research Center**

The Health Systems Research Center (HSRC) was established in 1969 by the University System of Georgia Board of Regents as an interdisciplinary and interinstitutional program of health systems research, community outreach and continuing education, building upon a health related academic program activated at Georgia Tech in 1958.

The general aim of HSRC is to develop, apply and disseminate new knowledge and techniques in the analysis, planning, design, implementation, demonstration and evaluation of improved operational and managerial systems for the delivery of health care services to the public, utilizing systems science and management engineering. Emphasis is upon systematic planning, engineering design and scientific management in respect to health care facilities, manpower and methods.

Organizationaliy, HSRC is the community outreach arm of the School of Health Systems within the College of Engineering. The center is affiliated with the Division of Systems and Computer Services of the Medical College of Georgia in Augusta. It maintains active collaboration with other academic institutions, hospitals and other health care organizations, health planning and governmental agencies and other groups throughout Georgia and other states and in several foreign countries.

Faculty and students of the various schools of Georgia Tech may participate in HSRC programs and utilize the center as a focal point and mechanism for interdepartmental research programs or projects and for cooperative arrangements with the outside community.

Health systems courses and curricula leading to the Bachelor of Science in Health Systems and the Master of Science in Health Systems are administered by the School of Health Systems of the College of Engineering and are described in chapters four and five.

**Interdisciplinary Programs**

The Office of Interdisciplinary Programs, established in October 1973, is a focus for interdisciplinary study at Georgia Tech. There are currently three units, the Bioengineering Center, the Environmental Resources Center and the Center for Radiological Protection, within the Office of Interdisciplinary Programs. None of the centers offers designated degrees, but members of the faculty teach courses in other departments and schools of the institute, assist in the development of interdisciplinary curricula, conduct various research projects, engage in public service programs and coordinate appropriate interdisciplinary activities.

**Bioengineering Center.** The Bioengineering Center’s emphasis is on the application of the knowledge, techniques and approaches of the physical sciences, engineering, social sciences and management to the problems of the biological sciences. In addition to developing interdisciplinary study and research opportunities for qualified students at Georgia Tech, the center conducts cooperative programs in bioengineering education and research with other units of the university system and with several private universities and foundations.

**Environmental Resources Center.** The Environmental Resources Center coordinates applications of Tech’s expertise in science and technology to address problems of managing environmental resources. It organizes and administers water resources research projects throughout Georgia and disseminates their results.

**Center for Radiological Protection.** The Center for Radiological Protection serves as a focus for research and training in radiological protection (health physics). Research is conducted and coordinated by its faculty and analytical support is provided through its Environmental Radiation Laboratory. These research programs are complementary to and supportive of Nuclear Engineering’s undergraduate and graduate degree programs in health physics.

**Library**

The Price Gilbert Memorial Library's scientific, engineering, architectural and management collection includes 900,000 volumes, 1,200,000 microtexts and 220,000 other bibliographic units. The library will accommodate one million volumes and seat 2,000 users.

The library has a collection of over one million patents, the largest in the Southeast. The library acquires research reports from the National Technical Information Service, the U.S. Department of Energy and the National Aeronautics and Space Administration. It is a depository for publications issued by the U.S. Government Printing Office and for maps issued by the U.S. Defense Mapping Agency, Topographic and Aerostatic Centers, U.S. Geological Survey and the U.S. National Ocean Survey. The government documents collection contains 300,000 publications and 100,000 maps.

Over 12,000 serials, including 6,500 periodicals, are currently received, approximately 75 percent of them in scientific and technical fields. Especially strong is the collection of abstracts, indices and bibliographies for science and engineering.

Microfiche copies of the entire card catalog are available on every floor in the library and in each academic department on campus. The Georgia Tech library is associated with eight other libraries in the Atlanta area and in Athens, Georgia and offers a union catalog of the holdings of all member libraries.

**Nuclear Research Center**

The Frank H. Neely Nuclear Research Center provides Georgia Tech with outstanding research facilities in the field of nuclear science and engineering. In the center are a five megawatt heavy-water moderate research reactor with multiple irradiation facilities, a 100 kilocurie remotely operated hot cell, a 100 kilocurie cobalt 60 irradiation facility, radiochemistry laboratories,
counting facilities, PDP data acquisition systems and a complete machine shop. The center is under the administrative responsibility of the School of Nuclear Engineering.

**Oak Ridge Associated Universities**

Georgia Tech is one of the sponsors of Oak Ridge Associated Universities (ORAU), a nonprofit education and research management corporation of 43 colleges and universities. ORAU conducts programs of research, education, information and human resource development for a variety of government and private organizations. It is particularly interested in the areas of energy, health and the environment.

Among ORAU’s activities are competitive programs to bring undergraduates, graduate students and faculty members to work on research problems at the research facilities of the United States Department of Energy. Participants are selected by ORAU and the staffs of the facilities participating in the ORAU programs, which are Oak Ridge National Laboratory, the Oak Ridge Y-12 Plant, the Oak Ridge Gaseous Diffusion Plant, the Atmospheric Turbulence and Diffusion Laboratory in Oak Ridge, the Savannah River Laboratory and Savannah River Ecology Laboratory in Aiken, S.C., the Comparative Animal Research Laboratory in Oak Ridge, the Puerto Rico Nuclear Research Center and the Energy Research Centers at Bartlesville, Okla., Pittsburgh, Pa. and Morgantown, W. Va. The ORAU Institute for Energy Analysis, the Special Training Division, the Medical and Health Sciences Division and its other programs are also open to qualified students and faculty members.

**Undergraduate**. The ORAU Undergraduate Research Training Program offers juniors majoring in the sciences, engineering and mathematics an opportunity to spend 10 weeks during the summer working in directed research programs at these sites.

**Graduate**. The ORAU Laboratory Graduate Participation Program enables a candidate for an advanced degree, upon completion of all requirements for work-in-residence except research, to work toward completion of his or her research problem and preparation of the thesis at one of the participating sites.

**Faculty**. Georgia Tech faculty members under the ORAU Faculty Research Participation Program, can go to a facility for varying periods up to three months, for advanced study and research. It is also possible to combine a sabbatical with a longer appointment.

Stipends are available. The student stipends are at fixed rates that change from time to time. Faculty stipends are individually negotiated, based upon the current university salary. Dr. L. E. Weaver, director, School of Nuclear Engineering, is the Georgia Tech representative.

**Skidaway Institute of Oceanography**

Located on Skidaway Island near Savannah, the Skidaway Institute provides a complex of coastal- and marine-related educational and research opportunities. Members of the Tech faculty and their students can arrange to participate in ongoing research or initiate research consistent with the facility’s purpose.

**Southern Technical Institute**

Southern Tech is located in Marietta, Georgia, 15 miles north of Atlanta and offers both associate and baccalaureate degree programs in several fields of engineering technology and also offers associate degree programs in fire science technology and textile management technology.

The college is accredited by the Southern Association of Colleges and Schools. The Engineers’ Council for Professional Development (ECPD) has accredited the curricula leading to the bachelor’s degree in apparel, architectural, civil, electrical, industrial, mechanical and textile engineering technology as well as the curricula leading to the associate degree in apparel; architectural; civil, (structural and surveying options); electrical (electronic and computer control options); industrial (industrial engineering technology option); mechanical; and textile engineering technology.

Other degree programs include the associate’s degrees in industrial engineering technology (management option), electrical engineering technology (nuclear safety option) and fire science technology.

The campus covers some 150 acres, one mile west of Interstate 75 in Marietta. On-campus housing for single women and men is available. Over 2,300 students attend the college in both day and evening classes. Eighty-five percent of the students are from Georgia with 65 percent being from the Atlanta metropolitan area.

Additional information about the college may be obtained by contacting the Office of Admissions and Records, Southern Technical Institute, Marietta, Georgia 30060 (404) 424-7210.

**Student Life**

The dean of students and the dean’s staff are responsible for coordinating the administering out-of-classroom student services and activities. Complete information concerning all student activities, organizations and general student information is contained in the Student Handbook, available to all students on campus.

**Community Services**. Through community service, Georgia Tech applies its resources to the needs of the community and provides outlets for creative individual response to social problems.

**Counseling Center**. The Counseling Center assists students with almost any difficulty. Professional counselors assist in a completely confidential manner with academic, career and personal difficulties whenever requested. Additional services include career information, catalogs from other colleges, information for admission to law, business and graduate schools and a wide variety of interest, ability and personality tests and seminars.

**Fraternities and Sororities**. The Fraternity Affairs Office and Women’s Program Office coordinate and administer the many activities and programs of the 33 social fraternities and sororities on the Tech campus.
Housing Office. The Housing Office supervises 3,550 single spaces and 300 married student apartments. A residence hall program provides counselor services, programs and activities for the dormitory residents. For further information refer to Dormitory Resident Guidebook available at the Housing Office.

Infirmary. The modern 70-bed infirmary is fully staffed with medical doctors, including a psychiatrist, registered nurses and technicians. All students are provided this service for a quarterly fee. Major medical insurance is optional at a nominal fee.

International Students. International students’ services and programs help students from other countries adjust to Georgia Tech and to American customs and culture. Many of the 650 students from 60 foreign countries assist in providing programs to promote intracultural understanding and adjustment.

Orientation (FASET). The new student orientation program familiarizes the new undergraduate student with the activities and academic programs at Georgia Tech as well as the traditions, services and opportunities on campus.

Placement. The Georgia Institute of Technology operates a centralized placement operation serving all degree candidates for career employment. The principal services available to students and employers are campus interviews, a weekly bulletin listing position vacancies and communication information for more than 3,000 prospective employers. In addition, the Fred W. Ajax Placement Center staff conducts orientation and employment seminars to aid students in their employment search. Summer and part-time position openings are also made known to the students through the placement center. Formal campus interview periods are October and November and January through April.

Student Center. The Fred B. Wenn Student Center is the campus “living room.” The staff of this center plans and coordinates programs and activities for students, faculty, alumni and their guests.

Student Government. Tech’s student government provides the means for self-government in all areas of the institution’s student-related activities. Through the student council and the graduate senate the student body maintains responsible and respected participation in both academic and non-academic areas which affect the student.

Student Publications and Radio. The student publications and radio communications boards oversee the budgeting and operation of the official student newspaper, yearbook and other publications and the operation of the student FM radio station, WREK.

Women's Programs. Women students services and programs are directed toward involving female students in all phases of campus life and providing resources to fulfill the institute’s intention of accepting as many qualified female students as apply.

Affiliated Organizations

The Georgia Tech Athletic Association

This nonprofit corporation administers intercollegiate sports at Georgia Tech. The board of trustees consists of seven faculty members, three alumni and three students. The president of Tech is president of the board. The board aims to secure cooperation of the faculty and students in athletic affairs, to maintain a high standard of sportsmanship and to maintain facilities which make it possible for students to take part in athletic activities. Intercollegiate schedules are played in football, basketball, cross country, swimming, track, golf, tennis, baseball, gymnastics, wrestling, volleyball and softball.

The Georgia Tech National Alumni Association

The Alumni Association is a nonprofit corporation dedicated to serving Georgia Tech. Some of its objectives are to maintain an up-to-date record of each alumnus, publish Tech Topics and the Georgia Tech Alumni Magazine, organize and service local alumni clubs, operate a free placement service for alumni, organize special alumni events, furnish a medium through which alumni may aid the president and faculty, aid visiting alumni, help publicize the achievements of Georgia Tech and raise funds for Tech through the annual alumni roll call. The executive director is the central contact for all alumni.

The Georgia Tech Foundation, Inc.

This nonprofit corporation solicits and administers funds for Georgia Tech and its students. The foundation is directed by a board of outstanding alumni business leaders who administer the funds received to the best of their judgment for the improvement of the school. The funds are presently used to supplement the compensation of faculty members in order to obtain or retain outstanding faculty members, to underwrite special programs which cannot be financed by state funds for the development of Georgia Tech and to assist faculty members to improve their professional qualifications and standing through advanced study.

The Georgia Tech Research Institute

This not-for-profit corporation administers and seeks funds for research activity in all administrative divisions of Georgia Tech. It is the coordinating agency for patent applications and other matters related to the protection and use of technological discoveries made at Georgia Tech.

Accreditation

The Georgia Institute of Technology is an accredited member of the Southern Association of Colleges and Schools. Accreditation has been given by the Engineers’ Council for Professional Development, the national engineering accrediting agency, to the four-year engineering curricula leading
to bachelor's degrees in the following fields: aerospace engineering, ceramic engineering, chemical engineering, civil engineering, electrical engineering, engineering science and mechanics, industrial engineering, mechanical engineering, nuclear engineering and textile engineering as well as to the graduate programs leading to master's degrees in the following fields: aerospace engineering, ceramic engineering, civil engineering, electrical engineering, industrial engineering, mechanical engineering, metallurgy, nuclear engineering, sanitary engineering and textile engineering.

The curriculum leading to the degree Master of Architecture is accredited by the National Architecture Accrediting Board. The curriculum leading to the bachelor's degree in chemistry is accredited by the American Chemical Society. The College of Industrial Management is accredited by the American Assembly of Collegiate Schools of Business.

No accrediting agency has yet been established in the field of health systems, but the School of Health Systems has been admitted to associate institutional membership in the Association of University Programs in Health Administration for future accreditation review.

Degrees

The Georgia Institute of Technology at present offers curricula leading to the following undergraduate degrees.

- Bachelor of Aerospace Engineering
- Bachelor of Ceramic Engineering
- Bachelor of Chemical Engineering
- Bachelor of Civil Engineering
- Bachelor of Electrical Engineering
- Bachelor of Engineering Economic Systems
- Bachelor of Engineering Science
- Bachelor of Industrial Engineering
- Bachelor of Mechanical Engineering
- Bachelor of Nuclear Engineering
- Bachelor of Textile Engineering
- Bachelor of Science
- Bachelor of Science in Applied Biology
- Bachelor of Science in Applied Mathematics
- Bachelor of Science in Applied Physics
- Bachelor of Science in Applied Psychology
- Bachelor of Science in Building Construction
- Bachelor of Science in Chemistry
- Bachelor of Science in Economics
- Bachelor of Science in Health Systems
- Bachelor of Science in Information and Computer Science
- Bachelor of Science in Industrial Design
- Bachelor of Science in Industrial Management
- Bachelor of Science in Management Science
- Bachelor of Science in Physics
- Bachelor of Science in Textile Chemistry
- Bachelor of Science in Textiles
Special Programs

The Cooperative Plan

Since 1912 Tech has offered two plans of study in engineering: the standard four-year plan and a five-year cooperative plan for students who wish to combine practical experience with technical theory.

Approximately 1,700 students enrolled in the cooperative program are employed in over 360 industries throughout the country.

The cooperative division offers programs for majors in aerospace, ceramic, chemical, civil, electrical, industrial and systems, mechanical, nuclear and textile engineering, including textiles and textile chemistry, and in chemistry, engineering science and mechanics, information and computer science, physics and industrial management. The academic curricula are identical to those offered regular four-year students.

The plan operates on alternating college and industrial quarters. Students are divided into two sections, the first registering in June and the second in September. The co-ops of section one and those of section two alternate between industry and college, exchanging places with each other every three months for four years. At the beginning of the fifth year the two sections merge and remain at college together until graduation in June, when each cooperative student receives a bachelor's degree, cooperative plan, in the student's particular field.

Students in the cooperative division are selected from applicants on the basis of high scholarship.

Practical experience, the primary purpose of the plan, is a valuable asset to young graduates starting out in their chosen professions. Neither college laboratory experience nor practical working experience during summer vacations can take the place of organized co-op training in industry. The plan provides, to a substantial degree, the experience most companies require their engineers to have before promoting them to positions of responsibility.

The work experience is an aid to students who seek employment after graduation. It may also help them decide early in their college careers whether they wish to continue the study of engineering, science or management as a life profession.

The second purpose, understanding the human element, is another important consideration. While working in industry, students come in daily contact with both college and noncollege men and women among their fellow employees. Through working with such diverse groups, students get a practical insight into sociology, ethics, economics and psychology that never could be gotten from textbooks.

A third and significant purpose is financial. Firms that employ cooperative students compensate them for service rendered. Although students are not able to earn all of their college expenses, as a rule they can earn more than half.

Students interested in applying for admission to the cooperative plan should write to Director, Cooperative Division, Georgia Tech, Atlanta, Georgia 30332, for the division's bulletin, which gives such information as fees, living expenses and wages paid students while at work.

Dual Degree Program

Many high school students are seeking a broadly based educational experience involving the types of college programs generally found at a liberal arts college as well as professional education in technology. Georgia Tech has developed an extensive network of college contacts through the Dual Degree Program to serve their needs. Under this plan the student attends a liberal arts college for approximately three years, then comes to Tech for two years. Upon completion of the program the student receives a bachelor's degree from the liberal arts college and a bachelor's degree from Georgia Tech.

Programs of study at Tech may be centered in any of the various specialty areas of engineering, science, mathematics or management, as well as in engineering technology degree program at Southern Technical Institute. The colleges participating in the Dual Degree Program include most of the units of the University System of Georgia, the Atlanta University Center Colleges and 72 other colleges and universities throughout the nation. The list of participating colleges is increasing rapidly and includes 10 traditionally black colleges as well as 20 predominantly women's colleges. A Dual Degree Program applicant is considered a transfer student and must meet all requirements for transfer.

ROTC

Georgia Tech has three entirely voluntary ROTC programs: Army, Navy and Air Force. All three programs accept both men and women.

Six hours of basic ROTC and nine hours of advanced ROTC may be used as elective credit toward a degree. Students who earn a baccalaureate or higher degree and successfully complete the advanced ROTC courses of any of the three services are selected for commissioning in either the reserve or the regular forces.

Each ROTC unit offers scholarship programs of two, three and four years. All juniors and seniors selected for the advanced courses receive a substantial monetary allowance each month while enrolled in ROTC.

Preprofessional Programs

Premedical, predental and prelaw programs are offered at Georgia Tech. None of these is specified as a degree program as such, but students who take the proper courses from the various curricula will attain the objectives usually associated with these programs.

To obtain a prelaw background, a bachelor's degree in almost any engineering or management area or a degree in psychology would be most ac-
Joint Enrollment Program for High Schoolers

Georgia Tech admits a limited number of gifted students who have finished the eleventh grade and who have academic credentials that would place them in the upper part of Tech's freshman class.

Students admitted in this category will normally take all their coursework at Tech. The courses taken will include those subject areas needed to fulfill the high school requirements for graduation. High school credit is given for such courses and the student actually graduates with his or her high school class. All work taken at Georgia Tech is also applicable toward an institute degree if it is a part of a particular curriculum undertaken by the student at a later date.

To be eligible to participate in this program, the local school system must have signed the appropriate agreement with the Georgia Institute of Technology. Students should check with local school officials to determine if their particular system is a participating member. If so, the student should check with the high school counselor regarding specific course, test and recommendation requirements for JEPHS. If further information or assistance is required, contact the Admissions Office at Georgia Tech.

Special Studies

Georgia Tech is dedicated to helping each student realize his or her full academic potential. For this purpose a variety of programs presents different approaches to aid in overcoming academic stumbling blocks. Each of the programs is based on voluntary participation by students needing the services available.

A mathematics laboratory is available where any Georgia Tech student needing help with a freshman level mathematics course may obtain tutoring. The laboratory is operated by the mathematics department from 1 to 5 p.m. Monday through Friday during weeks when classes are in session.

A laboratory course conducted by the English department in the mechanics of reading is designed for students who desire to increase their reading speed and improve their comprehension of written material.

English and literature for international students are courses designed for students whose native language is not English. They are intended to introduce international students to written and spoken English as well as American social situations, customs, ideas and literature.

English for students who fail the regents' examination is a special course taught for students who desire further preparation before retaking it.

STEP is a service located in the Bridge Room of Brittain Dining Hall where students may obtain help with any freshman level course. This help is in the form of quick answers to telephoned questions on current assignments, short personal tutoring sessions and occasional group coaching in particularly troublesome areas. STEP is coordinated through the office of the dean of engineering.

Admissions

For any information regarding admission to Georgia Tech, write to the:

Director of Admissions
Georgia Institute of Technology
Atlanta, Georgia 30332

Both freshen and transfer students are accepted for all four academic quarters, which begin in September, January, March and June.

Freshmen and transfer** student deadlines for submission of the Application for Admission and all required credentials are as follows:

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<thead>
<tr>
<th>Quarter</th>
<th>Residents</th>
<th>Non-Residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>April 1*</td>
<td>January 1</td>
</tr>
<tr>
<td>Fall</td>
<td>April 1*</td>
<td>January 1</td>
</tr>
<tr>
<td>Winter</td>
<td>December 1</td>
<td>December 1</td>
</tr>
<tr>
<td>Spring</td>
<td>March 1</td>
<td>March 1</td>
</tr>
</tbody>
</table>

Current residents are required to have submitted their applications prior to the last day of registration.

**Note: Transfer students should plan their transfer so as to allow ample time for official final transcripts from their previous school to be sent to Georgia Tech. If official final transcripts have not been received prior to the last day of registration, the student seeking transfer will not be allowed to complete registration.
Enrollment, Dual Degree, Early Admissions and Early Notification; and the entire range of admission details is covered in the Admissions Catalog which is specifically designed to present all information needed by applicants up to the point of enrollment at Georgia Tech.

**Admission of International Students**

A special information pamphlet for foreign students is available upon request which indicates the application procedures for both freshman and undergraduate transfers and other basic information helpful to applicants from other countries. In general, international students are accepted for fall quarter only.

**Advanced Placement and Honors Program**

Superior students entering Georgia Tech may receive college credit for courses completed in high school if their scores on the college board advanced placement program examinations indicate a satisfactory knowledge of college course work. Advanced placement and credit are offered by the Schools of Chemistry, Mathematics and Physics and Departments of English and Social Sciences. Minimum AP score for consideration in English, mathematics or history is three. The minimum in chemistry or physics is four.

Advanced placement is possible in chemistry on the basis of high scores on the college board achievement tests. A number of students in the engineering college whose scores on the SAT-verbal and the English achievement test examinations are sufficiently high is given the option of waiving one or more of the freshman courses as prerequisites to enrollment in the upper-level courses offered by the English department. An honors program is offered in mathematics. Participation in advanced placement, advanced sectioning and honors programs is voluntary.

Under certain conditions, up to 12 hours of credit for high school language study is granted by the Department of Modern Languages. See page 153.

**Veterans Program**

As early as possible, and preferably at least one month before entering Georgia Tech, any student planning to enroll under any of the Veterans Administration programs should visit the financial aid office on the Georgia Tech campus to initiate enrollment certification procedures. The veteran being certified for the first time should bring such items as proof of discharge (DD-214). Veterans previously certified must have their VA claim number. Eligible veterans will be certified in advance of enrollment in order to expedite the first benefit check. Students who request enrollment certification on the day of registration should anticipate a four to six week delay in the receipt of the first benefit check. All questions regarding procedures for certification should be directed to the Office of Financial Aid located on the ground floor of the Administration Building on the Georgia Tech campus.

The veteran planning to study under veterans' benefits at the Georgia Institute of Technology should apply for admission as any other student. Eligibility for Veterans Administration benefits has no direct relationship to the institution. All financial transactions are directly between the student and the Veterans Administration. The institution serves only as a source of certification and information to the Veterans Administration.

Most veterans who served on active duty for more than 180 days, any part of which occurred after January 31, 1955 and before January 1, 1977, are generally eligible for financial support to attend college. Generally, sons and daughters between 18 and 26 years old of deceased veterans, those of living veterans who have disabilities which are considered to be total and permanent and those of veterans whose death or disability was a result of service in the armed forces are eligible for financial benefits to attend college. Applicants in these categories should ask their local Veterans Administration office for complete details.

The local Atlanta Veterans Administration address is 730 Peachtree Street, NE, Atlanta, Georgia 30308.

**Health Information**

Health information record forms are mailed to students with the notice of their acceptance for enrollment. These forms are to be completed by the prospective student and mailed to the director of health in sufficient time to be received prior to the date of initial registration. After review of the report, the school physicians determine the assignments to physical training.

Any student who desires special consideration because of mental or physical disability should have his or her physician write an explanatory letter to the director of health giving full details of the disability and any desired limitations on physical activity. This letter is to be attached to the health information record. Any special examinations or reports needed to determine eligibility for enrollment or assignment are at the expense of the student, not the school. Any student who fails to submit the required immunization record prior to registration will have the necessary immunization ordered by the school at the expense of the student. Completed forms should be mailed to:

- Director of Health
- Student Health Service
- Georgia Institute of Technology
- Atlanta, Georgia 30332

**Readmissions**

Georgia Tech students who find it necessary to discontinue enrollment for one or more quarters, with the exception of a summer quarter, must apply for readmission when planning to return to the institute. An application for readmission may be obtained from the registrar and must be completed and returned no later than the date indicated by the following schedule:

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>August 1</td>
</tr>
<tr>
<td>Winter</td>
<td>December 1</td>
</tr>
<tr>
<td>Spring</td>
<td>March 1</td>
</tr>
<tr>
<td>Summer</td>
<td>June 1</td>
</tr>
</tbody>
</table>

Additional information is available in chapter six of this catalog, "Rules and Regulations," section VI-F.
Academic Advising

The faculty of each school has the obligation to provide each student enrolled in that school the opportunity to obtain consultation on his or her academic program and to receive advice on course selection. Students are encouraged to seek assistance from their faculty advisers whenever a problem occurs concerning their academic programs. A student who does not know the identity of the faculty adviser should seek assistance from the school director.

Academic Regulations

Detailed information regarding the academic regulations of the institute is contained in this catalog, under “Rules and Regulations.” Questions concerning academic regulations should be directed to the general office of the student’s major school or to the registrar, room 104, Administration Building.

Grading System

Detailed information regarding the grading system is contained in this catalog under, “Rules and Regulations,” section IV.

Institute Rules for the Pass-Fail System

At the option of the student’s major school, up to a maximum of 12 hours credit towards a bachelor’s degree or six hours credit towards a graduate degree may be allowed for courses taken under the pass-fail system, with a grade of “pass.” The department or school offering a course may, if it desires, restrict enrollment on a pass-fail basis. In order that credit for a particular course taken on the pass-fail system be counted towards the degree requirements, the student’s major school must approve the course. Approval may be given on an individual basis or a school may establish blanket rules for its majors. Courses taken under the pass-fail system will not be included in the calculation of the grade point average, whether the grade be pass or fail. Withdrawal from courses taken on a pass-fail basis will be handled under the same rules as for courses taken on a graded basis.

Students who register under the pass-fail system will be so designated on the official class rolls and the only grade that will be recorded is a “pass” or a “fail.” The criteria for a grade of “pass” are determined by the department or school offering the course. Under no circumstances will the basis for registration be changed from credit to pass-fail or from pass-fail to credit after the last day to make schedule changes. In no event will a pass-fail grade be changed at a later time to a letter grade. It is recognized that there will be times when, due to changes in the degree requirements, a course for which degree credit could be earned on a pass-fail basis at the time the course was taken will not be acceptable at a subsequent time. In such cases the student’s major school will decide if a course taken with a grade of “pass” will be accepted in fulfillment of the degree requirement.

Transfer Credit

The basic policy regarding the acceptance of courses by transfer is to allow credit for courses completed with satisfactory grades (C or better) in other accredited colleges provided the courses correspond in time and content to courses offered at the Georgia Institute of Technology. In no case will credit be allowed (except by examination) for courses completed at another institution that have previously been failed at Georgia Tech. An official transcript, requested by the student, must be on file in the office of the registrar before credit can be awarded.
Enrolled students at Georgia Tech must receive prior approval from the student's major school and the registrar before scheduling courses at other institutions.

Auditors
Any officially enrolled student who has obtained the approval of his or her adviser and the departments of instruction concerned may audit courses. No credit is granted for courses scheduled on an auditing basis, however, and students are not permitted to change to or from an auditing status except through the regular procedures for schedule changes and during the period for changes as published in the official calendar for each quarter. All students registered as auditors are required to pay tuition at the regular rate. Members of the faculty or staff of the Georgia Institute of Technology may not sit in on a course providing permission is obtained from the department concerned and the registrar.

Constitution and History Examinations
The Georgia law as amended March 4, 1953 requires that before receiving an undergraduate degree all students pass examinations or pass comparable courses in United States and Georgia history as well as United States and Georgia Constitution. Courses which may be substituted for the United States and Georgia Constitution requirement are Pol. 1251 or Pol. 3200. Courses which may be substituted for the United States and Georgia history examinations are Hist. 1001, Hist. 1002, Hist. 3010 or Hist. 3011.

Regents' Testing Program
A requirement which every student in the University System of Georgia (of which Georgia Tech is a part) must meet in order to be eligible for an undergraduate degree is the passing of an examination designed to measure proficiency in reading and English composition. This examination, known as the Regents' Test, is to be taken before the end of the sophomore year. If failed, it may be repeated. It must be passed before graduation. Students who reach 105 hours credit towards a degree will not be allowed to continue scheduling credit work toward the degree until the exam is passed.

Major Area Examinations
All students completing requirements for baccalaureate degrees are required by the University System of Georgia to take a major area examination prior to being certified as having completed all requirements for the degree.

ROTC Credit
Six quarter hours in basic ROTC courses and nine quarter hours in advanced ROTC courses are the maximum credits allowed toward meeting the requirements for any degree. See "Rules and Regulations," section XVI.

Physical Education
All students entering Georgia Tech are required to satisfactorily complete three credit hours in physical education courses. It is expected that this requirement will be completed during the student's freshman year. Unless medically disqualified, all students will be required to complete swimming (P.E. 1010) plus two additional courses. One of these must be selected from the remaining courses at the 1000 level and one must be selected from the 2000 level.

The health information record will determine any medical exemptions from physical education courses. All certificates of disability from personal physicians must be endorsed by the Student Health Services before they will be accepted by the department.

Students who are exempt for medical reasons from all physical education activity courses will be required to satisfactorily complete P.E. 1040 (Health Education) to complete their physical education requirement. Students who are medically exempt from a single 1000 level course including swimming must substitute an additional 1000 level course in its place.

Transfer students will be granted credit for comparable physical education courses completed at other institutions.

Students who are 25 years of age or older upon matriculation to the institution have the option of satisfying the physical education requirement for graduation by completing the regular physical education requirements or by satisfactorily completing P.E. 1040.

The following is a listing of the courses by categories as they relate to this requirement.

Water Safety: P.E. 1010 (to be required of all medically qualified)

Personal Health and Physical Fitness Activities (Students select one course from this category):

<table>
<thead>
<tr>
<th>Course</th>
<th>Course</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.E. 1020</td>
<td>P.E. 1050</td>
<td>P.E. 1040</td>
</tr>
<tr>
<td>P.E. 1030</td>
<td>P.E. 1090</td>
<td>P.E. 1040</td>
</tr>
</tbody>
</table>

Recreational and Leisure Activities (Students select one course from this category):

<table>
<thead>
<tr>
<th>Course</th>
<th>Course</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.E. 2010</td>
<td>P.E. 2070</td>
<td>P.E. 2110</td>
</tr>
<tr>
<td>P.E. 2020</td>
<td>P.E. 2075</td>
<td>P.E. 2120</td>
</tr>
<tr>
<td>P.E. 2040</td>
<td>P.E. 2080</td>
<td>P.E. 2130</td>
</tr>
<tr>
<td>P.E. 2050</td>
<td>P.E. 2090</td>
<td>P.E. 2140</td>
</tr>
<tr>
<td>P.E. 2055</td>
<td>P.E. 2100</td>
<td>P.E. 2150</td>
</tr>
<tr>
<td>P.E. 2060</td>
<td>P.E. 2101</td>
<td>P.E. 2160</td>
</tr>
</tbody>
</table>

Humanities and Social Sciences Requirements
A tabulation of the work required for degrees in the curricula offered by the Georgia Institute of Technology is given in this catalog, "Curricula and Degrees."

At least 36 credit hours of humanities and social sciences must be included in all curricula leading to an undergraduate degree.

Students in all degree programs must take at least 36 hours of humanities and social sciences distributed as follows.

<table>
<thead>
<tr>
<th>Category</th>
<th>Hours Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities and Social Sciences</td>
<td>36</td>
</tr>
</tbody>
</table>

The following is a listing of the courses by categories as they relate to the total required work in humanities and social sciences:

<table>
<thead>
<tr>
<th>Category</th>
<th>Courses</th>
</tr>
</thead>
</table>

This includes all certificates of activity courses. All certificates of activity courses must be endorsed by the Student Health Services before they will be accepted by the department.
Financial Information

Costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Resident of Georgia</th>
<th>Nonresident of Georgia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarterly Fees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matriculation Fee</td>
<td>$195.00</td>
<td>$195.00</td>
</tr>
<tr>
<td>Nonresident Fee</td>
<td>$0.00</td>
<td>$430.00</td>
</tr>
<tr>
<td>Transportation Fee</td>
<td>$3.50</td>
<td>$3.50</td>
</tr>
<tr>
<td>Student Activity Fee</td>
<td>$24.00</td>
<td>$24.00</td>
</tr>
<tr>
<td>Health Service Fee</td>
<td>$28.00</td>
<td>$28.00</td>
</tr>
<tr>
<td>Total</td>
<td>$250.50</td>
<td>$680.50</td>
</tr>
<tr>
<td>Quarterly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Books and Supplies</td>
<td>$70</td>
<td>$70</td>
</tr>
<tr>
<td>Room Rent</td>
<td>$217-247</td>
<td>$217-247</td>
</tr>
<tr>
<td>Board</td>
<td>$350-390</td>
<td>$350-390</td>
</tr>
<tr>
<td>Personal Expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(clothing, laundry,</td>
<td>$160</td>
<td>$160</td>
</tr>
<tr>
<td>recreation, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Per Quarter</td>
<td>$1050-1120</td>
<td>$1480-1550</td>
</tr>
<tr>
<td>Total Per Year (3 quarters)</td>
<td>$3150-3360</td>
<td>$4440-4650</td>
</tr>
<tr>
<td>Total Per Year (2 quarters) for co-op students in school</td>
<td>$2100-2240</td>
<td>$2960-3100</td>
</tr>
<tr>
<td>2 quarters instead of 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional Freshman Expenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pocket calculator, drawing supplies (in addition to quarterly costs)</td>
<td>$140</td>
<td>$140</td>
</tr>
<tr>
<td>Total per year freshmen only</td>
<td>$3290-3500</td>
<td>$4580-4790</td>
</tr>
</tbody>
</table>

Part-time students (those carrying less than 12 credit hours per quarter) who are legal residents of Georgia will be charged $15 per credit hour. Non-residents will be charged $47 per credit hour. All students scheduling six hours or more must pay the transportation, student activity and health service fees of $46.50.

The above expenses do not include fraternity, club dues or personal trans-
portation expenses. Since changes in fees may occur without notice, the student must refer to information provided on registration day by the Office of the Vice-president for Business and Finance for official amounts on fees and other institutional charges for each individual quarter. An extra fee may be charged in special courses. A deposit (in addition to the dormitory room deposit) is required of each accepted applicant for admission to the fall quarter as required in the letter of admission. Approximately two weeks following registration, this deposit will be refunded to the student by check mailed to his or her campus post office box. Any student who withdraws during the first quarter of his or her attendance shall have his or her admission deposit deducted before any computation is made of the refund to which the student may be entitled.

Obligations of Students. An individual is not officially enrolled at Georgia Tech until all tuition, matriculation, student activity and medical fees for the current quarter are paid. Once enrolled, every student is obligated to remit, return or submit all other financial obligations that may become due, as well as property or records of the institute, within the time prescribed by the institute. Failure to fulfill any such obligation will result in denial of registration privileges for subsequent quarter(s). Such denial of registration privileges is in addition to and from any disciplinary measures which may be taken pursuant to the Student Conduct Code (paragraph XI, "Student Rules and Regulations").

Other Fees. Each person receiving a diploma must pay a diploma fee before graduating.

Examinations at other than regular examination times will be granted in exceptional cases only and by faculty action. Normally a fee will be charged in such cases.

A late registration fee of not more than $16 is charged at the rate of $10 for the first day after regular registration, and an additional $2 for each of the next three days. If a student does not pay all required fees by the end of the first week of the quarter, his or her registration will be cancelled.

Refund of Fees. Refunds of matriculation, tuition or dormitory rents for reasons of withdrawal from the institute or dropping of subjects may be considered only upon written application to the business office for refund of fees. The application must be dated and signed by the individual requesting the refund.

A form is available from the registrar or the cashier's office to request the refund. A copy of the withdrawal application or drop slip must accompany fee refund application. Student activity and medical fees are not refundable. Requests for dormitory rent refunds must be completed at the housing office by the individual.

Students who formally withdraw during one week following the scheduled registration date are entitled to a refund of 80 percent of the fees paid for that quarter.

Students who formally withdraw during the period between one and two weeks after the scheduled registration date are entitled to a refund of 60 percent of the fees paid that quarter.

Students who formally withdraw during the period between two and three weeks after the scheduled registration date are entitled to a refund of 40 percent of the fees paid for that quarter.

Students who formally withdraw during the period between three and four weeks after the scheduled registration date are entitled to a refund of 20 percent of the fees paid for the quarter.

Students who withdraw on or drop a subject after a period of four weeks has elapsed from the scheduled registration date will not be entitled to a refund of any part of fees paid for that quarter. All requests for refunds must be received in the Office of the Vice-president for Business and Finance within one month following the registration date.

Definition of Legal Residence

Because the overwhelming proportion of financial support for the operation of the public institutions of higher education in Georgia comes from the citizens through the payment of taxes, the determination of whether a student is classified as a resident or nonresident of the state is a significant matter. The fees paid by resident students cover only about one-fourth of the total cost of their education in the university system. Therefore, Georgia taxpayers are contributing three-fourths of the necessary funds to provide quality education to the citizens of the state.

The practice followed by state colleges and universities of assessing nonresident students a higher tuition rate is a rational attempt by states to achieve a partial cost equalization between those who have and those who have not recently contributed to the state's economy, even though there is no way to determine the degree to which higher tuition charges equalize the cost of educating residents and nonresidents. The duration residency requirement (usually 12 months) imposed by most, if not all, states is considered by the courts to be a reasonable period during which the new resident can make tangible or intangible contributions to the state before being allowed the benefit of attending state colleges upon the payment of resident fees.

The foregoing considered, the board of regents has adopted the below listed policies governing the classification of students as residents and nonresidents in keeping with its responsibility to the citizens of Georgia for an appropriate assessment of non-resident fees to insure that out-of-state students pay a fair and reasonable share of the cost of their education.

1. (a) If a person is 18 years of age or older, he or she may register as a resident student only upon a showing that he or she has been a legal resident of Georgia for a period of at least 12 months immediately preceding the date of registration. (b) No emancipated minor or person 18 years of age or older shall be deemed to have gained or acquired in-state residence status for fee purposes while attending any educational institution in this state, in the absence of a clear demonstration that he or she has in fact established legal residence in this state.

2. If a person is under 18 years of age, he or she may register as a resident student only upon a showing that his or her supporting parent or guardian has been a legal resident of Georgia for a period of at least 12 months immediately preceding the date of registration.

3. A full-time employee of the University System and his or her spouse and dependent children may register on the payment of resident fees.
4. Nonresident graduate students who hold teaching or research assistantships requiring at least one-third time service may register as students in the institution in which they are employed on payment of resident fees.

5. Full-time teachers in the public schools of Georgia and their dependents, children may enroll as students in the university system institutions on the payment of resident fees, when such teachers have been legal residents of Georgia for the immediately preceding nine months, were engaged in teaching during such nine month period and have been employed to teach full-time in the public schools of Georgia during the ensuing school year.

6. All aliens shall be classified as nonresident students; however, an alien who is living in this country under a visa permitting permanent residence shall have the same privilege of qualifying for resident status for fee purposes as a citizen of the United States.

7. Foreign students who attend institutions of the university system under financial sponsorship of civic or religious groups located in this state may be enrolled upon the payment of resident fees, provided the number of such foreign students in any one institution does not exceed the quota approved by the board of regents for that institution.

8. If the parents or legal guardian of a minor changes his or her legal residence to another state following a period of legal residence in Georgia, the minor may continue to take courses for a period of 12 consecutive months on the payment of resident fees. After the expiration of the 12 month period the student may continue his or her registration only upon the payment of fees at the nonresident rate.

9. In the event that a legal resident of Georgia is appointed as guardian of a nonresident minor, such minor will not be permitted to register as a resident student until the expiration of one year from the date of court appointment or from the date of proper showing that such appointment was not made to avoid payment of the nonresident fees.

10. Career consular officers and their dependents who are citizens of the foreign nation which their consular office represents, and who are stationed and living in Georgia under orders of their respective governments, shall be entitled to enroll in university system institutions on payment of resident fees. This arrangement shall apply to those consular officers whose nations operate on the principle of educational reciprocity with the United States.

11. Military personnel and their dependents stationed in Georgia and on active duty will not be assessed a nonresident fee but shall pay the same fees assessed residents of Georgia, effective beginning summer quarter, 1977.

Procedure for handling: this will be handled on a quarter-to-quarter basis as a waiver rather than a reclassification. Waivers may be obtained from the Residence Committee Office, ground floor, Administration Building by presenting a copy of military assignment orders and fee card. Military personnel on temporary assignment will not be eligible for this waiver.

If there is any question concerning residence status, students should contact the chairman of the Residence Committee, Administration Building in writing or by telephone (404/894-4610). Applications for classification as a legal resident for fee payment purposes must be received by the Residence Committee not later than one month prior to the academic registration date for the quarter in which the student seeks admission as a resident of Georgia.

Undergraduate Financial Aid

Financial aid at the Georgia Institute of Technology is intended to assist as many students as possible to meet normal college expenses. No student should fail to consider attending Georgia Tech because of financial reasons. Georgia Tech will aid students either through school funds or by directing the student to other sources. The financial aid applicant should realize, however, that the amount of aid that can be granted seldom meets all educational expenses, and financial assistance will have to be supplemented by the student, family or other outside sources.

The Financial Aid Office has the responsibility of administering all funds provided to Georgia Tech for the assistance of undergraduate students. It also receives and assigns awards forwarded to the institution from outside agencies for the use of individual students.

All entering students, including transfer students, who wish to be considered for scholarships, grants, loans and/or work opportunities for any quarters of the academic year beginning in September should submit a Georgia Institute of Technology financial aid application prior to February 15. (A Financial Aid Form should be submitted to the College Scholarship Service no later than February 1.) Financial aid awards to entering students are normally made prior to May 1.

Although the cooperative program at Georgia Tech is not a financial aid program, many of those who attend are able to assist themselves with their college expenses through this program. Approximately one-fifth of the undergraduate enrollment attends under the cooperative plan and earns from $3,000 to $4,500 per year. Co-op enrollment is restricted to students in the fields of engineering, science and industrial management. Since financial aid is not a prerequisite for consideration, a student attending under the cooperative plan will not be denied consideration for other aid because of his or her enrollment. Students desiring other information on the cooperative program should write to the director of the Cooperative Division, Georgia Institute of Technology, Atlanta, Georgia 30332.

Many students obtain part-time employment at Tech or in the Atlanta area. Atlanta is a center of business activity and offers students a wide range of opportunities to earn money to use toward college expenses. Students must register for at least 12 credits in order to receive financial aid. Financial aid available through the college may be in the form of scholarships, loans, or work opportunities. The amount granted will vary according to individual and family need.

Although the cooperative program at Georgia Tech is not a financial aid program, many of those who attend are able to assist themselves with their college expenses through this program. Approximately one-fifth of the undergraduate enrollment attends under the cooperative plan and earns from $3,000 to $4,500 per year. Co-op enrollment is restricted to students in the fields of engineering, science and industrial management. Since financial aid is not a prerequisite for consideration, a student attending under the cooperative plan will not be denied consideration for other aid because of his or her enrollment. Students desiring other information on the cooperative program should write to the director of the Cooperative Division, Georgia Institute of Technology, Atlanta, Georgia 30332.

Many students obtain part-time employment at Tech or in the Atlanta area. Georgia Tech's placement center attempts to keep an up-to-date listing of opportunities and most students will be able to help themselves through part-time employment if they so desire.

The primary purpose of financial aid at Georgia Tech is to provide assistance to students who, without such aid, would be unable to attend college. The primary responsibility for financing an education rests with the student and his or her family. Any financial aid is, therefore, awarded according to individual need and individual college costs. Financial aid includes scholarships, grants, loans and employment, which may be offered to students singly or in combination.

The family of the applicant is expected to make a maximum effort to assist the student with college expenses. Financial assistance from colleges and other sources should be viewed only as supplementary to the efforts of the family.

The student also has a responsibility to contribute to his or her college expenses through such sources as savings, summer earnings and contributions from friends and relatives. Students receiving aid are expected to use part of their summer earnings to defray college costs.
Students applying for financial aid should have their applications for admission on file by January 1 preceding the fall or summer they expect to enter.

Applications for financial aid may be obtained by calling or writing the Director of Financial Aid, Georgia Institute of Technology, Atlanta, Georgia 30332, (404) 894-4160. Requests for further information on any program of aid should also be directed to the above address. A current Undergraduate Financial Aid bulletin, which lists all awards and all applicable procedures and regulations, will be sent upon request.

**Medals and Prizes**

**The American Institute of Architects Medal and Certificate**

The School Medal of the American Institute of Architects is given annually to a student in Architecture accredited by the National Architectural Accrediting Boards, to a graduating student in recognition of scholastic achievement, character and promise of professional ability. The award is made possible through an endowment fund provided by the executors and heirs of the Henry Bell laboratories Outstanding award is made to the senior student in the School of Engineering Science and Mechanics who ranks among the first five of the class on the basis of at least four complete quarters having the highest scholastic average.

**Delta Kappa Phi**

Delta Kappa Phi is the oldest national honorary textile fraternity in the country. An annual award of an engineering handbook is made to the highest ranking sophomore student in mechanical engineering (based upon at least four quarters of work).

**Aerospace Engineering Medal**

The James Edward Oglietheorpe Chapter of the Daughters of the American Colonists presents annually a medal to the member of the graduating class in aerospace engineering who has made the highest scholastic average, based on the work of at least four complete quarters.

**Industrial Management Certificate**

The Industrial Management Society, senior honorary organization for I.M. students, awards annually a certificate of scholarship to the senior in the College of Industrial Management who ranks first in the class on the basis of all scholastic work taken at Georgia Tech.

**Gordon Gambill Memorial Endowment Award**

An annual award of a book to the athlete with the highest academic average each year at the sophomore, junior or senior level from the following disciplines: English, History, Mathematics, Science and Modern Language.

**Medals and Prizes**

**The American Institute of Architects Medal and Certificate**

The School Medal of the American Institute of Architects is given annually to a student in Architecture accredited by the National Architectural Accrediting Boards, to a graduating student in recognition of scholastic achievement, character and promise of professional ability. The award is made possible through an endowment fund provided by the executors and heirs of the Henry Bell laboratories Outstanding award is made to the senior student in the School of Engineering Science and Mechanics who ranks among the first five of the class on the basis of at least four complete quarters having the highest scholastic average.

**Delta Kappa Phi**

Delta Kappa Phi is the oldest national honorary textile fraternity in the country. An annual award of an engineering handbook is made to the highest ranking sophomore student in mechanical engineering (based upon at least four quarters of work).

**Aerospace Engineering Medal**

The James Edward Oglietheorpe Chapter of the Daughters of the American Colonists presents annually a medal to the member of the graduating class in aerospace engineering who has made the highest scholastic average, based on the work of at least four complete quarters.

**Industrial Management Certificate**

The Industrial Management Society, senior honorary organization for I.M. students, awards annually a certificate of scholarship to the senior in the College of Industrial Management who ranks first in the class on the basis of all scholastic work taken at Georgia Tech.

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An annual award of a book to the athlete with the highest academic average each year at the sophomore, junior or senior level from the following disciplines: English, History, Mathematics, Science and Modern Language.

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An annual award of a book to the athlete with the highest academic average each year at the sophomore, junior or senior level from the following disciplines: English, History, Mathematics, Science and Modern Language.
sports: baseball, basketball, football and track. This award is made in honor of the late Gordon Gambill, class of 1913.

The William Gilmer Perry Award
The Department of English awards annually a $50 bond to the student in his or her first year who has done the best work in freshman English. This award is made through the courtesy of the Georgia Tech Foundation, Inc., in honor of Dr. William Gilmer Perry, late professor of English.

Alpha Pi Mu Award
The Alpha Pi Mu Award is presented annually to extend recognition and honor to the senior student in industrial engineering who has exhibited outstanding scholastic achievement tempered with those individual characteristics which the members of Alpha Pi Mu consider necessary for success. The recipient of the award is chosen from the three top seniors so that the presentation is made at the annual Honors Day exercises.

The American Institute of Industrial Engineers, Atlanta Chapter Award
The American Institute of Industrial Engineers, Atlanta Chapter, annual award is presented to the industrial engineering senior who is most outstanding in scholastic attainment and trial management and is the most promising all-around student. The recipient is selected by a committee from a list of three candidates who have the highest point average among the graduating members of the student chapter of the ASCE and who have completed at least six quarters of work at the institute.

The American Society of Civil Engineers Award
The American Society of Civil Engineers Award is given annually by the Georgia Section of ASCE. The recipient is selected by a committee from a list of three candidates who have the highest point average among the graduating members of the student chapter of the ASCE and who have completed at least eight quarters of work at the institute. The award consists of the junior membership entrance fees and a cash prize of $90.

Army ROTC Awards
The Georgia Tech Honor Award is awarded annually to the outstanding senior cadet.

The Superior Cadet Ribbon Award is awarded annually to the outstanding cadet in each year for scholastic and military achievements.

The Beta Theta Pi fraternity, Georgia Tech chapter, presents annually the McGuire Medal to the outstanding distinguished military student of the Army ROTC.

The Georgia Society of Daughters of Colonial Wars presents annually a medal to the ROTC senior for excellence in Army ROTC leadership.

The Joseph Habershaw chapter of DAR presents annually a medal to the senior who attains the highest rating in leadership development throughout the student's ROTC career.

The Armed Forces Communication Association presents an award annually to the outstanding senior Army ROTC cadet in the field of communications and electronics.

The American Legion Post No. 1 awards medals to an Army ROTC cadet and senior for excellence in scholastic achievement.

The American Legion Fifth District award is given annually to the junior and senior for Army ROTC cadet for excellence in military achievement.

The Professor of Military Science awards are presented annually to the junior and senior who are outstanding in the performance of daily military duties.

The Society of American Military Engineers presents annually a medal to the outstanding senior engineering student of the Engineer ROTC Branch.

A medal is given annually by the American Ordnance Association to the senior ordnance cadet who attains the highest rating in leadership and ordnance scholarship.

The John Sergeant Memorial Award is awarded annually to a senior infantry cadet who displays distinguished leadership.

The Association of the U.S. Army ROTC Medal is awarded annually to the outstanding senior cadet.

The Association of the U.S. Army presents annually a medal to the outstanding Infantry Branch junior.

The American Legion Medal is presented annually to the outstanding basic cadet who is accorded the highest rating in military subjects, personal qualifications, leadership and scholastic average.

The ANAK Society annually presents medals to the three freshmen who attain the highest ratings for proficiency in leadership and scholarship.

The General Dynamics award is presented annually to the outstanding senior in the flying category.

The Air Force Times Award recognizes annually the senior showing most initiative in community relations.

The Military Order of the World Wars presents annual awards to the most outstanding cadet in each aerospace studies class.

The Air Force ROTC Cadet Medal of Honor is presented annually to the outstanding distinguished military student of the Air Force ROTC.

The ANAK Society of Georgia Tech annually presents a medal to an AFROTC cadet for outstanding contribution to esprit de corps.

The Scabbard and Blade Military Society gives annually an award for outstanding leadership in AFROTC corps training.

The local chapters of the Daughters of the American Revolution present annual awards to outstanding seniors in AFROTC.

The American Legion Medals are annually awarded to both junior and senior AFROTC cadets for excellence in military achievement and scholastic achievement.

The Fulton County Voiture 217 La Societe des 40 Hommes et 8 Chevaux Medal is annually awarded to the outstanding senior in the flying category.

The Sons of American Revolution Award is presented annually to the outstanding freshman.

The Daughters of Founders and Patriots of America Award is presented annually to the outstanding sophomore.

The Old Guard Battalion of the Gate City Guard presents annually an award for excellence in AFROTC.

The Reserve Officers’ Association presents annual awards to outstanding cadets in A.S. 4000, A.S. 3000 and A.S. 2000.

The Armed Forces Communication and Electronics Association Award is presented annually to Outstanding AFROTC senior in the engineering field.

The Air Force Association annually presents an award for excellence in AFROTC.

The Air Force Association gives annually an award for excellence in AFROTC.

The General Dynamics award is presented annually to the outstanding senior in the flying category.

The Air Force Times Award recognizes annually the senior showing most initiative in community relations.

The Military Order of the World Wars presents annual awards to the most outstanding cadet in each aerospace studies class.

Naval ROTC Medals and Awards
The Georgia State Society, United States Daughters of War of 1812 awards a gold
medal each year to the NROTC senior who achieves the highest rating in naval science.

The ANAK Society annually awards two medals: one to the NROTC junior showing highest proficiency in leadership, and one to the NROTC freshman showing highest proficiency in naval science. The Scabbard and Blade Society gives an award annually to an outstanding NROTC senior.

The McGuire Medal, awarded by the Beta Theta Pi fraternity, is presented annually to a distinguished senior. The Atlanta chapter of the Reserve Officers Association annually presents an award to an outstanding sophomore NROTC student. An appropriate award is presented each year to selected NROTC members of the Georgia Tech Rifle Team for proficiency in rifle marksmanship.

The Society of American Military Engineers annually awards ten engineering medals for the outstanding engineering NROTC seniors and ten medals for the outstanding engineering NROTC juniors selected from all NROTC schools in the United States. The United States Naval Institute presents awards annually to the senior scholarship NROTC student and the senior College Program NROTC student having the highest cruise aptitude marks for summer training.

The Marine Corps Association annually presents an award to an outstanding senior NROTC student who is a candidate for commission in the U.S. Marine Corps. The Georgia Tech Honor Award is awarded annually to the outstanding NROTC senior in scholarship, military achievement, and leadership.

The Armed Forces Communication and Electronics Association presents a gold medal and certificate to the outstanding NROTC senior majoring in electrical, electronic or communications engineering.

The Fulton County Voiture 217 La Societe des 40 Hommes et 8 Chevaux presents a medal to the outstanding NROTC senior and junior for excellence in military achievement.

The American Legion Post No. 1 Award is presented to an outstanding NROTC sophomore in scholarship. The American Legion Fifth District Awards are presented to an outstanding NROTC senior and junior for excellence in military achievement. The Fulton-DeKalb Council of the Navy League of the United States presents a naval officer's sword to the senior NROTC student contributing most to the prestige of the NROTC unit. The Old Guard Battalion of the Gate City Guard presents a naval officer's sword to the scholarship NROTC senior possessing most officer-like qualities.

The U.S. Marine Corps Reserve Officers Association presents a Marine Corps officer's sword to the outstanding Marine Corps option senior. The Naval Reserve Association Award is an engraved watch presented each year to the NROTC senior showing outstanding proficiency in leadership.

The Professor of Naval Science Award is presented to the NROTC junior with the highest scholastic average in navigation.

The North American Rockwell Award is awarded to the outstanding NROTC senior in the flight indoctrination program.

The General Dynamics Award is a plaque with scroll presented to an NROTC student for outstanding achievement.

The Georgia Society of Professional Engineers Award
An award in recognition of demonstrated awareness of professional concepts in engineering is made annually by the Georgia Society of Professional Engineers.

The most outstanding engineering senior in the state of Georgia is chosen on the basis of interest in the professional aspects of engineering as evidenced by unquestioned personal integrity, participation in technical and professional activities and scholastic standing.

Alpha Kappa Psi Scholarship Award
The Epsilon Sigma Chapter of Alpha Kappa Psi, a professional business fraternity, awards annually the Alpha Kappa Psi Scholarship Key to the senior student pursuing a degree in the School of Industrial Management, who has attained the highest scholastic average for three years of collegiate work at Georgia Tech.

Ernest Boggsus Award
This award is made annually by the Surveying and Mapping Society of Georgia to an outstanding senior in civil engineering who is majoring in surveying and photogrammetry. The student is recom-
Information for Graduate Students

General Information

The faculty of the Georgia Institute of Technology grants advanced degrees in engineering, science, management, architecture and city planning through the Office of Graduate Studies and Research.

The goals of the office are to establish an educational environment that will encourage and assist students to develop their capabilities both as professionals and as human beings, to encourage students and faculty to press research vigorously for the discovery and generation of new knowledge, to investigate ways of applying such knowledge innovatively for the benefit of society and mankind and to foster the development of new tools, objects and ideas.

Graduate study is particularly recommended for those students whose interests and aptitudes carry them beyond routine application. It may be undertaken either to broaden knowledge of a given field or to increase competence and interest in independent research. It is for the student who wishes to work in research, development, design, or consulting; it is for the student of management who aspires to the formulation as well as the administration of policy, and it is for those who desire to enter the profession of education in the fields of engineering, science, or management.

Degrees and Programs of Study

Doctoral Programs

Programs of study and research leading to the Ph.D. degree are offered in the following disciplines and areas:

Aerospace Engineering
Ceramic Engineering
Chemical Engineering
Chemistry
Civil Engineering and Sanitary Engineering
Economics
Electrical Engineering
Engineering Science and Mechanics
Geophysical Sciences
Industrial and Systems Engineering
Master's Programs

Programs of study and research leading to the Master of Science degree are offered in the following disciplines:

- Aerospace Engineering
- Applied Nuclear Science
- Applied Physics
- Architecture
- Biology
- Ceramic Engineering
- Chemical Engineering
- Chemistry
- City Planning
- Civil Engineering
- Electrical Engineering
- Engineering Science and Mechanics
- Geophysical Sciences
- Health Systems
- Industrial and Systems Engineering
- Industrial Management
- Information and Computer Science
- Mathematics
- Mechanical Engineering
- Metallurgy
- Nuclear Engineering
- Operations Research
- Physics
- Psychology
- Sanitary Engineering
- Textile Engineering
- Textiles

Master of Architecture and Master of City Planning degrees are also available.

See detailed description of programs and courses under appropriate school designations.

Degrees may be awarded with or without designation of the field, based upon the recommendation of the school concerned.

The Department of City Planning also offers joint programs with the School of Civil Engineering, the College of Architecture and the University of Georgia School of Environmental Design. Each of these joint programs leads to the simultaneous awarding of two master's degrees.

The School of Health Systems offers options in health systems analysis and health systems planning, both of which lead to the degree, Master of Science in Health Systems. Also available are various interdisciplinary and interinstitutional programs through the Health Systems Research Center and the Medical College of Georgia.

Special Programs

Interdisciplinary Programs

All graduate degrees are offered through the administrative channels of the several schools of the institute authorized to offer such degrees. Within this framework, however, arrangements are available for offering special study and research programs for students who desire to pursue a degree within a wider perspective than that of a single discipline.

Programs of this type are available through cooperation with the bioengineering, environmental resources and health systems research centers and through several informal programs based on interests of small groups of faculty in such areas as atomic collisions, complex systems design, radiological health, solid waste technology, transportation and surface science technology. Also see the multidisciplinary programs listed by the College of Engineering on page 66.

The Academic Common Market

The institute participates in the Academic Common Market Program managed by the Southern Regional Education Board. The market is an interstate agreement among southern states for sharing academic programs. Residents of the participating states who qualify for admission and who are approved by their state coordinators may enroll on an instate tuition basis. Georgia Tech programs offered on this basis include ceramic engineering, city planning, geophysical sciences, health systems, nuclear engineering and textile engineering.

Courses for Secondary School Teachers

Recognizing that the systems of secondary and higher education in the state of Georgia are mutually supportive, Georgia Tech offers a limited number of courses at the graduate level designed to prepare high school teachers to provide instruction in selected areas of architecture, science, engineering and technology. Courses are restricted to areas uniquely available, or available in unusual strength, at Georgia Tech.

Credit for satisfactory performance is recorded in the Office of the Registrar in the usual manner, but may not be counted toward any degree currently offered at Georgia Tech.

Interested persons should consult officials of the appropriate colleges and departments for details.

Policies and Regulations

Though final authority rests with the Academic Senate, the graduate committee with the approval of the Senate, is responsible for establishing academic policy for the graduate program. This committee reserves the right to change requirements for degrees as may be appropriate. Students who are enrolled at the time such changes are made shall have the privilege of following either the regulations stated in the catalog effective the quarter in which they enrolled, or the regulations in the catalog which records the change.

The institute-wide policies and regulations that govern the graduate program are recorded in this catalog. The several schools may make additional rules concerning programs and the pursuit of degrees in their schools, but these rules may not contradict institute policies and regulations.

Graduate Student Work Loads. The minimum hours for which a student
may be enrolled is three. The maximum hours for which a student may be
enrolled is 18. A full-time student must be enrolled for at least 12 hours. The
special regulations concerning the number of hours of enrollment for stu-
dents who hold assistantships or fellowships or who work on a full- or part-
time basis are on file in each school and in the graduate office. The average
student is expected to devote four hours of effective work per week for each
credit hour scheduled at the graduate level.

**Staff Members.** No staff member beyond the rank of instructor will be per-
mitted to work for a master's degree in the school in which he or she serves.
No new staff member with the rank of assistant professor will be permitted
to work for a doctoral degree in the school in which he or she serves.

### Admissions Information

All correspondence concerning admission to graduate study should be di-
rected to the appropriate school. Necessary admission forms may be ob-
tained from the appropriate school or from the Office of Graduate Studies
and Research. These forms, together with letters of recommendation and
official transcripts of previous academic work should be mailed to the sev-
eral offices of the institute as specified in the instructions given on the
application blank and should be on file at the institute by August 1 for fall
quarter, December 1 for winter quarter, March 1 for spring quarter, and June
1 for summer quarter. No application fee is required. In addition, a graduate
studies brochure and a financial aid booklet designed specifically for gradu-
ate student needs may be obtained by writing to:

- Office of Graduate Studies and Research
- Georgia Tech
- Atlanta, Georgia 30332

**Graduate Record Examinations**

Applicants may be required by the director of their school to submit results
of the Aptitude and Advanced tests of the Graduate Record Examinations
(GRE).

Students applying to the Schools of Biology, Geophysical Sciences, Psy-
chology, Textiles, Industrial Management (economics only), Industrial and
Systems Engineering (operations research program only) and Information
and Computer Science (Ph.D. applicants only) are required to submit GRE
scores. Applicants to the Schools of Biology, Chemistry and Mathematics
must take the Aptitude and Advanced tests of the GRE. All scores should be
sent directly to the school and not to the graduate office. Students applying
to the College of Industrial Management are required to supply General
Management Aptitude Test (GMAT) scores and should have these scores
sent directly to the dean of the College of Industrial Management.

Information as to time and location at which these tests are given can be ob-
tained by writing to Graduate Record Examinations, Educational Testing
Service, Box 955, Princeton, N.J., 08540. Inquiries from students in western
states should be addressed to 1947 Center Street, Berkeley, California 94704.
Information on the GMAT test may be obtained by writing to the Educational
Testing Service, Box 966, Princeton, N.J., 08540.

### Types of Standing

**Full graduate standing** will be accorded those applicants holding a bache-
lor's degree from an approved institution whose previous work has been of
a nature and quality sufficient to offer reasonable assurance of immediate
success in advanced study.

Conditional graduate standing will be granted to applicants holding a
bachelor's degree from an approved institution whose previous work, be-
because of deficiencies either in content or quality, must be supplemented by
additional work or demonstrated ability to be performed at a specified level.

Admission as a special graduate student may be granted to students who
do not wish to qualify for an advanced degree at Georgia Tech, but who can
demonstrate that the pursuance of certain advanced work will be of real
benefit.

Students working toward a second bachelor's degree will be registered in
the undergraduate school.

Students who are graduate students in good standing at another univer-
sity may be admitted as transient graduate students after filing an applica-
tion and verification of good standing status. The work undertaken will not
be applicable toward a Georgia Tech degree.

### Readmission

Students who interrupt the continuity of their graduate programs by not reg-
istering for one quarter (summer quarter excepted) must seek readmis-
sion by filing with the registrar a completed request for readmission form by
August 1 for fall quarter, December 1 for winter quarter, March 1 for spring
quarter and June 1 for summer quarter. Request forms are available from
the registrar's office.

### Reactivation of Application

Students who have been admitted for graduate study at Tech but who do not
enter in the quarter for which they applied and subsequently wish to be
considered for a later quarter must reactivate their application for the new
quarter. Since files are kept by the graduate office and the registrar's office
for only one year on "never entered" students, these students will have to
supply a whole new set of application materials if they delay more than one
year in the reactivation request. To reactivate an application the student
must request reactivation in writing to the registrar by August 1, December
1, March 1 or June 1 for the fall, winter, spring or summer quarters,
respectively.

### Undergraduate Students

Well qualified undergraduate students with at least a 2.7 cumulative GPA
may schedule graduate courses in their senior year. The student must obtain
permission from his or her adviser and the director of the school in which
the course is offered.

Credit toward the master's degree for work by undergraduates will be al-
lowed only under the following conditions:

1. The student must have been in residence at the Georgia Institute of
Technology for at least two quarters before registering for the course for which he or she desires graduate credit.

2. Credit for the course must not have been applied toward an undergraduate degree.

3. The student must petition the Graduate Committee of the Academic Senate to request such credit.

TOEFL for International Students

Test of English as a Foreign Language (TOEFL) is required of all international students coming from countries in which English is not the native language. The student should arrange to have the Educational Testing Service send test results to the registrar’s office as early as possible, for this information constitutes a part of the material reviewed for admission to graduate study at Georgia Tech. Students who make low scores will be required to take remedial work in English before being classified in full standing.

Students who wish to take TOEFL in any country except Hong Kong, India, Nepal or Taiwan should obtain the TOEFL Bulletin of Information for Candidates, International Edition. Copies of this Bulletin and the registration form may be obtained in a number of cities outside of the United States. They often are available at American embassies and consulates, offices of the United States Information Service (USIS), United States educational commissions and foundations abroad and binational centers. In addition, several private organizations distribute TOEFL Bulletins. Among them are 1. the Institute of International Education (IIE) in Nairobi, Kenya; Paris, France; and Lima, Peru; 2. the African-American Institute (AAI) in Dar es Salaam, Tanzania; and Lagos, Nigeria; 3. the American Mideast Educational and Training Services (AMIDEAST) in Tehran, Iran; Amman, Jordan; Beirut, Lebanon; Tangier, Morocco; and Cairo, Egypt; and 4. the American-Korean Foundation in Seoul, Korea.


Registration

Registration dates will be found on page 1 of this bulletin. New graduate students must report first to their school at 8 a.m. on registration day, when further instructions regarding registration procedures will be made available.

Each new graduate student must plan for an interview with the director of his or her school of specialty during the week before registration to prepare the proposed program of graduate study.

Orientation for new graduate students is conducted in the fall quarter just before registration.

The Master's Degree

Prerequisites

Applicants are expected to hold a bachelor's degree from a recognized institution and to have graduated in the upper half of their class. Students must show evidence of preparation in their chosen field sufficient to ensure profitable graduate study.

Matriculation Requirements

A student is matriculated for a graduate degree upon admission to graduate study with either full or conditional standing. The student must have taken the TOEFL or met the English Language requirement for admission to graduate study. Students who have matriculated for the master's degree are required to maintain continuous matriculation if the original requirements for the degree remain unchanged. If continuous matriculation is not maintained, the student's credentials are subject to re-evaluation and additional requirements for the degree may be imposed.

Continuous matriculation will be maintained by the student if he or she is officially registered for at least one quarter per calendar year during the period of six years following original admission. A student who fails to register in any quarter in which he or she is registered in the preceding quarter must re-establish registration. Twelve credit hours per quarter, excluding audit hours, will be considered the minimum for which full residence credit may be granted. Lighter schedules will be prorated on this basis in computing residence gained.

The institution has no residency requirement for master's level degrees.

Academic Requirements

The minimum number of approved credit hours required for the master's degree shall be 50, credited as follows.

With thesis:

<table>
<thead>
<tr>
<th>Course Credit Hours</th>
<th>Minimum</th>
<th>Total</th>
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<tr>
<td>in major field</td>
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<tr>
<td>at 6000 to 9000 level</td>
<td>18</td>
<td>18</td>
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<tr>
<td>for degree</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>Research hours</td>
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Without thesis:

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>in major field</td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>at 6000 to 9000 level</td>
<td>35</td>
<td>50</td>
</tr>
</tbody>
</table>

A student must earn a graduate grade average of at least 2.7 and satisfy other requirements of his or her school before being certified for a master's degree. Grade points are given for all courses in which grades are reported.

*The term "major field" as used in these regulations indicates a basic field of knowledge rather than a department of specialization.

** Must have approval of school director.
They are computed as follows: for each credit received in a course, 4 grade points are granted if the grade is A, 3 if B, 2 if C, 1 if D and 0 if F. The grade average includes the grades on all courses scheduled by the student after being admitted to graduate study plus the grades on all courses listed on the student’s approved program of study which have been earned at Georgia Tech prior to the student’s admission to graduate study. Other than thesis hours, only six hours may be taken “pass-fail” (see p. 18).

Undergraduate courses required for graduation in the discipline (designated degree) or discipline-of-origin (undesignated degree) at Georgia Tech may not be applied toward a masters degree. No graduate credit will be given for any course not approved by the school, graduate committee and academic senate.

The student, in conference with the faculty adviser, should prepare a program of study for the master’s degree as a guide in planning his or her academic schedule. According to the requirements of the school in which the student is enrolled, the student may be required to submit this program to the director of the school. The student must submit an approved program of study form (attached to his petition to graduate) to the Registrars Office.

Admission to Candidacy for the Master’s Degree

Admission to graduate standing does not constitute acceptance as a candidate for an advanced degree. To obtain consideration for this privilege the student must have shown evidence of ability to pursue a program of graduate study and research. A mere accumulation of credits is not sufficient. A petition for a degree, with an approved program of study attached (forms available in the registrar’s office), is to be submitted to the registrar during the quarter prior to the final quarter in which the work for the degree is to be completed. To receive favorable action on this petition, the applicant must ordinarily have met the following requirements:

1. The student must show that he or she will have satisfactorily completed course requirements for the master’s degree. (see Academic Requirements).
2. The student must have completed, or be scheduled to complete during the quarter, any required noncredit prerequisite work outlined at the time of his or her matriculation.
3. The student must have an overall grade point average of at least 2.7 and satisfy the requirements of his or her school.
4. The student must have completed satisfactorily any language requirement imposed.
5. The student must have passed any qualifying or comprehensive examinations required by the department in which he or she is registered.
6. The student must have filed with the Office of Graduate Studies and Research an approved thesis topic and have made satisfactory progress on his or her thesis if it is a part of his or her program.

Requirements for Award of the Degree. The graduate committee normally recommends to the Academic Senate the awarding of the master’s degree to any candidate who:

1. has an overall grade point average of at least 2.7 and has satisfied the requirements of his or her school,
2. receives final acceptance of his or her thesis from the office and deposits three unbound copies with the library,
3. supplies the office with a publishable abstract of his or her thesis, up to 300 words, the accuracy of which has been certified by the thesis adviser,
4. presents an approved program of study (complete within a period of not more than six consecutive calendar years) to the Registrar in accordance with the deadline set forth in the institute calendar,
5. passes any general examinations, oral or written, required by his or her school and
6. is, at the time, a registered student.

Language Requirement. A reading knowledge of one appropriate foreign language may be required at the option of the school in which the student is registered. Foreign students will be expected to show adequate mastery of English.

Transfer of Credit. The rules relative to and the process for obtaining transfer of credit for graduate level courses are as follows.

1. Transfer credit (up to 9 hours) can be obtained for graduate level courses taken elsewhere in the United States if they have not been used for another degree. A current transcript is required for this evaluation.
2. Joint-enrollment students may be allowed to receive graduate credit for up to one-third of the hours required for the degree for graduate courses taken at Emory University or Georgia State University. (1) provided such courses are not offered at Georgia Tech, (2) are approved in writing in advance by the student’s adviser and school director, and (3) are passed with a grade of C or better. “Advance approval” is satisfied when the courses appear on the student’s proposed program of study.
3. No transfer credit will be granted from universities outside the United States and Canada; however, international students can obtain credit for courses previously taken, and not used for another degree by filling out an “Examination for Advanced Standing Authorization Request Form”, paying the appropriate fee at the cashier’s office, and passing the examination for advanced standing. Each school or department which normally teaches the equivalent course will administer such examinations, if warranted.
4. The process for obtaining transfer of credit:
   a. The student must confer with his or her graduate adviser to ascertain whether the courses to be transferred are a logical part of the student’s graduate program. The courses would typically be those appearing on the approved program of studies form for the master’s program student.
   b. A doctoral program student would normally not be seeking transfer of credit.
5. If the courses are appropriate, the student should take a copy of the current transcript that shows the courses, appropriate descriptive materials, such as catalog description and textbook used, to the school on campus that teaches or comes close to teaching the courses. These courses must be evaluated by a member of the appropriate faculty who will indicate the number of credit hours and the Georgia Tech counterpart. The professor should prepare a transfer credit form and if he or she
is not the school director, the school director should cosign it. The transfer credit form should then be sent directly to the registrar, with the student's Approved Program of Study attached.

c. If the student wishes to transfer more than nine hours, he or she must file a petition with the graduate committee including statements of possible justification for the granting of such a petition. On this petition there must be a recommended action by the student's school director. Transfer credit forms must accompany such a petition to serve as documentation.

The Master's Thesis

A master's thesis is a requirement for the master's degree except in those cases where the director of the school in which a student is registered may consider additional course work of more importance in meeting the student's approved objective.

Students who meet the requirements for the master's degree by completing a combination of course work and thesis are required to register for a minimum of 17 hours of credit in thesis. (See section above on matriculation requirements.)

A candidate whose program includes a thesis must present a treatise in which are set forth in clear, articulate form the results of an investigation directed by a member of the faculty of the institute. The purpose of the thesis is to further the educational development of the student by requiring him or her to plan, conduct and report an organized and systematic study of importance.

The Manual for Graduate Theses, available from the Graduate Office, specifies the requirements for the thesis.

The Doctoral Degree

The degree of Doctor of Philosophy is basically a research degree awarded in recognition of demonstrated proficiency and high achievement in research. After adequate preparation the candidate must complete a searching and authoritative investigation of a special area in the field of his or her choice, culminating in a written dissertation covering that investigation. The dissertation must be either an addition to the fundamental knowledge of the field, or a new and better interpretation of facts already known. It must demonstrate that the candidate possesses powers of original thought, talent for research and ability to organize and present findings.

Matriculation Requirements

Ordinarily a student will be admitted for study at the doctoral level only if he or she has graduated in the upper quarter of the class. This requirement may be modified for those who have shown unusual promise in their work toward a master's degree.

Except for this restriction, the matriculation requirements are identical to those outlined for the master's degree.

At least three full-time quarters must be spent in residence at the Georgia Institute of Technology. Ordinarily research for the doctoral dissertation must be carried out while in residence on the campus. However, when the candidate has met the residence requirements, he or she may be permitted under special circumstances to pursue further work in absentia if done under the direction of a faculty member and approved by the Office of Graduate Studies as well as the director of the school concerned.

Admission to Candidacy

Admission of a student to candidacy for the doctorate is based primarily upon the passing of certain comprehensive examinations. These examinations have as their objective the testing of the student's knowledge of the general field in which the student is to receive his or her degree, as well as the specialized portion of this field in which his or her research is being carried out. In general, the student will find it advisable to complete at least five quarters of course work beyond the B.S. degree before taking these examinations.

The comprehensive examination will normally be given at least once a year, in the fall or in the spring. The examinations are the responsibility of the school which will grant the degree. The student shall be informed of the scope of the examinations.

Students will be guided in the planning of a program of study and in the preparation of these examinations by a guidance committee appointed by the director of the school. The duties of the committee shall include evaluation of the background and interests of each entering student, aiding the student in planning course work and consultation with the student from time to time for purposes of evaluating and aiding his or her progress.

The student will be expected to take examinations in all courses in which he or she is regularly enrolled. The student's grades in these courses will be reported in the usual manner to the registrar.

The student must satisfy the following requirements prior to admission to candidacy for the degree.

1. The comprehensive examinations must have been passed.
2. The student must have filed with the director of his or her school and the Office of Graduate Studies a formal statement naming the student's thesis adviser and setting forth the research topic, the purpose of the investigation and the steps by which the student proposes to conduct it.

Upon satisfactory completion of these requirements, with approval of the thesis topic, the applicant may be formally admitted to candidacy for the degree.

A petition for a degree is to be submitted to the registrar during the quarter prior to the final quarter in which the work for the degree is to be completed. Petition forms are available in the registrar's office.

The requirements for the degree must be completed within five years from the end of the quarter in which the candidate passes the comprehensive (qualifying) examinations.

Major and Minor Fields of Study

While there are no fixed course requirements for the doctorate, the student will be expected to pursue both a major and a minor field of study. The student's program will usually require two or more years of course work beyond undergraduate study.
In addition to an adequate knowledge of the major field in which research is to be carried out, the student will be asked to demonstrate a mastery of some other, smaller body of knowledge within or, preferably, outside the student's school. This area of study is referred to as a minor field. The purpose of the minor is to encourage a wider interest in the part of the student and to provide a broader basis for the evaluation of his or her capabilities. The minor will normally consist of at least 15 quarter hours of work in related courses, chosen by the student in consultation with his or her guidance committee. The minor must be approved by the Office of Graduate Studies. After the minor is satisfactorily completed, this fact should be transmitted to the graduate office accompanied by the grades in the courses for final approval and recording.

Completion of the minor is not a prerequisite for admission to candidacy, but it must be approved and completed before clearance for the degree.

Language Requirements

Every doctoral candidate is required to have had exposure to some cultural and functional aspects of foreign languages before being granted the degree. The student may satisfy this requirement by any one of the following options:

1. The student may pass two years of course work in foreign language at the college level with an average grade of C or better. This may include one year each in two different languages or two years in one language. Every two years of foreign language course work in a particular language in secondary school will be considered equivalent to one year of college course work.

2. The student may enroll in one of the following sequences of courses and earn an average grade of C or better:
   a. French 4075–6–7 Intensive Readings in French.
   b. German 4075–6–7 Intensive Readings in German.
   c. Russian 4075–6–7 Intensive Readings in Russian.
   e. Linguistics 4075–6–7 Languages for Science and Technology.

3. The student may petition for and pass a written equivalency test in one foreign language administered by the Department of Modern Languages in lieu of formal course work. The proficiency level expected is comparable to that of a student just completing the present second-year language course in the Department of Modern Languages with a grade of C or better.

4. The student may present evidence or other experiences that clearly demonstrate an exposure to cultural and functional aspects of foreign language equivalent to the above, such as having been reared and educated in a mother tongue other than English.

It shall be the authority of the Department of Modern Languages to evaluate and certify to the graduate office the satisfactory completion of the above foreign language requirements for each candidate. If the student wishes to satisfy the language requirement using alternative one or four, he or she must supply complete official records and English translations of such records when appropriate.

Additional requirements of proficiency in reading or translating scientific literature in one or more foreign languages may be imposed by an individual school at its discretion.

The Dissertation

Prior to the student's admission to candidacy the candidate will present for the approval of the director of his or her school and the Office of Graduate Studies a formal statement naming the student's dissertation adviser and setting forth the topic that has been selected for investigation, the objectives the student hopes to gain and the steps by which the student proposes to gain them. The dissertation topic must give promise of being either a genuine addition to the fundamental knowledge of the field or a new and better interpretation of facts already known.

Instructions concerning the dissertation are obtainable from the Office of Graduate Studies. All dissertations are microfilmed and deposited with the University Microfilms Service. A charge of $25 must be paid by the student to the institute for this service.

The Doctoral Examination

If the Dissertation Advisory Committee finds the dissertation satisfactory, the candidate will be called for an oral examination on the subject matter of the thesis and the field in which it lies. The examination will be made by an examining committee approved by the Office of Graduate Studies. The student must be registered during the quarter in which the final examination is given and in the quarter in which he or she graduates.

If both the dissertation and the examination are satisfactory and the requirements of residence languages and the minor field have been complied with, the candidate will be certified as qualified to receive the degree of Doctor of Philosophy.

In the case of a failure on the final oral examination, on the recommen­dation of the examining committee one additional examination will be permitted. In case of failure no report of the result of the examination will be sent to the registrar, but a record will be kept in the Office of Graduate Studies. Additional requirements for the doctorate may be added by the schools at their discretion.

Financial Information

Costs

Note: conditions may arise beyond the control of the Georgia Institute of Technology which will cause the rate for tuition, fees, board and room to be changed during the next year without notice.

The following schedule of matriculation, tuition, student activity and other fees is effective for the 1979–80 academic session.

<table>
<thead>
<tr>
<th></th>
<th>Matriculation Fee Per Qtr.</th>
<th>Tuition Fee Per Qtr.</th>
<th>Transportation Fee Per Qtr.</th>
<th>Student Activity Fee Per Qtr.</th>
<th>Medical Fee Per Qtr.</th>
<th>Total Fee Per Qtr.</th>
<th>Total Fees Per Academic Year</th>
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<tr>
<td>Residents of Georgia</td>
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<td>$28</td>
<td>$250.50</td>
<td>$751.50</td>
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<td>Nonresidents of Georgia</td>
<td>$195</td>
<td>$430</td>
<td>$3.50</td>
<td>$24</td>
<td>$28</td>
<td>$680.50</td>
<td>$2041.50</td>
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</table>
An extra fee may be charged in special courses.

Graduate students carrying a full academic load (12 credit hours or more per quarter) will be charged the full amount of all fees as shown above.

Part-time students (those carrying less than 12 credit hours per quarter) who are legal residents of Georgia will be charged $16 per credit hour in satisfaction of the matriculation fee and $48 for the student activity and medical fees unless the student is carrying less than six credit hours. For these students only the matriculation fee is charged. All other graduate students will have an additional tuition fee of $36 per credit hour. The minimum number of hours a student may enroll for is three. All students must pay the transportation fee. A charge for one quarter hour is made for registration for a zero credit hour seminar if the student is registering for less than 12 credit hours.

Graduate students who have completed the residence requirements for the degree may register for research only at the rate of $16 per designated equivalent credit hour. Hours for which the student is registered shall be consistent with a realistic appraisal of the amount of work yet to be done on the thesis or dissertation and the amount of faculty involvement required. Such registration carries no residence credit and must be approved by the Graduate Office.

Other Fees. Each person receiving a diploma must pay the appropriate diploma fee before graduating. A candidate for the doctoral degree must pay a charge of $25 for microfilming his or her dissertation and depositing it with the University Microfilms Service.

The cost of binding the three library copies of a student’s thesis or dissertation is borne by the institute.

A late registration fee is charged after regular registration. If a student has not paid all fees by the end of the first week of the quarter, his or her registration will be cancelled.

Refund of Fees. The institute has an established set of rules governing the refund of fees to students who must drop out of school (see page 24).

Obligations of Students. An individual is not officially enrolled at Georgia Tech until all tuition, matriculation, student activity and medical fees for the current quarter are paid. Once enrolled, every student is obligated to remit, return or submit all other financial obligations that may become due, as well as property or records of the institute, within the time prescribed by the institute. Failure to fulfill any such obligation will result in denial of registration privileges for subsequent quarter(s). Such denial of registration privileges is in addition to and apart from any disciplinary measures which may be taken pursuant to the Student Conduct Code, pg. 333 (paragraph XI, “Student Rules and Regulations”).

Financial Assistance

The institute offers financial aid from a variety of sources to assist students with the pursuit and completion of their degree as rapidly as circumstances permit.

Inquiries for financial aid should be addressed to the director of the school in which the student plans to study.
student and company requirements. Academic fees, costs of texts and a supply allowance may be paid by the company.

**Graduate Employment.** Appointments of graduate students in the Engineering Experiment Station may be made on the recommendations of the director of the school in which the student is registered, the director of the experiment station and the Graduate Office. Graduate students are appointed as graduate research assistants. They may participate in investigations which are conducted in the experiment station on the subject of a thesis, provided the subject is acceptable to the school director concerned and the degree of responsibility borne by the student is considered sufficient.

**Veterans Program.** Veterans may be eligible to receive educational assistance through the Veterans Administration while enrolled and pursuing an approved program of education or training if they were discharged after January 31, 1955, under conditions other than dishonorable from a continuous period of active duty of 181 days or more. If the period was less than 181 days, a veteran may be eligible if the discharge was for service-connected disability.

The VA provides educational assistance to children of veterans who died or are permanently and totally disabled as the result of service-connected disability incurred or aggravated during active service in the Armed Forces, or children of individuals on active duty who are listed for more than 90 days as missing in action, captured by a hostile force or forcibly interned by a foreign government or power.

The Financial Aid Office at Georgia Tech serves as the veterans affairs center on campus and provides enrollment certification to the Veterans Administration for eligible students. New students and enrolled students wishing to be re-certified should make application to the Financial Aid Office at least six weeks prior to the planned quarter of enrollment if the first benefit check is desired for use in registration.

Any questions or comments may be directed to the Financial Aid Office at Georgia Tech.

**Sponsored Assistantships.** The School of Health Systems awards assistantships to a number of graduate students for participation in the community outreach program of the Health Systems Research Center. Sponsored funding is provided by cooperating health care institutions and health service organizations in the metropolitan Atlanta area. These appointments are normally on a one-third-time basis and provide compensation and tuition waivers comparable to those for research and teaching assistantships.

Currently participating in this program are Atlanta Heart and Lung Clinic, Crawford W. Long Memorial Hospital, Fagin Advisory Services, Georgia Baptist Hospital, Health Care (HMO), Hospital Investors, Joint Board of Family Practice, MEDICUS and Piedmont Hospital.

**Sponsored Fellowships.** The institute has a number of fellowships that are contributed by various industrial organizations, foundations and trust funds for the support of outstanding graduate students. These fellowships assist students in pursuing their studies and research full time. The name given each fellowship listed below indicates the donor or person(s) memorialized by the fellowship.

**Allied Chemical Foundation Fellowship**
A $4,500 fellowship to a candidate for the Ph.D. in textile science and engineering.

**Burroughs Corporation**
An assistantship of $4,000 each 12 months. Awarded to M.S. students only. Selection is based on socioeconomic criteria and promise of professional accomplishment.

**Domencia Rea D'Onofrio Fellowship**
A fellowship in all schools of instruction—recipient must be from Italy. Stipend of $3,500.

**Edward Orton, Jr. Foundation Fellowship**
A fellowship in ceramic engineering carrying a stipend of $1,800 for 12 months study, plus $200 for equipment and supplies.

**E. I. du Pont de Nemours & Company, Inc.**
A grant of $10,000 to be allocated to each of four schools, chemical engineering, chemistry, electrical engineering and mechanical engineering. It is to be used to enhance or maintain the strength of their instruction in science and engineering.

**Eno Foundation of Transportation Fellowship**
A $7,000 fellowship to the School of Civil Engineering to cover tuition, living expenses and other necessary costs for the 1979–80 academic year.

**Ford Foundation Fellowship**
Fellowship and loan for doctoral studies in engineering. These awards are a combination of fellowship and teaching research assistantships valued at up to $3,000 plus tuition and fees and may be awarded for a calendar year including the usual vacation periods. Also, loans based on need up to $3,000 annually will be available to well qualified graduate students motivated toward academic careers. The loans will be cancelled at a minimum rate of $1,000 per year for each full-time year of service in an academic career in the United States and Canada.

**Foundation in Refractories Education—F.I.R.E.**
A $5,000 fellowship in ceramic engineering. This is for students whose interests are in the refractory materials area.

**G. B. Espy Faculty Bioengineering Fellowship**
A fellowship to aid Georgia Tech professors in moving into the medical profession as bioengineers. To be eligible a person must be currently a member of the Georgia Tech staff, possess either a Ph.D. or Sc.D. in chemical engineering, electrical engineering, mechanical engineering or nuclear engineering and at the time of application be accepted by a medical school as a full-time student in a program of study leading to the M.D.

**Graduate and Professional Opportunities Program Fellowships.** These fellowships, granted to the institute by the Office of Education, DHEW, are available to women and minorities who wish to pursue a graduate degree program in architecture, engineering, information and computer science or geophysical sciences. The awards are $3,900 each plus all tuition and fees for four quarters of study and are renewable for up to four years.
Gulf Oil Foundation Graduate Fellowship
A $6,000 fellowship to the School of Chemical Engineering. Stipend not less than $3,000 plus tuition and fees. Balance to be used as an unrestricted grant to the school not to exceed $1,000.

Howard Pyle Safety Research Fellowship
A fellowship for advanced study leading to a doctorate in a safety-related discipline with an emphasis on research. It has a stipend of $2,500 with a total allowance of $450 for dependent children plus tuition and fees (up to $4,000).

IBM Fellowship
One fellowship of $3,600 for 12 months. Awarded to doctoral students only. Selection is based on socioeconomic criteria and promise of professional accomplishment.

Mary White Staton
A fellowship in all schools of instruction—recipient must be from Colombia, South America. Stipend of $2,000.

National Consortium for Graduate Degrees for Minorities in Engineering Fellowship
Candidates for participation in this program are selected from minorities (black Americans, Puerto Ricans, American Indians and Chicanos). At the time of application the student should be enrolled in the junior year of undergraduate study in one of the engineering disciplines. In addition to the graduate stipend, this program provides an opportunity for summer work experience in one of several off-campus research laboratories. An applicant's record must indicate the ability to pursue graduate studies in engineering. Some students who are presently in their senior year of undergraduate study will be accepted into the program. For further information write to the Office of Graduate Studies, Georgia Institute of Technology, Atlanta, Georgia 30332.

Paul R. Yopp Fellowship
A fellowship in mechanical engineering to an outstanding graduate student covering a stipend, tuition and fees.

Robert & Company Associates Fellowship
A fellowship in architecture. $1,200 stipend. Recipient must be a native of Georgia.

Robert & Company Fellowship
A fellowship to be used in civil, electrical or mechanical engineering. $1,200 stipend. Recipient must be a native of Georgia.

Sandoz Foundation Fellowship
A $5,000 fellowship in textile chemistry. These funds are for stipend, tuition and fees, equipment and faculty supervision.

Schlumberger
Two fellowships in electrical engineering. Tuition and fees, plus $3,000 stipend. Total grant $5,500.

Tennessee Eastman Fellowship
A $4,000 fellowship to the School of Chemical Engineering. Stipend not less than $2,500 per calendar year or $3,000 if there are dependents, plus tuition and fees. Balance to be used as an unrestricted grant in the school.

Texaco Fellowship in Metallurgical Engineering
A fellowship to encourage graduate studies in metallurgical engineering. Awarded at the discretion of the Department of Metallurgy in the School of Chemical Engineering. Stipend is $3,000 plus tuition and fees for a 12-month period.

Union Camp Fellowship
A $5,000 fellowship in chemistry and chemical engineering. Tuition and fees, plus a minimum of $250 per month to the student for a period of at least nine months, the remaining money to be used for department needs.

United States Steel Foundation Loan Fund
A short term loan fund designated to assist graduate students in engineering, physics, chemistry and mathematics. Administered by the Financial Aid Office.

Whirlpool Corporation
Three graduate fellowships in engineering (electrical, mechanical and textile). Stipend, plus tuition and fees.
Curricula and Degrees

College of Architecture
Established in 1975, school in 1948, department in 1908.


General Information
The College of Architecture, established in 1908 as the Department of Architecture, was elevated to the status of a school in April, 1948 with the change in name of the institution to the Georgia Institute of Technology. It became a college on July 1, 1975.
The original four-year curriculum led to the degree Bachelor of Science in Architecture, but in 1934 this was extended to a five-year program awarding the degree Bachelor of Architecture, which was offered as a first professional degree until 1972.

The four-year degrees, Bachelor of Science in Building Construction and Bachelor of Science in Industrial Design were established in 1958 following a period during which the curricula in these disciplines functioned as options under architecture. Recent changes in the content of all curricula take precedence over the listings in earlier catalogs.

The degrees Master of Architecture and Master of City Planning were initiated in 1952 and a joint degree program with the simultaneous award of both degrees has been in operation since 1969. Two-year joint degree programs between city planning and civil engineering (transportation) and city planning and environmental design (landscape architecture) at the University of Georgia are currently available.

The original aim and first objective of the college has been to prepare students for the profession of architecture. The scope of man's concern with the environment is of such breadth in current practice, however, that architects and planners not only must exhibit strength in the traditional role of building and space design, but also must reemphasize related interests in the social sciences and psychology, structural and mechanical systems, management of construction and field processes and economic and feasibility programming. Graduates with such grounding contribute effectively to teams that create and control the man-made environment at every scale, from the production of the smallest utilitarian object to community, city and regional planning. It is to this end that, over the years, the College of Architecture has embraced as many disciplines in design and planning as possible, not only to educate its students in specialized environmental fields, but also to liberalize and expand the education through their interaction.

Architecture

The undergraduate curriculum in architecture prepares the student through basic professional studies and general education to receive the degree Bachelor of Science (undesignated) at the end of four years. It should be noted that this is not a professional degree in architecture and will not be recognized as such by the National Architectural Accrediting Board and the National Council of Architectural Registration Boards; professional degree accreditation applies only to the degree Master of Architecture, awarded after two years of graduate study.

For architecture majors, averages in architectural design will be checked at the end of each year-group of three courses (Arch. 1001-2-3, etc.). A student will not be permitted to enter a more advanced group until his or her record in the previous group equals 2.0 or better. All work executed in the college becomes the property of the college and will be retained or returned at the discretion of the faculty. The faculty reserves the right to refuse for credit any project executed outside the precincts of the college, or otherwise executed without proper coordination with the instructor.

### Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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<th>3rd Q.</th>
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<tr>
<td>Arch. 1001-2-3</td>
<td>Design Fundamentals</td>
<td>1-12-5</td>
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<td>Arch. 1201-2-3</td>
<td>Architectural History</td>
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<td>Math. 1307-8-9</td>
<td>Mathematics</td>
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### Sophomore Year

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<tr>
<td>Arch. 2001-2-3</td>
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<tbody>
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<td>Architectural Design</td>
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<td>Arch. 3401-2-3</td>
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### Senior Year

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¹ Electives: A total of 68 hours of electives are included in the undergraduate curriculum in architecture and, with the advice of faculty counselors, they should be programmed to include the categories below; these categories will satisfy the core curriculum requirements of the College of Architecture in the humanities and social sciences, additional professional requirements
of the curriculum in architecture and will allow a degree of latitude for the student to plan toward concentrated study in the graduate program.

Humanities: nine credit hours are to be devoted to English literature courses, or to appropriate modern language courses at the 3000 level or above. Note that the architectural history sequence will satisfy the remaining nine credit hours of humanities requirements.

Social Sciences: 18 credit hours, including at least three hours in each of sociology, political science, psychology and history.

General Electives: 39 credit hours may be structured to best further the student's professional goals, but must include at least six credit hours of advanced architectural history and six credit hours in visual communication studio courses. Military training is an optional program of the institute, but in case basic ROTC and advanced military are elected, no more than 15 credit hours of general electives may be used for this purpose or will be credited toward the requirements for a degree. See "Curricula and Degrees." Department of Physical Education and Recreation, for freshman physical education requirements for both men and women. (The College of Architecture will accept only the three required hours of P.E. toward meeting the requirements for a degree.)

Senior Year Study Abroad Program

The College of Architecture Study Abroad Program is designed to give senior students in architecture the opportunity to complete all or part of their senior year in residence in Paris, France. The program offers courses parallel to those in the regular program, as well as specialized opportunities for travel and individual study interests. Students participating in the program are registered in the Ecole des Beaux Arts and live in housing arranged by the institute. Courses are conducted by Georgia Tech faculty; faculty of the Ecole des Beaux Arts also participate periodically with the program.

Students are encouraged to enroll in French language and culture courses at Georgia Tech prior to their senior year. This will provide better preparation for this opportunity of living, studying and traveling in Europe.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
<th>2nd Q.</th>
<th>3rd Q.</th>
</tr>
</thead>
<tbody>
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</table>

1 Electives: Same as those listed under Architecture, Senior Year.

Graduate Programs in Architecture

The graduate professional program in architecture at Georgia Tech offers a two-year course of study for persons seeking the Master of Architecture as the first professional degree and a one-year program for persons already holding a professional degree in architecture. Both programs afford the student opportunities for concentration within the professional sphere of architecture. Programs are also available for applicants holding an undergraduate degree in fields other than architecture.

The Two-Year Program

The program is structured for persons holding a four-year degree with a major in architecture from a school offering an accredited professional degree in architecture. Students having appropriate concentration in architecture in their undergraduate studies can expect to complete this program in two years. The degree awarded upon completion is the professional degree Master of Architecture which is accredited by the National Architectural Accrediting Board.

The program has three major areas of study. They are: Theories, Methods and Architecture; Urban Studies and Architecture; and Behavioral Studies and Architecture. Conceptually, these can be seen as spanning a range of contexts from the regional and urban through the building specific to the personal.

There are a number of study topics related to each of the above. For example, within Theories, Methods and Architecture is included: design theories, methods and applications; architecture and development process; and construction management. Included in Urban Studies and Architecture are: urban form; urban development; transportation; environmental design; housing; and preservation and conservation. Behavioral Studies includes: studies in environment and behavior; health facility design; and institutional building design.

The areas of study indicate only some of the choices available as topics of concentration. A minimum concentration study program has the following requirements:

- Concentration course credits ............................................. 12
- Concentration studio credits ........................................... 12
- Thesis credits .............................................................. 18
- Electives ................................................................. 38
- Total ............................90

The One-Year Program

Persons holding a first professional degree in architecture (Bachelor of Architecture; Master of Architecture or equivalent) from an accredited school of architecture are normally expected to finish the program during one academic year (50 credit hours). As with the two-year program, the course work is developed within the major study areas outlined above.

Building Construction

In tandem with the roles of the architect and engineer, the constructor assumes responsibility for bringing a building or group of buildings into physical reality. The Building Construction Program emphasizes habitable construction rather than bridges, dams or other civil work. Basic degree requirements encompass the areas of techniques, operations and management, from which the student may then expand in directions of individual interest through a series of professional electives.

Primary objectives of the Building Construction Program are: a) to provide a set of experiences through which technical and management skills can be obtained, along with a broad educational base, to equip the student for movement toward leadership roles in the construction industry; b) to
develop an educational mix that includes both practical applications and management areas such as scheduling, cost control, construction management, value engineering and estimating; c) to provide a curriculum specifically tailored to those entering the construction industry, which retains positive linkages with architecture and engineering in areas of overlap; and d) to look to the future, as well as the current "state-of-the-art," challenging current methods where appropriate and seeking superior solutions through innovation.

**Freshman Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
<th>2nd Q.</th>
<th>3rd Q.</th>
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<tr>
<td>Arch. 1201-2-3</td>
<td>Architectural History</td>
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<tr>
<td>Chem. 1101-2</td>
<td>General Chemistry</td>
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<tr>
<td>Geo.S. 2100-2</td>
<td>Physical Geology</td>
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<tr>
<td>Math. 1307-8-9</td>
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**Sophomore Year**

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<td>Building Anatomy</td>
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<tr>
<td>B.C. 2001-2-3</td>
<td>Design of Building Systems</td>
<td>1-12-5</td>
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<tr>
<td>Econ. 2000</td>
<td>Microeconomics</td>
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<tr>
<td>E.S.M. 3701-2</td>
<td>Statics, Strength of Materials</td>
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</tr>
<tr>
<td>Phys. 2111-2-3</td>
<td>Elementary Physics</td>
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**Junior Year**

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<td>B.C. 3301-2-3</td>
<td>Construction Practice</td>
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<td>Mgt. 3700</td>
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**Senior Year**

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<td>Facilities Planning, Building Economics</td>
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</tbody>
</table>

Industrial Design

Industrial Design is the process of integrating beauty and utility in the design of machine-made objects and services. The field focuses on product design but also includes the design of packaging, exhibits, interiors and corporate identity. The industrial designer, with broad interests in a specialized age, is a person who must be artist, businessman and engineer combined.

The Georgia Tech program offers a well-rounded course of study with early emphasis on basic design. Projects emphasize realistic design situations; students are encouraged to develop a diverse background in order to expand individual talents and respond to changing opportunities in the field. Most faculty members are practicing designers with extensive experience in the field.

Grade averages in design courses are checked at the end of each year-group of three courses (I.D. 2001-2-3, etc.). A student is not permitted to enter a more advanced group until his or her record in the previous group equals 2.0 or better. All work executed in the college becomes the property of the college and will be retained or returned at the discretion of the faculty. The faculty also reserves the right to refuse credit for any project executed outside the precincts of the college or otherwise executed without proper coordination with the instructor.
Georgia Tech's Industrial Design program is approved by the Industrial Designers Society of America (I.D.S.A.).

### Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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**Totals** 12-16-17 12-16-17 12-16-17

### Sophomore Year

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<td>I.D. 2301-2-3</td>
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**Totals** 12-15-17 12-15-17 12-15-17

### Junior Year

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<td>Materials and Process Design</td>
<td>1-3-2</td>
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**Totals** 12-15-17 12-15-17 12-15-17

### Senior Year

<table>
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<th>Subject</th>
<th>1st Q.</th>
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<td>1-16-8</td>
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<td>I.Sy.E. 3113</td>
<td>Physiological and Biomechanical Analysis of Work</td>
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</table>

**Totals** 10-16-17 10-16-17 10-16-17

*Eighteen credit hours of technical electives are to be chosen from the departmental list.

A total of 48 additional credit hours of electives are included in the curriculum for industrial design and, with the advice of faculty counselors, they should be programmed to include the categories below. These categories will satisfy the core curriculum requirements of the College of Architecture in the humanities and social sciences, additional professional requirements of industrial design and will allow a degree of latitude for the student to pursue individual interests.

**Departments:**

- Humanities: nine credit hours are to be devoted to English literature courses or to appropriate modern language courses at the 3000 level or above.
- Social Sciences: 18 credit hours including at least one course each in sociology, political science and psychology.
- General Electives: 21 credit hours may be structured to best further the student's professional goals, but must include at least six credit hours in visual communication studio courses.
- Military Training: 3 credits of ROTC and advanced military are elected, no more than 15 credit hours of general electives may be used for this purpose or will be credited toward the requirements for a degree.
- ROTC: 12 credits are to be used for ROTC designation.

**Graduate Program in City Planning**

Three types of degree programs are available for students interested in the fields of urban and regional planning: the two-year professional Master of City Planning degree (recognized by the American Institute of Planners for membership purposes), the joint Master of City Planning and Master of Science in a related field and the undesignated Master of Science degree (not recognized by the American Institute of Planners but considered a degree in a related field for membership purposes).

**Master of City Planning Degree**

The two-year curriculum requires, for most students, five quarters of coursework, one quarter for a thesis and one quarter as an intern in the office of an approved planning agency. Required courses are: Engl. 3019, C.P. 6000, 6010, 6020, 6030, 6060, 6090, 6100, 6110, 6120, 6140, C.P. 6260, 6270, 6350, 6360, 6703, C.E. 6704, Soc. 6375 and electives—nine credit hours.

With the approval of his or her faculty adviser, a student may substitute 25 credit hours in a field of specialization instead of the thesis provided the student has appropriate undergraduate preparation. At least six credit hours must be in independent study.
Joint Degree in Urban Design

A joint degree program is offered in urban design as a cooperative effort between the architecture and city planning programs. Students completing this program receive the Master of Architecture and the Master of City Planning degrees. The program requires a minimum of 100 hours (two years) for those who hold the Bachelor of Architecture degree and 134 hours (two and 2/3 years) for those who hold the Bachelor of Science degree.

College of Engineering

Dean—William M. Sangster; Associate Deans—F. W. Schutz, Jr., Charles R. Vail, J. Richard Williams; Assistants to the Dean—Carolyn C. Chesnutt, Colleen A. Donahue, Paul Reynolds, Jr.

General Information

The College of Engineering comprises 11 degree-granting schools of instruction and research. The ten schools of engineering offer programs of study and research leading to bachelor's, master's and doctoral degrees, and the School of Health Systems offers programs leading to bachelor's and master's degrees. Certain of these schools also offer programs in one or more subdisciplines or subspecialties. These degree offerings are summarized in the following table.

<table>
<thead>
<tr>
<th>College of Engineering Degree Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Engineering</td>
</tr>
<tr>
<td>Ceramic Engineering</td>
</tr>
<tr>
<td>Chemical Engineering</td>
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<tr>
<td>Metallurgy</td>
</tr>
<tr>
<td>Civil Engineering</td>
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<tr>
<td>Sanitary Engineering</td>
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<tr>
<td>Electrical Engineering</td>
</tr>
<tr>
<td>Engineering Science and Mechanics</td>
</tr>
<tr>
<td>Health Systems</td>
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<tr>
<td>Industrial and Systems Engineering</td>
</tr>
<tr>
<td>Operations Research</td>
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<tr>
<td>Mechanical Engineering</td>
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<tr>
<td>Nuclear Engineering</td>
</tr>
<tr>
<td>Textile Science and Engineering</td>
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<tr>
<td>Textile Chemistry</td>
</tr>
</tbody>
</table>

*B = Bachelor’s Degree  M = Master’s Degree  PhD = Doctor of Philosophy Degree

The programs in engineering are designed to provide a fundamental understanding of the engineering sciences, which are based on mathematics and the natural sciences and of the basic concepts of the humanities and social sciences and then to furnish an understanding of the manner in which these elements are interwoven in engineering practice. Each curriculum provides enough flexibility through elective course opportunities to permit a certain amount of program individualism, even as basic requirements are met.

Freshman Engineering Electives


Multidisciplinary Programs in Engineering

In addition to its degree programs, the College of Engineering provides unusual opportunities for specialized study in engineering through its multidisciplinary certificate program offerings. Any student in good standing who is pursuing a degree through one of the eleven schools of the college, or through the College of Architecture, may select elective courses and the subjects of special problems or thesis research as to satisfy simultaneously both the requirements of his or her major degree program and the requirements of a specialized multidisciplinary program, provided that the school through which the standard degree is being sought is a participant in that program. Upon graduation, the successful student receives both the degree in the major field of study and a certificate attesting to successful completion of the particular related multidisciplinary program. The table on page 66 shows both currently available multidisciplinary program offerings (identified by X's) and those which are in the planning stage (identified by asterisks), as well as the levels of the major degree programs with which they are associated. It should be noted that the planning process in certain multidisciplinary program areas includes inputs from certain schools and departments from outside the College of Engineering and that none-engineering-designated multidisciplinary certification is potentially available to institute students from outside that college.

General Requirements of Undergraduate Multidisciplinary Programs. The specific design of the multidisciplinary program of any participating undergraduate student, while as individualized as possible, must meet certain general requirements as well as requirements that are specific to that multidisciplinary area. The general (minimum) undergraduate multidisciplinary requirements are: (1) the program must relate the student's major area to the given multidisciplinary area; (2) courses must be taken under more than one academic unit; (3) at least four courses and 12 credit hours (not required by name and number in the student's major) must be taken in a coherent program; (4) at least three of those courses and nine credit hours must be at the 3000 level or higher; (5) at least two of those courses and six credit hours must be outside the major field (crosslisted courses may be
General Requirements of Graduate Multidisciplinary Programs. The specific design of the multidisciplinary program of any participating graduate student, while as individualized as possible, must meet certain general requirements as well as requirements that are specific to the multidisciplinary area. The general (minimum) graduate multidisciplinary requirements are the same as those listed above for the undergraduate programs, with the following exceptions: (1) at least three of the coherent multidisciplinary program courses as well as nine credit hours must be at the 6000 level or higher; (2) a grade of B or better must be earned on each course counting toward a multidisciplinary certificate; (3) students at the doctoral level must, on an individual basis, meet additional requirements specified by the student's doctoral committee, consistent with a program beyond the master's level whose objective is to develop a doctoral level multidisciplinary program. Detailed information and specific requirements of the various undergraduate-level and graduate-level multidisciplinary programs may be obtained through the Office of the Dean, College of Engineering.

School of Aerospace Engineering
Daniel Guggenheim School of Aeronautics
Established in 1930


General Information
The School of Aerospace Engineering prepares students at the bachelor's, master's and doctoral levels for a career in vehicle engineering with primary emphasis on flight vehicles. The school is housed in three buildings having a floor space of 85,000 square feet with a majority of this space devoted to instructional and research laboratories.

Undergraduate Programs
The first two years focus on course work in the areas of chemistry, mathematics, physics, humanities and social sciences. Aerospace disciplines and related engineering sciences are emphasized in the third and fourth years. The undergraduate curriculum is designed to provide each student with a general background for either industry or graduate school at the end of four
years. The program stresses both the theoretical and experimental aspects of aerospace engineering.

A certain degree of specialization is available to undergraduate students through the proper choice of electives or certain substitutions for required courses or both, depending on the student's abilities and career objectives. These specialized disciplines are acoustics, aeroelasticity, aerospace vehicle design, bioengineering, experimentation and instrumentation, fluid dynamics of pollution, helicopters and V/STOL aircraft, propulsion, structural dynamics, structures and supersonic and hypersonic vehicles.

A premed track is available to undergraduate students. This requires an additional academic year of chemistry and one academic year of biology. Students may substitute these courses for the electives and for certain required courses in the present curriculum.

**Graduate Programs**

The graduate programs at both the master's and doctoral levels are flexible so that students may tailor their course and research work to individual career objectives. The following areas of specialty are available.

**Aeroelasticity.** Dynamic response and loads, flutter, servoaeroelastic instabilities and control, static aeroelastic instabilities and loading, unsteady aerodynamics—V/STOL and conventional aircraft and vibrational characteristics of vehicles.

**Fluid Mechanics.** Atmospheric boundary layer flows, computational fluid dynamics, helicopter aerodynamics, laminar and turbulent flows, plasma and reacting gas dynamics, rarefied gas flows, statistical theory of turbulence and V/STOL aircraft.

**Propulsion.** Combustion instability, external burning, propulsion system noise, solid rocket propellant research and supersonic combustion.

**Structures.** Buckling and postbuckling of structures, composites, elastic and inelastic stress analysis, fracture mechanics, fatigue behavior, structural reliability and statistical methods of structural analysis, vibration and dynamic stability of structural elements, wave propagation and use of acoustic emission methods.

**Urban and Societal Engineering.** Air pollution, biomechanics, fire research and noise pollution.

Facilities for each of the above academic areas are housed in the aerospace laboratories. They include low speed, high speed, MHD and low density wind tunnels, anechoic chamber, combustion chamber, combustion bomb, helicopter test stand, high and low temperature test machines, fatigue and creep machines, humidity chamber, environmental test chamber, analog and digital computers, data acquisition systems, Fourier analyzers, scanning electron microscope and associated instrumentation, such as transducers, lasers, tape recorders, etc.
Junior Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
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<tr>
<td>A.E. 3000-1-2</td>
<td>Fluid Mechanics I, II, III</td>
<td>4-3-5</td>
<td>4-3-5</td>
<td>4-3-5</td>
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<td>A.E. 3100-1</td>
<td>Structures II, III</td>
<td>4-3-5</td>
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<td>E.E. 3700</td>
<td>Circuits and Instruments</td>
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<td>E.E. 3710</td>
<td>Electronic Systems</td>
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<td>Mechanical Vibrations</td>
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<td>Advanced Engineering Math</td>
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Senior Year

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<th>Course No.</th>
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<tr>
<td>A.E. 3102</td>
<td>Structures IV</td>
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<tr>
<td>A.E. 4000</td>
<td>Fluid Mechanics IV</td>
<td>4-3-5</td>
<td></td>
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<tr>
<td>A.E. 4200</td>
<td>Vibration and Flutter</td>
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<td>3-0-3</td>
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<tr>
<td>A.E. 4250</td>
<td>Jet Propulsion</td>
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<tr>
<td>A.E. 4350-1</td>
<td>Aerospace Engineering Design II</td>
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<td>A.E. 4410</td>
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</table>

1 See College of Engineering section “Curricula and Degrees” for engineering electives.
2 Eighteen credit hours in humanities and 18 credit hours in social science are required for graduation. To satisfy these requirements, humanities and social science courses must be selected from the College of Engineering listings in “Information for Undergraduate Students.”
3 These free elective courses may be taken at any time during a student’s course of study. However, if six credit hours of basic ROTC are elected, ROTC should be scheduled the first quarter the student is enrolled.
4 See “Curricula and Degrees,” Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.
5 Free electives. Not more than nine credit hours of advanced ROTC may be applied toward the requirements for a degree.

School of Ceramic Engineering

Established 1924

Director—Joseph L. Pentecost; Professors, A. T. Chapman, Willis E. Moody; Associate Professors—James F. Benzel; Assistant Professor—Joe K. Cochran, Jr.; Special Lecturers—R. A. Young and Robert Lane Mitchell.

General Information

The ceramic industry produces over $10 billion worth of products annually in the United States. These products range from brick, tile, glass, portland cement and dinnerware to high-temperature refractories for furnace linings, abrasives and sophisticated electronic components. These traditional products create a continuing demand for personnel trained in this field and new products which are continuously developing open new opportunities. Over the past 20 years these new products have included rocket nozzles and jet engine components, electronic circuitry for computers and fiberglass products for nose cones and missiles. Current developments include automotive exhaust catalyst supports and other pollution control devices, new lighting techniques and electrooptical materials.

The raw materials for ceramic products are the most plentiful minerals in the earth’s crust. Consequently, many are relatively cheap and result in durable, economical, temperature-resistant materials that are in continuous demand for innovative design.

Ceramic engineering applies sound scientific and engineering principles to solve manufacturing problems in the industry. Frequently these problems are complex and challenging for chemical and physical reactions are occurring at high temperatures. Measurements are difficult and cost constraints for economical production are always present.

The School of Ceramic Engineering offers a four-year curriculum leading to the bachelor’s degree and graduate work leading to Master of Science and Doctor of Philosophy degrees in ceramic engineering. The undergraduate curriculum is designed to prepare the graduate candidate for a position in the ceramic industry or for graduate work. Courses are also offered to non-majors to introduce them to ceramic materials and processes or to develop specific skills and knowledge in the application of ceramic materials.

Multidisciplinary Programs. See table on page 66.

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
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<td>General Chemistry</td>
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<td>Chem. 2113</td>
<td>Chemical Principles</td>
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<td>Elective</td>
<td>E.Gr. 1170, Introduction to Visual Communication and Engineering Design I (2-3-3) and one of the engineering electives¹</td>
<td>X-X-3</td>
<td>X-X 3</td>
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### Freshman Year (continued)

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<tr>
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### Sophomore Year

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<td>Cer.E. 3001</td>
<td>Ceramic Data Handling</td>
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<td>Cer.E. 3002</td>
<td>Properties of Engineering Materials</td>
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<td>E.S.M. 2201</td>
<td>Statics</td>
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<td>E.S.M. 3201</td>
<td>Applied Mechanics</td>
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<td>Math. 2307</td>
<td>Calculus IV</td>
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<tr>
<td>Math. 2308</td>
<td>Calculus and Linear Algebra</td>
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<tr>
<td>Phys. 2121-2-3</td>
<td>Physics</td>
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### Junior Year (continued)

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<td>Cer.E. 3003</td>
<td>Ceramic Processing I</td>
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<td>Ceramic Processing II</td>
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<td>Cer.E. 3005</td>
<td>Phase Equilibria for Ceramists</td>
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<td>Cer.E. 3006</td>
<td>Physical Ceramics I</td>
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<td>Cer.E. 3007</td>
<td>High Temperature Analysis</td>
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<tr>
<td>Cer.E. 3008</td>
<td>Glass Technology I</td>
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<td>2-3-3</td>
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<tr>
<td>Cer.E. 4018</td>
<td>Drying and Psychrometry</td>
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<td>Cer.E. 4052</td>
<td>Inorganic Phase Analysis and Identification</td>
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<td>Chem. 3412-3</td>
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Electives

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<tr>
<td>Electives</td>
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<td>13-9-16</td>
<td>14-12-18</td>
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</tbody>
</table>

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1See College of Engineering section “Curricula and Degrees” for engineering electives.
2These free elective courses may be taken at any time during a student’s course of study.
3See “Curricula and Degrees,” Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.
School of Chemical Engineering

Established in 1901


Chemical Engineering Program

General Information

Chemical engineers perform essential functions in industries that convert raw materials into useful finished products by means of chemical and physical processes. Almost every major manufacturing industry employs chemical engineers in research, development, design, production, sales, consulting and management positions. Substantial numbers of chemical engineers are employed in petroleum, petrochemical, pulp and paper, plastics, metallurgical, fiber, fertilizer, nuclear energy, space, rubber, food, photographic, heavy and fine chemical, mineral, pharmaceutical, textile and dye industries. Energy problems and environmental and pollution control activities require an increasing number of chemical engineers.

The School of Chemical Engineering offers programs leading to the degrees Bachelor of Chemical Engineering, Master of Science in Chemical Engineering, Master of Science in Metallurgy and Doctor of Philosophy. The doctoral program may be in either chemical engineering or metallurgy. Interdisciplinary programs and undesignated degrees are also available.

The following curriculum leads to the degree of Bachelor of Chemical Engineering and is designed to train students both for positions immediately upon graduation or for additional study leading to the master's and doctoral degrees.

It is a requirement of the School of Chemical Engineering that every required chemical engineering course be passed with a grade of C or better.

A six-week summer study program in the Department of Chemical Engineering of the University College London in London, England was initiated in the summer quarter, 1975. Selected juniors who participate in this program are allowed 12 credit hours of free or technical electives, some of which may be substituted for some of the chemical engineering laboratory courses.

Graduate Programs

The School of Chemical Engineering has a graduate program of advanced study and research in chemical engineering and metallurgy. Graduate activities in metallurgy are described in detail within the general description of the Metallurgy Program which follows. Chemical engineering graduate work can lead to the Master of Science Degree and the Doctor of Philosophy Degree. Both degrees involve a combination of advanced level courses and independent research or design work.

Master's degree candidates have two options, thesis and nonthesis. Both options require work on an independent project equivalent in scope to a master's research thesis. The nonthesis option can provide somewhat more flexibility in project selection and scope. Course selection for both the master's and doctoral degrees is quite flexible with individual plans of study developed for each student.

Research opportunities exist in a broad range of areas of importance to chemical engineers and society. Some of these areas are: air pollution control, biochemical engineering, polymer science, process design and simulation, chemical reaction engineering, development of alternate energy sources, biomedical engineering, pulp and paper technology, transport phenomena, fine particle technology and minerals processing.

Fracture and Fatigue Research Laboratory

The Fracture and Fatigue Research Laboratory (FFRL) was established to encourage interdisciplinary research and educational opportunities in the field of fracture and fatigue of materials. Faculty members representing various academic departments of Georgia Tech, as well as staff members of the Engineering Experiment Station (EES), are involved in its activities. Research in the FFRL is focused on the fracture and fatigue behavior of engineering materials. The research programs are interdisciplinary, based on a combined fracture mechanics-materials science point of view. Projects involving the behavior of metals, ceramics, polymers and composites all fall within the scope of the laboratory.

Graduate students participating in FFRL research usually enroll for the master's or doctoral degree in the traditional discipline of their choice. However, they pursue coursework related to a broader understanding of materials and they benefit from the association with other students and faculty in the interdisciplinary setting. Students with backgrounds in materials science, metallurgy, ceramics, chemistry, physics or any branch of engineering are encouraged to apply.

Metallurgy Program

General Information

The field of metallurgy is a vital component in our economy because of its central contribution to the selection and use of metals in all engineering and scientific fields. The program offers a master's degree in metallurgy and a doctoral degree. An excellent selection of undergraduate courses is offered in preparation and support of graduate studies. Course offerings and research activities cover a range of subject areas in the broad field of metallurgy. Subjects include mining engineering, extractive metallurgy, chemical metallurgy, corrosion science and engineering, physical metallurgy, mechanical metallurgy and metallurgical fabrication.
For undergraduates desiring to specialize in metallurgy, an undesignated degree program can be pursued which is equivalent in ECPD requirements to an accredited degree at any other school.

Research facilities are among the program's strongest features. Excellent general corrosion laboratory equipment is part of the corrosion research facilities in which hydrogen embrittlement, metal dusting, stress, corrosion, cracking and, medical implant and dental material investigations are carried out. Structural investigations of metals and alloys are done in the X-ray laboratory having a variety of general equipment and in the electron microscopy laboratories. These labs house a Siemens research electron microscope and the newly-acquired TEM-100C scanning transmission electron microscope, which is the most advanced equipment in the field. Metallographic equipment heat treatment furnaces and alloy melting equipment allow investigators to design and produce new materials. Mechanical testing facilities include both standard and specialized equipment, most notably the MTS universal mechanical testing equipment now being used for fatigue research in a range of alloys.

Graduates find employment with manufacturing firms in light and heavy industry and in research laboratories of private firms and federal agencies. Several recent graduates have filled positions of high responsibility in the Atlanta area and have been instrumental in advancing the level of materials engineering practice in Georgia.

The Metallurgy Program faculty participate in several multidisciplinary programs, including materials engineering, mineral engineering, manufacturing engineering, biomedical engineering and in the interdisciplinary program in surface science technology.

The Master's Degree

The program in metallurgy offers graduate work leading to the degree of Master of Science in Metallurgy. The student admitted for graduate work will normally have completed an undergraduate program in metallurgy or metallurgical engineering. However, students with undergraduate degrees or backgrounds in other fields (e.g., physics, chemistry, geology, chemical, ceramic, mechanical, nuclear or geological engineering) may qualify by taking certain minimum prerequisites during the early part of his or her graduate studies. To assure a smooth transition into the graduate Metallurgy Program, the student is encouraged to select appropriate electives during his or her undergraduate studies.

The Master of Science in Metallurgy curriculum offers two options: (1) physical metallurgy and (2) chemical metallurgy. Both have a common core of basic studies but differ in other aspects. Specialization in one of these areas does not alter the Master of Science degree. The student's individualized program of study for this degree must be prepared in conference with his or her graduate adviser. The proposed program must receive the approval of the graduate adviser and the director and will include a thesis.

Physical Metallurgy. This option deals with the relationships between chemical composition, structure and properties of metals and alloys. Activities of the physical metallurgist include the study of atomic structure of solids, alloy development and the mechanical, physical and corrosion behavior of metals and alloys in engineering applications.

Chemical Metallurgy. This option deals with the concentration of minerals from natural resources and the extraction of pure metal from these concentrates. Recycling of metal scrap and other waste products is also a specialty of the chemical metallurgist. The industries that usually require the services of the chemical metallurgist are iron, steel, aluminum, copper and other basic metal producers. In addition, the chemical metallurgy option deals with the fundamental characteristics of metal and alloy deterioration (corrosion) and the properties and structures of metal surfaces (surface science) in liquid and gas environments.

Financial assistance is usually available to the qualified graduate student in the Metallurgy Program. A number of fellowships and research assistantships from outside sources are available for this purpose. In addition, a limited number of Presidential Fellowships, Teaching and Research Assistantships are available from the institute. Industrial support is also available.

Waiver of out-of-state tuition is possible for qualified students.

The Doctoral Degree

The Doctor of Philosophy degree is directed toward the goal of attaining proficiency in the conduct of independent scholarly work. The degree program comprises course work in the principles of metallurgy, additional specialized courses both in the area of the doctoral thesis and in one or two other areas, demonstration of reading competence in a foreign language, the passing of a comprehensive examination and an independent research investigation.

Except for the requirement that 15 credit hours must be earned in a minor field, which may be any technical or nontechnical field that the student chooses, there are no definite course requirements for the doctoral degree in metallurgy. Most students find that they will schedule about 60 to 70 hours of courses.

Students are encouraged to commence participation in the departmental research programs early in their graduate careers. The undertaking of a doctoral thesis is usually reserved until the candidacy examination is passed, which may occur during the second graduate year for a well-prepared student.

Financial Aid

Financial assistance is available for graduate students in a variety of forms. Fellowships, research assistantships and teaching assistantships provide free tuition plus significant financial grants to cover living expenses. Further information can be obtained by writing the director of the School of Chemical Engineering.

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
<th>2nd Q.</th>
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<tr>
<td>Ch.E. 1101</td>
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### Multidisciplinary Programs

See table on page 66.

1. Eng. 1111-2, advanced level chemistry, is required for all chemical engineering majors. Students transferring into chemical engineering from other curricula not requiring the advanced level chemistry will be allowed to substitute Chem. 1101-2 for Chem. 1111-2, respectively, if taken prior to transferring.

2. Eng. 1001-2-3 is required for all chemical engineering majors and satisfies nine hours of the humanities requirement. Students transferring into chemical engineering from other curricula not requiring Engl. 1001-2-3 or students granted advanced placement will be allowed to substitute any nine hours of humanities for Engl. 1001-2-3. International students may substitute Engl. 1031-2-3 for Engl. 1001-2-3 and six hours of electives; only Engl. 1023 may be used as a humanities requirement (also see note 5).

3. See "Curricula and Degrees," College of Engineering section, for acceptable freshman engineering electives.

4. See "Information for Undergraduate Students," Physical Education Credit, for freshman physical education requirements.

5. The chemical engineering curriculum contains 54 hours of electives to be chosen from five groups in the normal distribution indicated to satisfy the requirements of the College of Engineering and the School of Chemical Engineering—humanities (9), social sciences (18), technological (9), physical education (3) and free (15). These electives may be taken at any time and in any order during the student's course of study. Up to 12 hours of these electives may be taken on a pass-fail basis.

6. Humanities and Social Sciences Electives—See "Information for Undergraduate Students," Humanities and Social Sciences Requirements, for the College of Engineering requirement and a listing of acceptable electives in these two groups (also see note 2). Students should also see the Constitution and History Examinations section in chapter two. Modern language is recommended for students considering graduate work.

7. Technical Electives—The technical requirement of the School of Chemical Engineering may be satisfied by any nine hours of advanced technical or scientific courses provided the course is not totally repetitious of a previous course. A suggested list of technical electives is available from the chemical engineering office and all questions concerning this requirement should be directed to the chemical engineering office. It is recommended that the technical electives be taken in the junior and senior years.

8. See "Curriculums and Degrees," College of Engineering section, for acceptable freshman engineering electives.

9. Free Electives—Fifteen hours of free electives are provided so that a student will be able to pursue specific interests. See the Physical Education Credit and the ROTC Credit sections for the maximum hours in these areas that may be applied toward degree requirements. If six credit hours of basic ROTC are elected, they should be scheduled beginning the first quarter the student is enrolled.
School of Civil Engineering

Established in 1896


General Information

The School of Civil Engineering offers courses in civil engineering and engineering graphics and programs leading to the degrees Bachelor of Civil Engineering, Bachelor of Science (undesignated), Master of Science in Civil Engineering, Master of Science in Sanitary Engineering, Master of Science (undesignated) and Doctor of Philosophy. Also offered is a joint two-year program leading to the awarding of the degrees Master of Science in Civil Engineering or Master of Science (undesignated, major in transportation engineering) and Master of City Planning.

Multidisciplinary Programs. See Table on page 66.

Program In Engineering Graphics

The School of Civil Engineering offers two courses in engineering graphics: E.Gr. 1170 and E.Gr. 1171. E.Gr. 1170 is required in most engineering curricula; E.Gr. 1171 is acceptable as an elective in all engineering curricula. Both courses may be used as electives in many nonengineering curricula.

The objective of the two-course sequence is to teach the student the principles of graphic expression. Because much of engineering design uses graphics as a tool, this activity is prescribed early in the student's career.

Bachelor of Civil Engineering

The four-year curriculum leading to the degree Bachelor of Civil Engineering is designed to enable the graduate to enter professional practice as an engineer or to continue his or her studies in programs leading to advanced degrees in the following broad fields of specialization: construction, environmental engineering, fluid mechanics, hydraulics, hydrology, sanitary engineering, soil mechanics, structures, surveying, transportation and water resources planning and management. The graduate of the B.C.E. curriculum may function in the areas of planning and design, construction, research and development, operations and maintenance. The curriculum leading to the degree Bachelor of Civil Engineering has been continuously accredited by the Engineers' Council for Professional Development since the inauguration of its accrediting program during the period 1936-38.

Graduates of the B.C.E. curriculum are eligible to seek licensing as registered professional engineers.

The course requirements of the Bachelor of Civil Engineering degree are tabulated here. Many of the courses need not be taken during the quarter indicated, but prerequisites must be satisfied. In addition to campus-wide academic requirements for graduation with a bachelor's degree, the following are also required for the B.C.E. degree:

(a) The scholastic average shall be a minimum of 2.0 for those quarters during which the last 54 hours toward the degree are taken.
(b) The number of quality points earned in civil engineering courses taken toward the degree must be at least twice the number of credit hours in those courses.
(c) No more than 12 hours of free electives may be taken on a pass/fail basis. No other courses may be taken on a pass/fail basis.

Bachelor of Science

This degree may be awarded to students majoring in civil engineering whose programs meet the following criteria:

1. All campus-wide regulations pertaining to this degree must be satisfied.
2. Submit for approval a program of study which leads to a definable goal before completion of 120 quarter hours.
3. The academic quality of the program of study submitted for this degree must be equivalent to that of the B.C.E. degree.

Freshman Year

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<td>Electives^5</td>
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<td></td>
<td>15-6-17</td>
<td>15-6-17</td>
<td>18-3-19</td>
</tr>
</tbody>
</table>

^1 See College of Engineering section "Curricula and Degrees" for engineering electives.
^2 These free elective courses may be taken at any time during a student's course of study. Physical education courses may not be used to satisfy this requirement.
^3 See "Curricula and Degrees," Department of Physical education and Recreation, for freshman physical education requirements for both men and women.
^4 Nine hours of free electives at the 3000 level or higher must be taken if advanced ROTC is not taken.
^5 C.E. electives. Each C.E. senior must choose four of the following courses: C.E. 4003, 4013, 4053, 4123, 4133, 4143, 4163, 4213, 4223, 4233, 4253, 4273, 4283, 4313, 4333, 4353, 4373, or 4774; or graduate level C.E. courses as approved by adviser and director (minimum 2.7 average required).
^6 Mathematics elective. Either Math. 2309, 3308 or 3215.
^7 See "Information for Undergraduate Students" section of this catalog for humanities, social science and modern language requirements.

### Master of Science

Three degrees in this category are awarded by the School of Civil Engineering: Master of Science in Civil Engineering, Master of Science in Sanitary Engineering and the undesignated Master of Science. Common requirements for these degrees, in addition to those specified in "Information for Graduate Students," are listed below.
1. A minimum of 50 hours of course work is required, of which none was used to satisfy requirements for a previous degree, as approved by the student's adviser and the director.

2. Up to 15 of the 50 hours may be in 3000-4000 level courses. Courses required for the B.C.E. degree may not be used to satisfy this requirement; other 3000-4000 level courses may be used subject to the approval of the advisor and director.

3. Up to six of the 50 hours may be taken on a pass/fail basis with the approval of the adviser and director.

4. Each M.S. student is required to either (a) write an M.S. thesis and schedule at least 17 hours of C.E. 7000, or (b) write an M.S. special research problem and schedule between six and 12 hours of C.E. 8756. No more than 17 hours of C.E. 7000, nor more than 12 hours of C.E. 8756, may be counted as part of the 50 hours required for the M.S. degree.

5. Students electing to write an M.S. thesis must take at least 18 hours of course work in their major field. Students electing to write an M.S. special research problem must take at least 27 hours of course work (including C.E. 8756) in their major field.

The Master of Science in Civil Engineering degree is awarded only to students who have previously earned the B.C.E. degree or equivalent. The Master of Science in Sanitary Engineering degree is awarded only to those students who have previously earned the B.C.E. degree or who have earned an accredited bachelor's degree in engineering and have taken undergraduate courses (for no credit toward the M.S.) required by their advisor and the director. The undesignated Master of Science degree is not awarded to students not meeting the above requirements, but who have satisfied all prerequisites for the courses in their M.S. program.

A wide range of M.S. programs is available in such fields as construction, environmental engineering, fluid mechanics, hydraulics, hydrology, sanitary engineering, soil mechanics, materials, structures, transportation and water resources planning and management. Students are encouraged to design his or her program around his or her own academic interests. The resulting program leads to a definable goal.

The degrees Master of Science in Civil Engineering and Master of Science in Sanitary Engineering are accredited by the Engineers' Council for Professional Development. The undesignated Master of Science degree is not an engineering degree; holders of this degree may not be licensed as professional engineers, unless they have an E.C.P.D.-accredited bachelor's degree in engineering.

Graduates of technology programs are not directly admissible to graduate study in the School of Civil Engineering.

**Doctor of Philosophy**

The Ph.D. is the highest degree awarded and as such requires the highest level of proficiency and achievement, both in knowledge and in the performance of research presented in a written dissertation. While there are no specific course requirements, most doctoral students spend approximately two years in course work beyond the bachelor's degree while conducting their research activities plus at least another year on full-time research.

**School of Electrical Engineering**

**Established in 1896**


**General Information**

Electrical engineers have pioneered the fields of electronics, computers, control, power and communication. Their work is vital in almost every sector of society. The tremendous effect of electrical engineering on society can be explained by the fact that electrical energy is the only known form of energy which can be transmitted efficiently under controlled conditions, even through a vacuum, and by means of which intelligence can be processed and transferred effectively even over extremely long distances.

The School of Electrical Engineering seeks to attract students who possess a verbal and written command of the English language, who exhibit logical thinking, creativity, curiosity, imagination, patience and perseverance, who have proved their academic excellence in mathematics, chemistry and physics.

At the undergraduate level, the basic required program of instruction in fundamental theory and laboratory practice is balanced by a broad range of electives. These electives are available in a wide variety of major areas such as audio engineering, communications, computer engineering, energy engineering, instrumentation, controls, optical engineering and urban engineering. The student, with the counsel and guidance of faculty advisers, designs his or her electives program around his or her own special interests.

The graduate programs leading to the master's and doctoral degrees are designed to provide a broad education covering more than one specialty, followed by in-depth studies of major and minor interest areas. The doctoral
program requires, in addition, concentration in a single specialty or in a group of closely related specialties.

Graduate programs include communications, computer systems, control systems, electric power, optical engineering, electromagnetics, instrumentation, network and system theory, physical electronics and signal processing. Multidisciplinary programs in areas such as computer engineering and acoustic engineering are offered jointly with other engineering schools on campus. Full programs of courses are offered during the summer quarter, making it possible for part-time students to continue an uninterrupted program of study throughout the year.

Housed in one of the finest facilities in the world, the school maintains a vigorous program of student-centered research conducted in well-equipped laboratories.

Additional information about the programs may be obtained from the school's Student Handbook or Graduate Brochure, available upon request, or by calling the school at (404) 894-2900. These sources of information must be consulted with respect to special rules and degree requirements by every student enrolled.

**Computer Engineering within the School of Electrical Engineering**

Computers have become an integral part of our society and are now used in all facets of society including scientific research, industry, business, commerce and now even the home with calculators and computer controlled appliances. With this increasing use comes an increasing demand for people who understand the design, construction, operation and application of computers. To satisfy this demand, new programs in computer engineering have been developed.

Computer engineering in the School of Electrical Engineering encompasses both traditional areas of computer engineering—the engineering of computers and engineering with computers. Engineering of computers emphasizes the design of computers and requires expertise in computational theory, digital design and computer architecture. Engineering with computers emphasizes the use of computers in engineering systems and requires computer interfacing techniques, both low level and high level programming techniques and a general knowledge of computer operating systems. Both areas require an in-depth understanding of computer software at the elementary and systems level. Hence, computer engineering encompasses all aspects of design, theory, and practice relating to: systems for digital and analog computation and information processing; components and circuits for computing systems; relevant portions of supporting disciplines; production, testing, application and reliability of computing systems; applications, use, and programming of computing devices and information processing systems; and the use of computers in electrical and electronic engineering.

Further details may be obtained by contacting the School of Electrical Engineering.

**Multidisciplinary Programs.** See table on page 66.

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### Table: Course Offerings

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
<th>2nd Q.</th>
<th>3rd Q.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electives</strong>¹</td>
<td>Humanities/Social Science/Modern Language</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Electives</strong>²</td>
<td>E.S.M. 2201 Statics</td>
<td>3-0-3</td>
<td>3-0-3</td>
<td>3-0-3</td>
</tr>
<tr>
<td><strong>Electives</strong>²</td>
<td>E.S.M. 3201 Dynamics I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math. 2307</td>
<td>Calculus IV</td>
<td>5-0-5</td>
<td>4-3-5</td>
<td>5-0-5</td>
</tr>
<tr>
<td>Math. 2308</td>
<td>Calculus V</td>
<td>5-0-5</td>
<td>5-0-5</td>
<td>5-0-5</td>
</tr>
<tr>
<td>Math. 3308</td>
<td>Differential Equations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phys. 2122</td>
<td>Electromagnetism</td>
<td>4-3-5</td>
<td>4-3-5</td>
<td>4-3-5</td>
</tr>
<tr>
<td>Phys. 2123</td>
<td>Optics and Modern Physics</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>E.E. 3200-50</td>
<td>Elements of Electrical Engineering</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>E.E. 3400</td>
<td>Instrumentation Laboratory</td>
<td>1-3-2</td>
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<tr>
<td><strong>Totals</strong></td>
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<td>18-3-19</td>
<td>15-3-16</td>
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**Junior Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
<th>2nd Q.</th>
<th>3rd Q.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electives</strong>¹</td>
<td>Humanities/Social Science/Modern Language</td>
<td>1-0-1</td>
<td>4-0-4</td>
<td>4-0-4</td>
</tr>
<tr>
<td><strong>Electives</strong>²</td>
<td></td>
<td>3-0-3</td>
<td>3-0-3</td>
<td>3-0-3</td>
</tr>
</tbody>
</table>
The 57 hours of electives must include a minimum of:

1. 3 hours of freshman English electives. See "Curricula and Degrees," College of Engineering.
2. 3 hours of junior-level or senior-level course work in written or oral communication of ideas which may be one of the following English courses: Engl. 3015, Engl. 3023, and Engl. 3015.
3. 3 hours of technical electives subject to school approval. Generally, the technical electives are junior or senior engineering (not E.E.), mathematics, or natural science courses. These electives must include one of the following five thermodynamics options: (1) M.E. 3720 (2) M.E. 3726 (3) M.E. 3322 and M.E. 3323 (4) Phys. 3141 or (5) a course or approved by the Regent's Professor.
4. 12 hours of technical electives subject to school approval. In addition, one course in graphics is strongly recommended.
5. 18 hours of technical electives, subject to school approval. These electives must include one of the following seven courses in applied probability: (1) E.E. 3340 (2) Phys. 3145 (3) I.Sy. E. 3207 (4) Biol. 3333 (5) Math. 3710 (6) Math. 3215 or (7) Math. 4215. E.E. 3340 will apply toward satisfying the E.E. elective course requirements. All other courses will apply toward satisfying the technical breadth requirement for the bachelor's degree in electrical engineering.

21 hours of free electives. These free electives may be taken at any time during a student's course of study. Up to 6 hours of basic ROTC and a maximum of nine hours of advanced ROTC may be used for elective credit in the program.

Three credit hours each of literature, history and political science must be included. One year of freshman English is strongly recommended. Additional humanities/social science/modern language electives and their required distribution are given in "Information for Undergraduate Students," Academic Regulations.

See "Information for Undergraduate Students," Academic Regulations, for physical education requirements for both men and women.

It is expected that each student, through independent study, attendance at seminars or formal courses, will acquire the ability to program simple problems on one of the digital computers available on campus prior to enrollment in E.E. 3200.

See "Curricula and Degrees," College of Engineering, for a listing of freshman engineering electives.

Additional degree requirements: all students are required by the University System of Georgia to take certain examinations in Constitution and history, in English proficiency and in their respective major areas. These examinations are described in chapter two, under Academic Regulations.

21 hours of free electives. These free electives may be taken at any time during a student's course of study. Up to 6 hours of basic ROTC and a maximum of nine hours of advanced ROTC may be used for elective credit in the program.

Three credit hours each of literature, history and political science must be included. One year of freshman English is strongly recommended. Additional humanities/social science/modern language electives and their required distribution are given in "Information for Undergraduate Students," Academic Regulations.

See "Information for Undergraduate Students," Academic Regulations, for physical education requirements for both men and women.

It is expected that each student, through independent study, attendance at seminars or formal courses, will acquire the ability to program simple problems on one of the digital computers available on campus prior to enrollment in E.E. 3200.

See "Curricula and Degrees," College of Engineering, for a listing of freshman engineering electives.

Additional degree requirements: all students are required by the University System of Georgia to take certain examinations in Constitution and history, in English proficiency and in their respective major areas. These examinations are described in chapter two, under Academic Regulations.

School of Engineering Science and Mechanics

Established 1959

Director and Professor—Milton E. Raville; Associate Director and Professor—Wilton W. King; Regents' Professor—Andrew W. Marris; Professors—Satyanadham N. Alluri, William J. Lnenicka, David J. McGill, George J. Simimarik, Charles E. S. Lueh, James T. S. Wang, Gerald A. Wempner; Associate Professors—Jerry M. Anderson, Donald G. Berghaus, Michael C. Bernard, Stephen L. Passman, George M. Rentzepis, Robert W. Shreeves; Assistant Professors—Hyland Y. L. Chen, John C. Clark, William A. Johnston, Arthur J. Kobiasz, Richard K. Kunz, Raymond P. Vito.

General Information

The School of Engineering Science and Mechanics administers the undergraduate curriculum leading to the degree Bachelor of Engineering Science and graduate programs leading to the degrees of Master of Science, Master of Science in Engineering Science and Mechanics and Doctor of Philosophy.

The primary objective of the undergraduate curriculum is to prepare students for careers in engineering and related fields emphasizing the fundamental principles and techniques of mathematics and the engineering sciences—solid mechanics, fluid mechanics, materials science, electrical sciences, heat transfer and thermodynamics. The curriculum, totaling 205 credit hours, provides for 82 hours of elective credit, including 16 hours of free electives, 16 hours of technical electives, 18 hours of restricted electives and 33 hours of humanities/social science/modern language electives. The engineering science curriculum is considered particularly well suited for the above average student whose specific goals within the general framework of engineering and the physical sciences have not yet been formulated.

Elective options provide in-depth study in interdisciplinary, technically-related areas as well as preparation for professional schools of business, law and medicine. Thus, the engineering science graduate has a wide choice of specialized areas that can provide a foundation for starting his or her career or for further study.
Graduate study and research in the School of Engineering Science and Mechanics includes work in modern continuum mechanics, stress analysis, stability, structures, dynamics, vibrations, space mechanics, fracture mechanics, finite element methods and other computational techniques, fluid mechanics, biomechanics, acoustics, wave propagation, applied stochastic processes, optimization techniques, materials science and experimental stress analysis. A wide variety of related graduate courses is also available to the E.S.M. graduate student in the other schools of the institute. Flexibility and interdisciplinary interests are encouraged in the planning of individual programs of study.

The faculty members of the School of Engineering Science and Mechanics hold degrees in most of the recognized branches of engineering, as well as mathematics and physics. Housed in two buildings, E.S.M. has excellent classroom, office and shop facilities and modern, newly-equipped laboratories. Various grants, assistantships and fellowships are available to students of outstanding merit.

**Multidisciplinary Programs.** See table on page 66.

### Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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<tr>
<td>Chem. 1101-2</td>
<td>Inorganic Chemistry</td>
<td>4-3-5</td>
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<td>E.Gr. 1170</td>
<td>Visual Communication and Engineering Design I</td>
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<td>2-3-3</td>
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<tr>
<td>Math. 1307-8-9</td>
<td>Calculus I, II, III</td>
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<td>Phys. 2121</td>
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<td>Electives2</td>
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<td>Electives6</td>
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### Sophomore Year

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</thead>
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<tr>
<td>E.S.M. 2101-2</td>
<td>Engineering Design I, II</td>
<td>0-3-1</td>
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<tr>
<td>E.S.M. 2201</td>
<td>Statics</td>
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<td>E.S.M. 3201-2</td>
<td>Dynamics I, II</td>
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<td>E.E. 3200</td>
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<td>Math. 2307</td>
<td>Calculus IV</td>
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<tr>
<td>Math. 2308</td>
<td>Calculus and Linear Algebra</td>
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<tr>
<td>Math. 2309 or 3308</td>
<td>Differential Equations</td>
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### Junior Year

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<td>E.S.M. 3111</td>
<td>Experimental Methods in Engr. Science</td>
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<tr>
<td>E.S.M. 3301</td>
<td>Mechanics of Deformable Bodies</td>
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<tr>
<td>E.S.M. 3302</td>
<td>Mechanics of Materials</td>
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<td>E.S.M. 3501</td>
<td>Fluid Mechanics</td>
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<td>E.S.M. 4210</td>
<td>Mechanical Vibrations</td>
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<td>E.E. 3250</td>
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<tr>
<td>E.E. 3400</td>
<td>Instrumentation Laboratory</td>
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<tr>
<td>Engl. 3023</td>
<td>Written Communication in Science, Business and Industry</td>
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<tr>
<td>M.E. 3322</td>
<td>Thermodynamics</td>
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<tr>
<td>M.E. 3323</td>
<td>Thermodynamics</td>
<td>3-0-3</td>
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<tr>
<td>M.E. 3342</td>
<td>Transport Phenomena I</td>
<td>3-0-3</td>
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<td>Elective Mathematics</td>
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<td>Electives</td>
<td>Humanities/Social Science/Modern Language</td>
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### Senior Year

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<td>E.S.M. 4122-3</td>
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Senior Year (continued)

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<td>Survey of Principles of Economics</td>
<td>3-0-3</td>
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<tr>
<td>Met. 3301</td>
<td>Engineering Materials</td>
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<tr>
<td>Elective</td>
<td>Either I.Sy.E. 4000, Introduction to Systems Theory, or M.E. 4445, Automatic Control</td>
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<tr>
<td>Elective</td>
<td>Mathematics</td>
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</tr>
<tr>
<td>Elective</td>
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<tr>
<td>Electives</td>
<td>Humanities/Social Science/Modern Language</td>
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<tr>
<td>Electives*</td>
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</tbody>
</table>

Electives* must be in the area of design, synthesis or systems.

1 See College of Engineering section, “Curricula and Degrees” for engineering electives.
2 These free elective hours may be taken at any time during a student’s course of study. However, if six credit hours of basic ROTC are elected, then it should be scheduled beginning at the first quarter the student is enrolled. A maximum of nine hours of free electives in junior and senior years may be in advanced ROTC.
3 To be selected from Math. 3110, 4215, 4320, 4581, 4582.
4 To be selected from Phys. 3143, 3002 or 3751. If Phys. 3143 is chosen, the extra two credits will be used as technical electives.
5 At least six hours of electives must be in the area of design, synthesis or systems.

School of Health Systems

Established in 1977, program in 1972, option in 1958

Director and Regents’ Professor—Harold E. Smalley; Professor—Jack W. LaPata; Associate Professors—Richard M. Bramblett, Daniel P. Golightly, James B. Mathews, Justin A. Myrick; Assistant Professors—Thomas H. Bowlin, Bonnie J. Kay; Lecturers—Howard E. Fagin, Charles Y. Thomason III.

General Information

Health Systems is that field of study and practice aimed toward improving the delivery of health care services through the application of systems science and management engineering. Emphasis is upon systematic planning, engineering design and scientific management in respect to health care facilities, manpower and methods. Because of the complexity of health care management problems, the body of knowledge that has come to be known as health systems builds upon and draws from other branches of engineering, computer technology, management science, architecture, behavioral science and the various health professions. Health systems is an allied health field grounded in the engineering profession.

A career in this field is challenging and rewarding in many ways. Health care is humanitarian and health services are important to society; the industry is large, expensive and in need of improvement. A career in health systems is an opportunity to use modern scientific methods in the performance of a vital public service.

Health systems specialists are in short supply and there are many job openings with hospitals, nursing homes, doctors’ offices, government agencies, universities, medical centers, research and planning organizations, manufacturers of hospital equipment, health insurance companies, management consultants, architectural firms and construction contractors.

The School of Health Systems is an academic division of Georgia Tech’s College of Engineering and it is affiliated with the Medical College of Georgia. The school has extensive programs of education, research and service, and through the Health Systems Research Center, it engages in interdisciplinary and interinstitutional research, continuing education and community outreach activities.

Programs of the school are a direct outgrowth of faculty involvement in this field since 1952 and of a health-related academic program begun at Georgia Tech in 1958. The school has been admitted to institutional membership in the Georgia Hospital Association and the American Hospital Association, the American Society of Allied Health Professions, the American Health Planning Association and the Association of University Programs in Health Administration. Close working relationships are also maintained with the Hospital Management Systems Society and with the Health Services Division of the American Institute of Industrial Engineers.

B.S.H.S. Curriculum

The undergraduate program was designed to prepare students for professional careers in the field of health systems and it provides an academically sound base for lifelong learning. Even though it is technical and analytical, the program of study places some emphasis upon interpersonal, organizational and societal relationships. And, although it is directed toward the health field, the program provides students with valuable knowledge and marketable skills needed in many different fields.

The curriculum enables students to keep their options open for a variety of positions in the health field. It provides considerable flexibility so that students from various fields can transfer into it without losing credit already earned. It contains sufficient electives to accommodate several specialty interests, including health systems analysis, health systems planning and premedical preparation. Modified versions of this curriculum are available under the dual degree (3-2) program.

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
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### Freshman Year

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Totals 18 17 17

### Sophomore Year

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<td>I.Sy.E. 3027</td>
<td>Applications of Probability</td>
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<td>Engineering Statistics I</td>
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<td>Math. 2010</td>
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<tr>
<td>Elective¹</td>
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Totals 16 17 17

### Junior Year

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<td>Hospital Functions</td>
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<td>Nonhospital Components</td>
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Totals 17 18 16

### Senior Year

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<td>H.S. 4570</td>
<td>Field Training Proposal</td>
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<td>H.S. 4571-2-3</td>
<td>Senior Externship</td>
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<td>H.S. 4693</td>
<td>Seminar</td>
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<td>Electives⁶</td>
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<td>Electives⁷</td>
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<td>Electives⁹</td>
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Totals 16 12 15

### Total Degree Requirements

196

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¹These courses apply toward satisfaction of the 18-hour social science requirement stated in "Information for Undergraduate Students."

²Either Pol. 1251 or 3200 gives exemption from U.S. and Georgia constitution examination and any one of Hist. 1001, 1002, 3010 or 3011 gives exemption from the U.S. and Georgia history examination. Students electing the examinations must substitute six hours of approved social science electives.

³Approved humanities courses are listed in "Information for Undergraduate Students." The 18 hours of humanities must include at least three hours of literature and the student should plan these and other electives with a view toward satisfying the rising junior English examination.

⁴See "Curricula and Degrees." Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.

⁵A list of recommended electives is available upon request. Free elective hours may include credit for P.E. and/or ROTC courses up to the maximums stated in "Information for Undergraduate Students."

⁶The student may choose any course with the H.S. prefix or a substitute course approved by the faculty.

⁷These are courses that describe the health field, medical affairs, the life sciences, the community or other aspects of the environment in which the graduate will practice and are to be selected from among courses approved by the faculty.

⁸These are courses that emphasize principles and techniques useful in analyzing or improving management systems and are to be selected from among courses approved by the faculty.

### Health Planning Option

The health planning option is provided in order to broaden the preparation of the health systems specialist for professional practice in the subspecialty of health systems planning. Such a planning function covers manpower, facilities, logistics, organization, finance, and other system components. It includes consideration of medical, behavioral, socioeconomic, demographic, ethnic, political, legal, and other environmental factors. Some health systems planners serve in government agencies, consulting firms or other organizations concerned with multi-institutional and community-wide systems of health care delivery. Others perform planning functions within man-
agreement engineering departments of individual hospitals, clinics or other health care institutions.

Health systems majors may emphasize health systems planning by utilizing their electives to include courses appropriate to the planning function. Such students should make their selections from the following categories:

**Case Studies Elective**
H.S. 4351 .................................................. 3

**Environmental Electives**
Mgt. 4290, Pol. 3217, 3220, 3221, 3250, Soc. 3310 ....................... 3
Econ. 3501, 4310, 4330, 4331, H.S. 3332 ................................ 3

**Health Systems Elective**
H.S. 4021 .................................................. 3

**Social Science Elective**
Soc. 1376 .................................................. 3

**Technical Electives**
I.Sy.E. 4028, 4044, 4157, I.C.S. 4334 .................................. 3
H.S. 3341 .................................................. 3

**Free Electives**
C.P. 1100, H.S. 3780 ........................................ 3
I.Sy.E. 4053, 4056 ........................................... 3

**Health Planning Courses** .................................. 27

**Remaining Free Electives** .................................. 14

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**Premedical Option**

The premedical option was designed to satisfy the normal course preparation required by most medical and dental schools while providing the systems orientation now being favored by leading medical educators. Nationally, about two of every three medical school applicants are rejected and the proportion for professed premeds still in undergraduate school is even higher. A significant advantage of this premedical option is that, if the student decides not to apply to medical or dental school or health career.

Under this premedical option, health systems majors satisfy all required courses of the B.S.H.S. curriculum and utilize their electives to include the key premed courses. Thus the graduate is fully qualified as a health systems specialist and is prepared for medical or dental school.

This option concentrates the premed courses in the freshman and sophomore years so as to gain the advantage of submitting the medical or dental school application early in the junior year. Therefore, a decision to elect this option should be made prior to or early in the freshman year.

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**Freshman Year**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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<td>Math. 1307-8-9</td>
<td>Calculus</td>
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<td>5</td>
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<tr>
<td>Elective</td>
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<td>Elective 3</td>
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**Totals** ................................................. 17  17  16

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**Sophomore Year**

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<td>Engineering Physics</td>
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**Totals** ................................................. 16  18  18

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**Junior Year**

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**Totals** ................................................. 17  17  15
The general purpose of the M.S.H.S. curriculum is to provide an academically sound, socially relevant educational experience which is graduate faculty.

Admission requirements include a bachelor's degree from a recognized institution, with a major in a scientific field (such as engineering, mathematics, statistics, computer science, physical science, social science or management science), a good academic record, a quantitative and analytic orientation, a year of calculus and an interest in the health field. If prerequisite courses in math, statistics or operations research are anticipated, the applicant should plan to begin the program of study in the spring or summer, otherwise in the fall quarter. However, applications for full-time or part-time study will be considered for initial enrollment in any of the four academic quarters which begin in September, January, March and June.

Financial support for M.S.H.S. students is often available through graduate assistantships, traineeships, scholarships, sponsored externships or part-time employment with cooperating health institutions or agencies. Nonresident tuition may be waived for holders of certain scholarships and assistantships, and for residents of Arkansas, Louisiana, Tennessee and West Virginia, under the SREB Academic Common Market. There is no application fee.

Doctoral Degree Opportunities

Health related graduate work leading to the Doctor of Philosophy degree is available through any one of several Georgia Tech schools authorized to offer the doctorate, for example, the School of Industrial and Systems Engineering, the School of Information and Computer Science or the College of Industrial Management. A health systems component may be arranged under a special interdepartmental program in which the School of Health Systems cooperates. A student interested in such an arrangement should obtain approval of his or her major school, then contact the director, School of Health Systems.

School of Industrial and Systems Engineering

Established in 1945, option in M.E., 1924-1945

Director—Michael E. Thomas, Associate Director for Undergraduate Programs—Nelson K. Rogers; Associate Director for Graduate Programs—William W. Hines; Associate Director for Research—V. E. Unger, Jr.; Professors—Mohktar S. Bazarra, Leslie G. Callahan, Stuart J. Deutsch, Augustine O. Esogbue, David E. Fyffe, John J. Jarvis, Cecil G. Johnson, Lynwood A. John-
student to gain experience in design activities in manufacturing, service or facilities, management information and controls, and systems

hours of senior-year electives may be waived. These credits, when

hours of approved graduate program flexible as does the senior year design sequence, which permits

engineering environments.

The principal strength of the program leading to the Bachelor of Industrial

B.I.E.

The typical strength of the program leading to the Bachelor of Industrial Engineering degree lies in a solid, well-coordinated core of courses in systems analysis and systems design, which relies heavily upon the engineering sciences, basic sciences and social sciences. Elective hours make the program flexible as does the senior year design sequence, which permits a student to gain experience in design activities in manufacturing, service or government industries. The broad spectrum of required course work associated with the design sequence qualifies the student to perform in operations and facilities, management information and controls, and systems engineering environments.

Options for Exceptional Students

An option program is available to encourage students with superior abilities to fully avail themselves of a range of unusual educational opportunities.

Participation in these programs requires demonstrated scholastic excellence, prior arrangements with the student's adviser and provides the following options, individually or in combination.

Graduate level courses in lieu of senior year electives. Students with a cumulative grade-point average of 3.0 or above may schedule up to 18 credit hours of approved graduate level courses. For such students, up to 18 credit hours of approved graduate level courses and six hours of project work may be made available for subsequent credit toward a graduate degree. In order to take advantage of this provision the student must request that the undergraduate degree petition be so designated and file a letter of intention with the registrar.

Accelerated study. Students with a 3.3 or above average during the three preceding quarters (including at least 45 credits), may complete course requirements for any nonproject industrial and systems engineering course at their own pace by self study with counseling and guidance by the course instructor. Students may register for any number of courses but must satisfy instructor and course examination requirements. This may be done by the student's own timing. Class attendance is not required. Arrangements must be made with course instructors prior to the start of the quarter.

Individual project and research work. Students with a 3.0 or above average during the preceding three quarters (including at least 45 credits) may schedule up to 18 credits of project or research work or both, done in collaboration with the faculty or advanced graduate students, which may be substituted for senior-year electives. Students with less than 3.0 average are limited to six credits of such project or research work.

Director's honor seminar. I SY.E. 4500 is for senior students with a 3.0 or above cumulative grade point average. It may be taken as an elective.

Governor's intern program. I SY.E. seniors enrolled in the governor's intern program may receive six hours of design credit (4104-5) and six hours of I SY.E. elective credit (4995) for participation in the program.

Visiting Scholar/Practitioner Offerings

Upon occasion, the school brings to campus selected individuals of unique accomplishment for course offerings built around their special areas of activity, thus making available a broader range of course materials than regularly provided. The typical schedule is Friday afternoon and evening instruction four times during the quarter.

Graduate Programs

The School of Industrial and Systems Engineering offers graduate programs leading to the degrees Master of Science in Industrial Engineering, Master of Science, Master of Science in Operations Research and Doctor of Philosophy.

The M.S.I.E. program is available for students holding the B.I.E. degree and for other engineers who satisfy prerequisites covering the principal subject matter of the current B.I.E. curriculum. The M.S.O.R. program is available for students holding the B.S. in engineering, mathematics or science. Requisites include work in probability, statistics, engineering economy, linear algebra, advanced calculus and optimization. These requirements may be satisfied after enrollment; however, such course work may not be applied to satisfy degree requirements.

The undesignated M.S. is intended for those students who desire to follow programs in applied statistics, systems engineering, organizational behavior and management of improvement, ergonomics and human engineering, industrialization or other special programs. Prerequisites are the same as for the M.S.O.R. program.
Except for the industrialization program, a student has two options: either 33 quarter hours of course work and a thesis or 50 quarter hours of course work and a written comprehensive examination. The industrialization program requires either 43 quarter hours of course work and a thesis or 60 quarter hours of course work and a written comprehensive examination.

The doctoral program is intended for highly gifted individuals whose past accomplishments and evaluations indicate a high potential for successful completion of the program requirements and a subsequent creative contribution to the field. Admission is, therefore, dependent upon student qualification rather than educational background in any specified discipline.

All degree curricula of the school are offered on a 12-month basis. Graduate programs may be started in any quarter.

Financial aid is available in the form of traineeships, fellowships and research assistantships.

**Multidisciplinary Programs.** See table on page 00.

**The B.I.E. Curriculum**

### Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
<th>2nd Q.</th>
<th>3rd Q.</th>
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<td>5-0-5</td>
<td>5-0-5</td>
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### Sophomore Year

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### Senior Year

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</table>
field, feedback and utilization of thermal and mechanical energy, the design and analysis of mechanical, thermal and fundamental characteristics of materials as applied to design and the application of fundamental subjects to the diverse problems of mechanical engineering are stressed. Nevertheless, it is possible to experience aspects of creative decisions and designs at the freshman level. Laboratory work and design projects are stressed.

Satisfactory completion of the curriculum leads to the degree Bachelor of Mechanical Engineering.

**Optional Programs**

While the curriculum is structured to meet the general educational goals of the majority of mechanical engineering students, the school regularly considers and approves major modifications of the basic program to allow a student with certain well defined educational objectives to pursue minor fields within the school or within Georgia Tech while earning a degree in mechanical engineering. In this way a student may achieve his or her basic degree in mechanical engineering while specializing in any one of a large number of other fields. Aside from the broad flexibility afforded by such special programs, a student following the regular M.E. curriculum takes a number of electives as well as special problems and projects, all of which allow latitude in pursuing his or her educational goals and special interests.

**Graduate Programs**

The School of Mechanical Engineering has a rapidly expanding and vigorous graduate program of advanced study and research in the areas of acoustics and noise control, automatic controls, bioengineering, combustion, complex systems design, controlled machine tools, dynamics and vibration, energy engineering, engineering design, environmental quality control, flammability, fluid mechanics, fluidics and fluid power, heat transfer, lubrication, magnetogasdynamics and plasma, manufacturing engineering, materials processing, materials science, mechanisms (synthesis and analysis), nuclear power, solar power, vehicle propulsion, thermal systems (analysis and design), thermodynamics (equilibrium and irreversible), transport processes and two-phase flows.

These graduate programs lead to the degrees Master of Science in Mechanical Engineering, Master of Science and Doctor of Philosophy for qualified graduates having backgrounds in engineering, mechanics, mathematics, the physical sciences and the biological sciences.

**Multidisciplinary Programs.** See table on page 00.

**School Facilities**

The School of Mechanical Engineering has many types of specialized instru-
ments and equipment associated with laboratories for the study of two-phase flow, lubrication and rheology, material processing, fire hazard and combustion, magnetohydrodynamics, energetics, fluidics and fluid power control, heat transfer, vibration and thermal stress, computer-aided design, automatic and digital control, machinery noise and other areas. The school is housed in a four-building classroom-research complex. Part of this complex is a modern classroom-seminar conference building which serves the institute.

The main research building of the school houses several remote terminals linked to the main campus research and teaching computer. It also has analog and micro computer facilities. The school research activity is served by its own machine and instrumentation shops with a log and micro computer facilities. The school research activity is served linked to the main campus research and teaching computer.

Additional information about the programs may be obtained from the school's Student Handbook or Graduate Student Information Brochure, available upon request, or by calling the school at (404) 894-3203. These sources of information must be consulted with respect to special rules and degree requirements by every student enrolled.

**Freshman Year**

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**Sophomore Year (continued)**

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**Junior Year**

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**Senior Year**

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Senior Year (continued)

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$^1$ See College of Engineering section "Curricula and Degrees" for engineering electives.
$^2$ These free elective courses may be taken at any time during the course of study. If ROTC is elected by the student these six credit hours may be applied for basic ROTC, which should be scheduled beginning the first quarter the student is enrolled.
$^3$ Nine hours of technical electives chosen from M.E. 3000, 4000 and 6000 level courses. Graduation courses (6000 level) must have consent of adviser. Courses other than these may be selected from mathematics, physics, chemistry, biology, another field of engineering or graduate courses.
$^4$ For selection of acceptable courses see list of electives allowed by the College of Engineering in "Information for Undergraduate Students."
$^5$ See "Curricula and Degrees," Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.

School of Nuclear Engineering

Established in 1962

Director—L. E. Weaver; Callaway Professor—W. M. Stacey, Jr.; Neely Professor—K. Z. Morgan; Regents' Professor—G. G. Eichholz; Professors—M. W. Carter, J. D. Clement, M. V. Davis, D. S. Harmer, B. Kahn, J. M. Kalifelz, R. A. Karam, J. L. Russell, Jr., J. H. Rust, A. Schneider; Associate Professors—M. A. Abdou, J. N. Davidson, J. W. Poston; Visiting Associate Professor—R.G. Bateman; Adjunct Assistant Professor—P. H. McGinley.

General Information

Nuclear engineering is the branch of engineering directly concerned with the release, control and utilization of all types of energy from nuclear sources and its environmental impact. Today nuclear energy is being used in a wide variety of applications from the exploration of outer space and the powering of human heart pacemakers to the generation of electricity. With the limited supply of fossil fuels and the growing concern about their environmental effect, the need for nuclear power to produce the large amounts of energy demanded by our society becomes more and more pressing. The School of Nuclear Engineering is playing a vital role in educating the technical manpower required to meet this need.

In addition to the Bachelor of Nuclear Engineering degree, the school administers the program leading to the Bachelor of Science degree in Health Physics. Health physics is an applied science concerned with the protection of man and the environment from the hazards of radiation. Typical activities of health physicists today are: development of sound philosophy and principles of radiation protection; practical application of these principles on-the-job in an industrial or medical setting or with a regulatory agency; and devising new methods and instrumentation for protection of individual workers and the general public.

Undergraduate Programs

The curriculum leading to the degree Bachelor of Nuclear Engineering is structured to meet the needs of both the student who contemplates employment immediately after graduation and the student planning to pursue graduate study. It has been tailored to provide maximum flexibility in the form of options for each student to develop his or her unique interests or capabilities. These options are built upon the core curriculum covering the basic principles of nuclear engineering: nuclear reactor core design, nuclear fuel design, reactor controls engineering, nuclear fuel process engineering, nuclear power economics and reactor operations.

Studies for the Bachelor's Degree in Health Physics may be planned to be terminal, leading to careers in radiation protection or environmental surveillance, or may be preparatory to further study at the graduate level for a professional career as a health physicist. The program also provides an excellent premedical education.

In addition to the campus-wide academic requirements for graduation with a bachelor's degree, the number of quality points earned in nuclear engineering courses taken toward the B.N.E. degree or B.S.H.P. degree must be at least twice the number of credit hours in those courses. Further, students in the B.N.E. degree program must obtain twice the number of quality points as credit hours for courses taken in thermodynamics and transport phenomena.

Program for the Bachelor of Nuclear Engineering

Freshman Year

<table>
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<tr>
<td>Phys. 3001</td>
<td>Modern and Nuclear Physics</td>
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<tr>
<td>N.E. 4201-2</td>
<td>Nuclear Reactor Physics I and II</td>
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Junior Year (continued)

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<tr>
<td>E.S.M. 3301</td>
<td>Mechanics of Deformable Bodies</td>
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<td>Transport Phenomena Laboratory</td>
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<td>Engineering Economy</td>
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<td>14-9-16</td>
<td>16-3-16</td>
<td>13-9-15</td>
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</table>

1 For selection of College of Engineering approved elective courses and requirements see "Curricula and Degrees." E.E. 1010 cannot be used as a substitution.
2 Free elective courses may be taken at any time during the course of study. If ROTC is elected
by the student, six credit hours may be applied for basic ROTC and a maximum of five credit hours for advanced ROTC. (A maximum of nine credit hours of electives may be used for advanced ROTC-five free electives and four hours technical electives).

Other courses may be substituted for these required courses. Substitutions are available from the general office of the School of Nuclear Engineering.

The electives will be selected by the student after consultation with his or her adviser. At least 10 credit hours must be in the areas of design, synthesis and systems. A maximum of four credit hours of technical electives may be used for advanced ROTC.

See "Curricula and Degrees," Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.

See "Information for Undergraduate Students."

Program for the Bachelor of Science in Health Physics

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
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<td>Phys. 2122</td>
<td>Electromagnetism</td>
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<tr>
<td>Phys. 2123</td>
<td>Optics and Modern Physics</td>
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<td>4-3-5</td>
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<tr>
<td>Math. 2307</td>
<td>Calculus IV</td>
<td>5-0-5</td>
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<tr>
<td>Math. 2308</td>
<td>Calculus and Linear Algebra</td>
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<td>5-0-5</td>
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<tr>
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<td>4-3-5</td>
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<td>2-3-3</td>
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<tr>
<td>N.E. 2401-2-3</td>
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Sophomore Year (continued)

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Elective4 Free

Totals 14-10-17 14-10-17 15-7-17

Sophomore Year

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<td>Phys. 2123</td>
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<td>4-3-5</td>
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<td>Math. 2308</td>
<td>Calculus and Linear Algebra</td>
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<td>Math. 2309</td>
<td>Ordinary Differential Equations</td>
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<tr>
<td>Biol. 2210-1</td>
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<td>4-3-5</td>
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<tr>
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<td>Computer Programming and Graphics</td>
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<tr>
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<td>Introduction to Health Physics</td>
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Junior Year

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<td>Phys. 3211</td>
<td>Electronics</td>
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<td>5-6-7</td>
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<td>N.E. 3110</td>
<td>Nuclear Radiation Detection</td>
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<tr>
<td>N.E. 4411-2-3</td>
<td>Radiation and Health Physics</td>
<td>3-3-4</td>
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<tr>
<td>Math. 4582</td>
<td>Advanced Engineering Mathematics</td>
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<td>Biol. 3335</td>
<td>General Ecology</td>
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<td>Biol. 4415/6730</td>
<td>Introduction to Radiation Biology</td>
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Electives2 Humanities/Social Science/Modern Language 3-0-3 3-0-3 3-0-3

Elective Technical 2-3-3

Totals 17-5-19 17-5-19 17-3-18

Senior Year

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<td>N.E. 4001-2-3</td>
<td>Nuclear Engineering Seminar</td>
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<td>Chem. 4701</td>
<td>Chemistry of Nuclear Technology</td>
<td>3-3-4</td>
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<td>Phys. 4211</td>
<td>Electronic Instruments</td>
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<td>2-3-3</td>
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<td>N.E. 4260</td>
<td>Radiation Shielding</td>
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<td>N.E. 4401-2-3</td>
<td>Health Physics Seminar</td>
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<td>N.E. 4440</td>
<td>Non-ionizing Radiation</td>
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<td>N.E. 4620</td>
<td>Nuclear Technology and the Environment</td>
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<td>Nuclear Reactor Engineering</td>
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</table>
Graduate Program

The School of Nuclear Engineering administers programs leading to the degrees Master of Science in Nuclear Engineering, Master of Science, Master of Science in Applied Nuclear Science and Doctor of Philosophy.

The program at the master's level provides 11 areas of emphasis: reactor engineering, reactor operations, nuclear fuels engineering, energy systems engineering, nuclear fuel cycle, computer applications, nuclear power management, fusion technology, radiation technology, environmental engineering and health physics.

These curricula are constructed from various combinations of nuclear engineering courses, supplemented with courses in other schools as appropriate. For the first eight areas, students with a Bachelor of Science degree in engineering take the Master of Science in Nuclear Engineering degree while students with a Bachelor of Science degree in science will enroll for the Master of Science Degree. Students completing studies in radiation technology or environmental engineering receive the Master of Science degree and students studying health physics receive the Master of Science in Applied Nuclear Science degree. Those students in computer applications, radiation technology and environmental engineering may elect to receive the Master of Science in Applied Nuclear Science degree, contingent upon their plan of study.

Depending on the career objectives of the student, a thesis may be encouraged as part of the Master of Science program. When appropriate, approved courses and research experience on a special problem may be substituted for a thesis.

The doctoral program is designed with great latitude to capitalize on variations in experience and interests of individual students. In addition to the courses offered by the School of Nuclear Engineering, students are encouraged to enroll in courses related to their subject areas that are offered by other schools.

Multidisciplinary Programs. See table on page 66.

Facilities

The facilities available on the Georgia Tech campus for instruction and research in nuclear engineering include the following: a five megawatt research reactor, a low-power training reactor, a sub-critical assembly, a 100,000 curie cobalt-60 source, several small digital computers, a CDC CYBER 70-74-28 computer, hot cells for handling radioactive materials, a complete nuclear instrumentation laboratory, a one million volt Van de Graaff generator and a pulsed neutron generator.

School of Textile Engineering

Established in 1899

Director—W. Denney Freeston; Callaway Professor—John L. Lundberg; Professors—Winston C. Boteler, Walter C. Carter, Wayne C. Tincher; Associate Professors—Milos Konopasek, L. Howard Olson; Assistant Professors—Agaram S. Abhiraman, David Brookstein, Fred L. Cook.

General Information

Textiles, one of man's oldest commercial ventures, continues to find new applications in the modern world. Fiber assemblies have many varied uses in our everyday life and are playing critical roles in new complex systems in space, medicine, safety, environmental control, transportation and construction.

Textile engineering encompasses the synthesis of polymers by nature and man, fiber fabrication processes, assembling of fibers into one-, two- and three-dimensional structures, modification of structural properties through dyeing, finishing and coating, and measurement of complex aesthetic and mechanical properties of fiber-based systems. New polymers and fibers, new methods of assembling fibers into useful products and new applications of fibers are being developed continually.

The School of Textile Engineering prepares students for rewarding careers in the polymer-fiber-textile industry. Graduates have positions in manufacturing supervision, technical service, sales, product and process development, research, quality control and corporate management. They participate in the design, development, manufacturing and marketing of a broad range of fiber-based and associated products. Many hold key management decision-making positions at a young age.

The textile industry is by far the largest manufacturing industry and employer in the Southeast. If apparel and other associated segments of the industry are included, the textile-based industry is the largest in the United States.
States, representing one out of every eight manufacturing jobs. This is more
than five times the number employed in the automobile industry. The textile
industry's needs for textile graduates each year far exceeds the number of
graduates.

Multidisciplinary Programs. See table on page 66.

Curricula

Three study programs are available leading to the degrees Bachelor of Tex
tile Engineering, Bachelor of Science in Textile Chemistry and Bachelor of
Science in Textiles. Each degree may be pursued in a regular four-year pro-
gram or the five-year cooperative plan.

A broad background is stressed because of the multidisciplinary nature
of textiles. Emphasis in the freshman and sophomore years is on mathe-
matics, chemistry and physics, and in the junior and senior years on mate-
rials science, polymer and textile chemistry, applied mechanics, business
administration and application of each field to the broad range of problems
encountered in textiles. All three programs provide for student selection of
a number of courses from a wide range of general and technical electives.

In place of the many conventional laboratory sessions, textile students
participate in a student operated and managed business venture. Students
design, develop, produce and market novelty textile products. Every partici-
 pant is exposed to all facets of the business environment.

Since most of the textile course work is concentrated in the last two years
of the programs, students from junior colleges and community colleges can
readily transfer into selected programs of the School of Textile Engineering.

In addition to campus-wide academic requirements for graduation with a
bachelor's degree, the number of quality points earned in textile courses
taken toward the degree must be at least twice the number of credit hours
in those courses.

Textiles For Other Majors

Students with other majors often enter the textile industry. To further their
careers, the School of Textile Engineering has developed coordinated course
offerings that will be helpful to students with this goal. Listings of recom-
manded course sequences in textiles are available in the School of Textile
Engineering office.

Graduate Program

The School of Textile Engineering has a graduate program leading to the
Master of Science and Doctor of Philosophy degrees. Students holding an
undergraduate degree in any one of several fields of science or engineering
may qualify for admission. An undergraduate degree in textile engineering,
textiles or textile chemistry is not a specific requirement. Each student pur-
sues an individually structured program.

The graduate course offerings encompass advanced study and research
in polymer synthesis, mechanics of fibrous structures, process dynamics,
dyeing and dye synthesis, viscoelasticity, experimental design, properties of
materials, polymer flow, polymer environmental stability, process control,
enertics and kinetics. The School of Textile Engineering has a variety of
active research programs in which students participate.

The School of Textile Engineering is housed in the Hightower Building, a
four-story classroom and laboratory facility. The building contains equip-
ment illustrating most major types of textile processing. Well equipped labo-
ratories are also available for the chemical and physical characterization of
polymers, fibers and fiber assemblies. Specialized equipment is available
for fabric flammability studies, polymer environmental stability experiments,
energy conservation and water pollution studies. Machine shop and instrumentation facilities with full-time
supporting technicians are housed within the building.

Program for Bachelor of Textile Engineering Degree

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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<tr>
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<td>Visual Communication and Engineering</td>
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<td>Phys. 2121</td>
<td>Particle Dynamics</td>
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<td>0-4-1</td>
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<td>Humanities/Modern Language</td>
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Sophomore Year

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<td>E.S.M. 3201</td>
<td>Dynamics II</td>
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<tr>
<td>Math. 2309</td>
<td>Calculus IV, V</td>
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<td>Phys. 2122-3</td>
<td>Electromagnetism, Optics and Modern Physics</td>
<td>4-3-5</td>
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<td>Computer Applications in Textiles</td>
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<tr>
<td>Text. 4200</td>
<td>Fiber Science</td>
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<table>
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### Senior Year

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### Program for the Bachelor of Science in Textiles Degree

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1. See "Curricula and Degrees," Department of Physical Education and Recreation for freshman physical education requirements for both men and women.
2. Twelve hours of electives must be approved by the department. Twenty-one must be humanities/social science/modern language electives. These free electives may be taken at any time during a student's course of study. Up to six hours of basic ROTC and a maximum of nine hours of advanced ROTC may be used for elective credit.

### Program for Bachelor of Science in Textile Chemistry

#### Freshman Year

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**Note:** The content above is a structured representation of the provided page. It includes the course numbers, subjects, and credits for each semester, along with notes on the requirements and electives. The table format helps in easily understanding the course distribution and credit requirements for each year.
### Freshman Year (continued)

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1 See "Curricula and Degrees," Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.
2 Fifteen hours of electives must be approved by the department. Twenty-seven hours must be humanities/social science/modern language electives. These free electives may be taken at any time during a student's course of study. Up to six hours of basic ROTC and a maximum of nine hours of advanced ROTC may be used for elective credit.
3 Chem. 1111-2 can be substituted for Chem. 1101-2.
4 Chem. 4201 can be substituted for Text. 4310.
5 Text. 4480-1 can be substituted for Text. 4900-1.
General Information

The College of Industrial Management prepares students for careers as managers or for additional study at the graduate level, stressing long-range career objectives rather than specific job knowledge. The continuing growth in number of organizations and the increasing complexity of modern industrial and governmental operations have resulted in a great need for college graduates with formal preparation in management and economics.

The College of Industrial Management offers three undergraduate programs leading to the Bachelor of Science in Management from other majors at Tech. Therefore, it is definitely in the student's advantage to determine as early as possible in consultation with the associate dean of the College of Industrial Management the requirements that must be met before transfer will be permitted.

Bachelor of Science in Industrial Management

The industrial management degree program develops students with a broad interest in all management activities and operating problems. The program builds upon knowledge of the functional, environmental, behavioral, economic and legal aspects of business, and provides analytic and conceptual tools for analyzing complicated problems. It prepares the student for managerial responsibilities and decision-making. The large number of elective hours allows the student, with his or her adviser, to tailor a program to his or her individual educational objectives. Elective concentration may be developed in such areas as organizational behavior, finance, accounting, computer applications, marketing, industrial relations and general management.

Freshman Year

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Sophomore Year

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### Bachelor of Science in Economics

Among the complex problems facing society today, economic issues stand in the forefront. Social objectives such as full employment, price stability, economic growth, adaptation to technological advances, efficiency in the management of complex industrial organizations and international prosperity all receive high priority in the nation's agenda. The program in economics, based on the management core, enables students to analyze complex economic problems and to understand policies for their solution.

Modern economics is analytically rigorous. The curriculum for this option prepares the student to cope with the advances that have been made in this field of study. The program requires a background in mathematics, statistics and economic theory.

A degree in economics is suitable for students who wish to major in an academic discipline, as opposed to a professional discipline, at the undergraduate level. Students also obtain professional management training through the elective courses in management. The degree in economics provides an excellent background for graduate work in economics, other social sciences or management.

### Freshman Year

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1. Science—one year of science is required in chemistry, biology or physics (complete series).
2. Unless notified to the contrary, all I.M. students are expected to satisfy the mathematics requirement with the sequence Math. 1711-12-13. Students may use the sequence 1307-8-9, 2307-8 with approval of the dean of the I.M. college. Some students, based on their high school background, will be notified by the I.M. office that they may satisfy the mathematics requirement with Math. 1710-11-12. Transfer students into the college must consult with the I.M. office to determine their mathematics requirement at the time of transfer.

2. No student may receive credit for more than three hours of P.E. towards degree. See "Curricula and Degrees;" Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.

3. U.S. -Georgia History to be satisfied with one of the following: Hist. 1001, 1002, 3010, 3011.

4. U.S. -Georgia Constitution to be satisfied with Pol. 1251 or Pol. 3200.

5. One year required of approved nonsurvey engineering courses, science or advanced math not required by the core curriculum. Engineering orientation courses may not be used to fulfill the requirement.


7. Choice of two of the intermediate economics courses 3000, 3001, 3002.

8. Mgt. 3301, 3310, 3320, 3330, 4331 or 4335.

9. Mgt. 3100, 4100 or 4110.
### Sophomore Year

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Totals | 15-0-15 | 15-0-15 | 15-0-15 |

1 One year of science is required in chemistry, biology or physics. Must complete series in same area.
2 This mathematics requirement may be satisfied by one of the following sequences as determined by the student’s background from high school: Math. 1711, 1712, 171S; Math. 1307, 1308, 1711, 1713 or Math. 1307, 1308, 1309, 2305, 2306.
3 No student may receive credit for more than three hours of P.E. towards degree. See “Curricula and Degree Requirements,” Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.
4 One year required of approved (nonsurvey) engineering courses, science or advanced math not required by the core curriculum. Engineering orientation courses may not be used to fulfill the requirement.
6 May substitute any course taught by the I.M. college.

### Bachelor of Science in Management Science

The management science program is designed for the student who possesses strength and interest in applying mathematics to managerial problems. The program, based upon a foundation of applied mathematics and the institutional aspects of the modern business, develops analytic modes organized to allocate resources within the firm. The curriculum also contains a three-course sequence of specialization which permits the student either to concentrate in an area or to strengthen his or her theoretical foundation.

Graduates of the option will typically be employed as staff analysts in industry and government, as systems analysts or in a wide variety of positions where a high degree of analytic ability is required. The program also provides a strong base for graduate study in business, economics, management science, operations research and related areas.

### Freshman Year

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### Senior Year

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<td>Mgt. 4195</td>
<td>Integrated Management Problems</td>
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### Graduate Program

The College of Industrial Management offers graduate programs leading to the degrees of Master of Science in Industrial Management (M.S.I.M.), the undesignated Master of Science and the Doctor of Philosophy.

The Master of Science in Industrial Management program gives a professional management education to students with baccalaureate degrees in any discipline. Calculus is the only prerequisite. However, the program allows students without mathematical training to acquire these skills. The M.S.I.M. program requires 20 courses (normally 60 hours).

The curriculum is highly flexible, with only five specific required courses, and students may waive a maximum of three of these required courses by examination. The student also must choose seven courses from four broad categories. These are one course from the set The Internal Environment, one course from the set The External Environment, two courses from the set Analytical Methods and three courses from the set The Functional Areas. The eight remaining courses are free electives. The students can choose according to their needs and desires. This flexibility gives each student a unique curriculum directed to individual educational and career goals.

Fall entry is preferred but a student may enter the master's program in any quarter with few scheduling problems. The normal course load is four
courses each quarter, which allows the completion of the program in five consecutive quarters.

The M.S.I.M. program is accredited by the A.A.C.S.B. A student may also pursue a program of study at the master's level in which a curriculum is designed to meet his or her individual needs. The course requirements are specified during a conference between the student and the adviser. Individually designed programs must be approved in advance.

The doctoral program in the College of Industrial Management is designed to complement and reflect the technological emphasis of the institute. All doctoral students are required to acquire expertise in both teaching and research.

Comprehensive examinations, which include both a general and a special examination, are required of all doctoral students. The general examination will be given when the student completes one full year of graduate work, the special examination when the student completes his or her course work. The student will be admitted to candidacy after successful completion of the special examination and the approval of the prospectus of his or her dissertation. On completion of the dissertation the student will be required to take a final oral examination as prescribed in the general regulations of the graduate division.

College of Sciences and Liberal Studies

The College of Sciences and Liberal Studies comprises seven degree-granting schools and eight nondegree-granting departments. These units offer a range of courses in the sciences, humanities, physical education and ROTC sufficient to provide the student in any degree program ample opportunity to lay the foundations of a genuine education.

The degree programs in each of the sciences are described in detail under the appropriate school heading. These programs, both undergraduate and graduate, have been designed with sufficient flexibility to provide a strong base in the chosen discipline and accommodate a variety of career objectives. For example, a number of graduate programs in the life sciences are available in biology, chemistry, physics and psychology. These programs provide the student with the opportunity to take advanced courses in interdisciplinary areas and to undertake thesis research under the joint direction of faculty members from different departments. Interdisciplinary programs in biochemistry, biophysics, molecular genetics, microbiology and psychology are available, and the broad research interests of the life sciences faculty provide the student with a very wide choice of thesis problems.

Department of Air Force Aerospace Studies

Established in 1950

Professor and Head—Colonel James L. Priest; Assistant Professors—Major Willoughby G. Burns, Ill, Major Robert Greenberg, Captain Randall L. Lanning, Captain Timothy J. Monaghan.

General Information

Air Force Reserve Officer Training Corps (AFROTC) program is divided into two phases. The first two years constitute the General Military Course (G.M.C.) and the last two years, the Professional Officer Course (P.O.C.).

Four-Year Program

Students entering the four-year program enroll in AFROTC courses in the same manner in which they register for other undergraduate courses. A formal application is not required. Students enrolled in the G.M.C. incur no military obligation. Students must compete for entry into the P.O.C., which is normally taken during the last two years of college. Selection is based upon the results of an Air Force medical examination, an Officer Qualifying Test, SAT scores and an interview by a board of Air Force officers. Cadets normally attend a four-week field training session conducted at an Air Force base between their sophomore and junior years. Co-op students may attend field training after graduation. Students accepted for the P.O.C. become members of the Air Force Reserve and receive a $100 per month tax-free subsistence allowance.

Two-Year Program

The two-year program and the last two years of the four-year program are identical in academic content. The basic requirement for entry into this pro-
gram is that the student have two academic years remaining in school. This may be at the undergraduate or graduate level, or a combination of the two. Selection of two-year applicants is predicated upon the same criteria as four-year program cadets. In addition, candidates must successfully complete a six-week field training course at an Air Force base during the summer preceding their enrollment. Applicants enter the P.O.C. upon their return to campus.

**AFROTC College Scholarship Program**

AFROTC college scholarships are available to qualified cadets in the two- and four-year programs. Scholarships cover tuition, matriculation, health services, student activities fees and books. All scholarship cadets also receive a $100 per month tax-free subsistence allowance.

**School of Biology**

Established in 1960


**General Information**

Programs of study offered by the School of Biology are designed to lead to competence in this basic science. The institute, with its strength in science and technology, provides unique opportunities for training and research in biology. The curriculum encourages program enrichment by incorporating course selections from other schools and departments.

The Bachelor of Science degree program provides for a combination of requirements and electives that ensure the attainment of a broad background in biology with sufficient flexibility to satisfy a wide spectrum of individual interests and career objectives. The undergraduate curriculum in biology is well suited to prepare students for graduate study or for medicine, dentistry or other health profession schools.

Optional courses of study are available for the undergraduate degree providing for specialization in a biological field, or for bioengineering studies in biology and mechanics or in biology and electronics. The latter combinations lead to the undergraduate degree biomechanics option and electronics option respectively.

The School of Biology offers graduate work leading to the Master of Science degree. Programs are flexible and are designed to serve the specific needs of the student. Interdisciplinary programs involving other schools within the institute are encouraged.

Members of the faculty are actively engaged in such research fields as aerobiology, biophysics, cell physiology, mammalian physiology, tumor immunology, ecology, microbiology, microbial and population genetics and radiation cytogenetics. Areas of strength include biophysics, ecology, genetics, microbiology and physiology.

**Premedical—Graduate Preparation Curriculum**

**Freshman Year**

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<tr>
<th>Course No.</th>
<th>Subject</th>
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<th>3rd Q.</th>
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<tr>
<td>Biol. 2212</td>
<td>Introductory Biology</td>
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<td></td>
<td>4-3-5</td>
</tr>
<tr>
<td>Chem. 1111-2.2113</td>
<td>General Chemistry</td>
<td>4-3-5</td>
<td>4-3-5</td>
<td>3-3-4</td>
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<td>Eng. 1001-2-3</td>
<td>Introduction to Literature</td>
<td>3-0-3</td>
<td>3-0-3</td>
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<td>Math. 1307-8-9</td>
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<td>5-0-5</td>
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<td>0-4-1</td>
<td>0-4-1</td>
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<td>Electives $^6$</td>
<td>Free</td>
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**Sophomore Year**

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<td>Biol. 3332</td>
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<td>Biol. 3335</td>
<td>General Ecology</td>
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<td>Eng. $^3$ 2001-2-3</td>
<td>Survey of the Humanities</td>
<td>3-0-3</td>
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<td>Chem. 3311-2-3</td>
<td>Organic Chemistry</td>
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**Junior Year**

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<td>General Microbiology</td>
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<td>Biol. 3330</td>
<td>Cell Physiology</td>
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<td>Biol. 3334</td>
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<td>4-3-5</td>
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<tr>
<td>Electives $^4$</td>
<td>Modern Language or Social Science</td>
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<td>Electives $^6$</td>
<td>Free or Technical</td>
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<td><strong>Totals</strong></td>
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</tr>
</tbody>
</table>
Senior Year

The minimum total number of credit hours required for a bachelor's degree in biology is 200. In addition to the required courses and electives of the freshman, sophomore and junior years, the 46 hours of free and technical elective courses required to complete the curriculum for the bachelor's degree may be taken in the senior year.

1 See “Curricula and Degrees,” Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.
2 These free elective courses may be taken at any time during a student's course of study. However, if six credit hours of basic ROTC are elected, then it should be scheduled beginning in the first quarter of the student is enrolled.
4 Six three-hour social sciences courses or modern language courses acceptable for social sciences credit (see “Humanities and Social Sciences Requirements”) are required. It is recommended that at least two courses be taken in a single social sciences area, e.g., history, philosophy and history of science, etc., and at least three courses be completed in a given language.
5 Chem. 3511 (biochemistry) may be substituted for Chem. 3313 (organic chemistry).
6 Of the 66 hours of free and technical electives indicated above, 43 hours must be departmentally approved technical elective courses in biology, chemistry, mathematics, physics or engineering. At least 20 of these hours must be biology course offerings. All technical electives must be chosen in conference with a faculty advisor to provide a meaningful, interrelated group ancillary to a specific field of interest. The other 23 hours are free electives. Not more than nine hours of free electives in the junior and senior years may be advanced ROTC.

School of Chemistry

Established in 1906


General Information

Included in the school are courses in chemistry required for various engineering curricula, a curriculum leading to the degree of Bachelor of Science in Chemistry, graduate courses and research leading to the degree of Master of Science in Chemistry and Master of Science in Nuclear Science and graduate courses and research leading to the degree Doctor of Philosophy in Chemistry.

The degree Bachelor of Science in Chemistry will be awarded upon the completion of the following prescribed courses and 63 quarter hours of elective work. A student must have had the prerequisites for any course he or she elects.

A prerequisite for senior courses is a minimum grade point average of 2.0 in the following courses: Chem. 3311, 3312, 3313, 3381, 3382, 3385, 3411, 3412, 3413 and 3481.

The great number of free elective hours in the chemistry curriculum permits concentrated studies in premedical and predental requirements, minor options in geochimistry and T-4 certification in association with Georgia State University. Free electives may also include options in written and oral communication, business and management, information and computer science, biochemistry, environmental chemistry, geology and other areas.

The School of Chemistry also offers graduate programs for both the master's and doctoral degrees in the fields of analytical, biochemistry, inorganic, nuclear, organic and physical chemistry.

Active research fields include biophysical chemistry, Brillouin spectra, carbonation chemistry, catalysis, chemistry of natural products, electron-transfer reactions, enzyme chemistry, instrumental methods of analysis, mass spectrometry, mechanisms of organic, biological and inorganic reactions, molecular spectra and molecular structure, nuclear chemistry, nuclear magnetic resonance, organic synthesis, organometallic chemistry, photochemistry, quantum mechanics, radioactive exchange reactions, structures of complex inorganic compounds, surface phenomena, theoretical chemistry and thermodynamic properties.

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
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<td>Chem. 1111-2</td>
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<td>Math. 1307-8-9</td>
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Sophomore Year

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<td>Math. 2308</td>
<td>Calculus and Linear Algebra</td>
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Junior Year

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Totals: 14-6-16 15-6-17 16-0-16

Senior Year

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Totals: 15-6-17 14-6-16 15-0-15

¹ The School of Chemistry recommends that German be taken in the freshman year. However, if science is taken in the freshman year then German must be taken later.
² These free elective courses may be taken at any time during a student's course of study. However, if six credit hours of basic ROTC are elected, ROTC should be scheduled for the first two quarters of the student's enrollment.
³ Electives, free: of the total free electives in the chemistry curriculum, at least 18 hours of science, selected from the College of Sciences and Liberal Studies listing in “Information for Undergraduate Students,” must be taken.
⁴ May be taken in the junior year.

General Information

At the freshman-sophomore level the Department of English offers a six-quarter series of courses devoted to the study of language and literature and to intensive practice in composition. The freshman courses stress the relationship between content and form; the sophomore courses emphasize the humanistic values of literature in Western culture. The practice in composition stresses logical thinking, proper organization of material, effective use of evidence, and clarity and precision of expression.

The department offers elective courses in both written and oral communication and in literature and language. The courses in communication include practical training in public speaking and in various kinds of writing that are useful in science, business and industry. The electives in literature cover a variety of approaches: major writers since the Renaissance studied in the scientific and philosophical context of their times, types of literary form, thematic approaches and seminars in individual writers. Credit in drama is granted for participation in productions of DramaTech, the student drama club.

Because of the great need for architects, engineers, industrial managers and scientists who are especially skilled in professional communication, the department offers a program leading to a Certificate in Technical and Business Communication. This certificate is awarded upon completion of Engl. 3008, 3015, 3019, 3023 and 3024 with at least a C grade. The order of these courses may be varied, except that 3015 must be taken before 3019 and 3023 must be taken before 3024. Attainment of this certificate qualifies the student for positions requiring a high level of ability in written and oral communication. Detailed information about this program may be obtained from the English Department office.

A special two-year program in the English language, composition and American literature is offered for students whose native language is other than English. Four of these courses—Engl. 1033, 2031-2-3—are classified as courses in the humanities.

Students who score sufficiently high on the Advanced Placement Examination administered by the College Entrance Examination Board are given credit for certain freshman-sophomore courses. A number of students in units whose curricula do not require Engl. 1001-2-3 and whose scores on the College Board SAT-Verbal and the English Achievement examinations are sufficiently high are given the option of waiving one or more of the freshman courses as prerequisites to enrollment in the upper-level courses offered by the department.

Department of English

School of Geophysical Sciences

Established in 1970


General Information

The School of Geophysical Sciences offers graduate study programs for those interested in understanding the earth and man's physical environment. The programs lead to the degrees Master of Science and Doctor of Philosophy. The term geophysical sciences is used in the broadest sense to include both physical and chemical studies of the earth, its waters and its atmosphere. Special emphasis is given to studying man's modification of the environment. Through joint research with engineers, students can relate their basic scientific studies to the solution of environmental problems.

Persons with a bachelor's degree in geology, meteorology, atmospheric science, chemistry, physics, mathematics, biology or engineering may be admitted to the graduate program. Individual programs of study will be tailored to each student's background and interests.

Present areas of specialization include geophysics, geochemistry, mineralogy, sedimentology, environmental geology, atmospheric dynamics, atmospheric physics and atmospheric chemistry. Interdisciplinary studies can be carried out in such areas as crystallography (crystal physics), geohydrology, engineering geology, nuclear geochemistry, organic chemistry, environmental studies and energy-meteorology relationships.

Research and study in oceanography are conducted in cooperation with the staff of the Skidaway Institute of Oceanography at Savannah, Georgia. Many of the staff members from both institutions hold joint appointments. Students desiring to do so may spend a significant portion of their time at Skidaway.

Undergraduate Program

The geophysical sciences are multidisciplinary with a strong dependence on the basic physical sciences, engineering and mathematics; therefore, undergraduate students interested in the geophysical sciences should work toward a bachelor's degree in one of these disciplines. An undergraduate enrolled in another Georgia Tech school may develop a substantial background in the geophysical sciences by proper choice of electives within his or her own degree program. For example, a specific set of upper-level courses is recommended for physics majors who are interested in geophysics.

A certificate program is available for students who desire formal recognition having taken a systematic series of courses in the geophysical sciences. Certificates are available for coursework in three areas: geochemistry, geophysics and engineering geology. Detailed listings of the requirements for these certificates are available in the office of the School of Geophysical Sciences.

A student may elect to pursue an undesignated bachelor of science degree under the direction of the faculty of the School of Geophysical Sciences.

Masters Degree Programs

Graduate study will be tailored to the background and interests of each student entering the School of Geophysical Sciences. In order to pursue the courses which may be accepted as part of a graduate study program in geophysical sciences, most students will need a background which includes introductory geology and a minimum of one year of university-level courses in mathematics, chemistry and physics. Some remedial work without graduate credit will be required of students who enter without this background.

In order to qualify for the degree Master of Science in Geophysical Sciences, a student must have completed a specific set of undergraduate courses in geophysical sciences. In addition, except for those students specializing in the atmospheric sciences, a geological field study requirement must be met. Completion of an approved thesis is required of all students who are to be awarded the degree Master of Science in Geophysical Sciences.

Students who wish to include more course work in a special technical area may be permitted to pursue a program of study which does not meet all the requirements for the designated master's degree. Such a program of study, approved by the faculty of the school, will lead to the degree Master of Science.

Doctoral Program

Persons with a strong background in the basic sciences and mathematics, who show a capability for high achievement in research in the geophysical sciences, may enter a program of study leading to the doctoral degree. A wide range of individual programs are available, owing to the multidisciplinary nature of the geophysical sciences. Except for those students specializing in the atmospheric sciences, a geological field study requirement must be met.

School of Information and Computer Science

Established in 1963

Acting Director—Henry S. Valk; Professors—Lucio Chiaraviglio, Philip H. Enslow, Jr., James Gough, Jr., Vladimir Slamecka, Pranas Zunde; Associate Professors—Richard A. DeMillo, Nancy A. Lynch, Philip J. Siegmann, T. C. Ting; Associate Professor—Librarian—Frances E. Kaiser; Assistant Profes-
General Information

The goal of the discipline of information and computer science is to enhance the problem-solving ability of man's mind by designing information processing automata and systems and delegating to them some of the functions of the human mind. During the last decade the use of computers has become indispensable in science, engineering, management, health care, education and other advanced professions. Many believe that in the near future information processing will become the nation's largest industry, that its disciplines will be centrally important in both science and society.

Georgia Tech's School of Information and Computer Science reflects this growth and potential. Established in 1963, with the sponsorship of the National Science Foundation, it was the world's first academic program in information science. Today the school is one of the largest graduate departments of the institute and is among the largest computer science schools in the United States. It offers the bachelor's, master's and doctoral degrees in information and computer science for professional and research careers in many areas of specialization. Of particular note is the school's degree program in biomedical information processing, offered jointly with the Emory University School of Medicine. In addition to its degree programs, the school also offers carefully designed computing course sequences for students in other majors.

I.C.S. students have free access to the school's extensive laboratories. These include a computer systems laboratory (which houses two PRIME 400s, a PDP 11/70, a large PDP 11/45, a PDP 11/20, a PDP 8/1, a GT-40, a NOVA 2/10, and a wide array of special information processing devices), a computer design laboratory and a human information processing laboratory. Other computing resources available to students of the school are the CYBER 70-Model 74-28 and CDC 6400 computers in the Georgia Tech Office of Computing Services.

Details of the academic and research programs of the school are described in brochures available upon request.

Undergraduate Program

The undergraduate program, established in 1972, leads to the designated degree of Bachelor of Science in Information and Computer Science. It provides comprehensive education in information and computer science and is hospitable to multidisciplinary career objectives. The program has two primary directions. The first is the acquisition of marketable knowledge and skills for professional careers in areas such as computer and communications systems design, programming languages and information systems design. The second direction prepares students for theory-oriented graduate work in information and computer science.

A total of 193 credit hours are required for graduation. The 42 hours of electives include up to 24 hours of course work in the areas of curricular emphasis.

Freshman Year

<table>
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<tr>
<th>Course No.</th>
<th>Subject</th>
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<td>Information and Society</td>
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<td>Chem. 1101-2</td>
<td>General Chemistry</td>
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<td>Engl. 1001-2-3</td>
<td>Analysis of Literature</td>
<td>3-0-3</td>
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<tr>
<td>Math. 1307-8-9</td>
<td>Calculus I, II, III</td>
<td>5-0-5</td>
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<td>Physical Education</td>
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<td>Electives⁴</td>
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Sophomore Year

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<td>Introduction to Discrete Structures</td>
<td>3-0-3</td>
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<td>I.C.S. 2250</td>
<td>Technical Information Resources</td>
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<td>Computer Programming</td>
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<td>I.C.S. 2600</td>
<td>Computer Organization and Programming</td>
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<td>I.C.S. 3113</td>
<td>Information Structures and Processes</td>
<td>3-0-3</td>
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<td>Econ. 2000-1</td>
<td>Principles of Economics I, II</td>
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<td>Math. 2307</td>
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<td>Math. 2308</td>
<td>Calculus V</td>
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<td>Phys. 2121</td>
<td>Particle Dynamics</td>
<td>4-3-5</td>
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<td>Phys. 2122</td>
<td>Electromagnetism</td>
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<td>Phys. 2123</td>
<td>Optics and Modern Physics</td>
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<td>Electives⁶</td>
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**Junior Year**

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<td>I.C.S. 3140</td>
<td>Introduction to Discrete Systems</td>
<td>3-0-3</td>
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<tr>
<td>I.C.S. 3150</td>
<td>Introduction to Mathematical Logic</td>
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<td>I.C.S. 3155</td>
<td>Introduction to Theory of Computing I</td>
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<td>3-0-3</td>
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<tr>
<td>I.C.S. 3342</td>
<td>Intro. to Computational Linguistics</td>
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<td>3-0-3</td>
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<td>I.C.S. 3422</td>
<td>Survey of Programming Languages</td>
<td>3-0-3</td>
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<td>I.C.S. 3600-1</td>
<td>Computer Systems I, II</td>
<td>3-0-3</td>
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<td>I.C.S. 3610</td>
<td>Computer Logic Design</td>
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<td>Math. 3215</td>
<td>Problems in Probability and Statistics</td>
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<td>Psy. 3303-4</td>
<td>General Psychology A, B</td>
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**Totals**

15-0-15 17-0-17 15-0-15

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**Senior Year**

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<td>I.C.S. 4120-1</td>
<td>Intro. to Information Processes I, II</td>
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<td>I.C.S. 4155</td>
<td>Introduction to Theory of Computing II</td>
<td>3-0-3</td>
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<td>I.C.S. 4300</td>
<td>Information Systems Computing</td>
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</table>

**Totals**

15-0-15 15-0-15 15-0-15

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1 With the consent of the school, these courses may be substituted for by other empirical science courses relevant to the student's program.

2 These courses apply toward satisfaction of one of the 18 hour humanities requirement stated in "Information for Undergraduate Students.

3 All students must complete three credit hours in physical education courses. Unless medically disqualified, all students must take another course at that level to substitute for the exempted course. Only students who are medically exempt from all "activity" P.E. courses may satisfy the requirement with P.E. 1040. Students who are 25 years of age or older upon matriculation have the option of completing the regular P.E. requirement or using P.E. 1040 to satisfy the requirement. A maximum of three credit hours of physical training may be applied toward the bachelor's degree.

These courses apply toward satisfaction of the 18 hour social sciences requirement stated in "Information for Undergraduate Students.

**Professional Graduate Program**

The objective of this one-year graduate program is to offer career education in the area of computer science in the department of Information and Computer Science. Graduates of this professional program qualify for senior technical and management careers in the information processing industry and for appropriate positions in government, health care, education, and the military.

To earn the master's degree, students must complete at least 50 quarter hours, of which a minimum of 35 must be in courses at the 6000-8000 level and earn at least a B+ /4.0 grade point average. A master's thesis, equivalent to 17 credit hours of graduate course work, is required of all students holding a bachelor's degree in information and computer science from the Georgia Institute of Technology (or a comparable degree from another institution). Students holding undergraduate degrees in quantitative fields other than computer science such as mathematics, the physical and natural sciences, engineering or the medical sciences, need not write a thesis. The four-year program begins in the fall quarter and its flexible curriculum draws on over 30 graduate-level courses in applied information, computer and systems science. Typical curricula in this program include courses in systems design, computer software, computer systems, information processing applications, management science, operations research, numerical analysis, industrial psychology and the social sciences.

Students applying for admission to the professional master's degree program must have earned a bachelor's degree from an accredited institution. While the undergraduate major is not specified, the prospective student's preparation should include substantial work in mathematics, at least through calculus, differential equations, set theory and introductory probability and statistics. Computing competence of the entering students should include knowledge of programming, data structures, and computer systems hardware and software. Students having weaker backgrounds are expected to enter the school in the preceding summer quarter (or earlier) to take the course work necessary to meet admission requirements.

**Doctoral Program**

The doctoral program in the School of Information and Computer Science prepares exceptionally qualified individuals for research, academic and policy-level management careers. The degree of Doctor of Philosophy is...
awarded by the Georgia Institute of Technology for independently conducting an original study resulting in a significant contribution to the discipline's body of knowledge, or in innovative applications of existing knowledge that have an important impact on the field.

The doctoral program normally requires at least three years effort. The first year of residence is devoted to the student's formal preparation in the foundations of the discipline and its branches, his or her demonstration of creative problem solving and a commitment to one of the major areas of the discipline as a research domain. The second phase of the doctoral program stresses continued study and guided research leading to the formulation of a thesis project. Thesis research and the dissertation defense complete the doctoral program.

Students applying for admission to the doctoral program should offer evidence of exceptional scholastic ability, intellectual creativity and research motivation. Preferable undergraduate preparation includes computer science, mathematics or other disciplines of science or engineering that encourage mathematical formalisms and experimental methodology. The students are assumed to be competent in the use of computers.

Research Opportunities
Involvement in the school's active research efforts is an important part of a student's education. One such effort, a many-faceted study of fully distributed processing systems, is supported by projects on decentralized control, interprocess communication, task distribution, portability by means of abstract machines, development of an appropriate abstract-based programming language and theory with emphasis on modeling, performance measurement and analysis of algorithms. Other on-going projects involve program testing, complexity theory, design of software engineering tools for microprogramming, human factors aspects of interactive computing, natural algorithms in human problem solving, development of intelligent systems that plan, infer, learn and understand natural language, knowledge-based systems for medical consulting, global communications facilities for technology transfer, pragmatic measures of information quality, empirical foundations of information science, modeling of information systems, and optimal utilization of information resources.

Graduate Programs
In Biomedical Information and Computer Science
In 1972, the Georgia Institute of Technology introduced pioneering graduate degree programs in biomedical information processing, intended for persons seeking interdisciplinary careers in the milieu of health care and medicine. The programs are offered jointly by the School of Information and Computer Science and the Emory University School of Medicine, with support of the National Institutes of Health.

The degree requirements, formats and standards of the graduate programs in biomedical information and computer science parallel the regular graduate programs of the School of Information and Computer Science. The professional program, leading to the degree of Master of Science in Information and Computer Science, emphasizes the engineering design of advanced information processing applications and systems in health care. The research program leading jointly to the doctoral degree in information and computer science and (presently) the Master of Science degree in Medical Science (the latter awarded by Emory University), stresses information-based studies relevant to biomedicine and health care. The curricula of both programs include substantial course work and internships at the Emory University School of Medicine, its clinical laboratories and affiliated hospitals.

These programs should prove attractive to two groups of persons seeking professional or research careers in biomedical information processing: recent college graduates in the natural or premedical sciences and engineering and persons holding advanced degrees in medicine. As a minimum, applicants for admission must have earned a bachelor's degree from an accredited institution and should show evidence of their ability and motivation to pursue advanced work in biomedical information and computer science. While the undergraduate major is not specified, all applicants seeking admission to these programs should have preparation in mathematics and in the use of computers.

Details of the program are described in a special brochure available upon request.

Elective Mini-Curricula
Computing competence is rapidly becoming an indispensable skill for all learned professions; consequently, quality education in science, engineering and management increasingly emphasizes formal instruction in computing. The School of Information and Computer Science offers all Georgia Tech students, regardless of major, elective course sequences in computing specifically designed to support the objectives of their future professions.

Four elective mini-curricula are offered for undergraduate students: computing for science and engineering, computing for industrial management, computer systems and information systems.

The core of these mini-curricula consists of four courses which emphasize digital computer organization, computer programming, data structures and information processing.

The first two mini-curricula serve students interested in the application of information processing and computing techniques to their respective field of knowledge or professions; the last two should appeal to students having deeper interest in applied information and computer science and those who may be leaning towards graduate work in this field. Detailed course schedules are available from the School of Information and Computer Science office.

Information, computer and systems science is an appropriate minor field of study for the doctoral students of the institute. Graduate students majoring in other departments of the institute are encouraged to formulate, in consultation with their advisers and I.C.S. faculty, programs of study that include formal training in computing tailored to their educational objectives.
School of Mathematics

Established in 1952


General Information

Mathematics provides the common language of science and is thus of fundamental importance in virtually all areas of science and technology. The School of Mathematics offers a wide range of service courses for students of science, engineering and management. It also offers work leading to the bachelor’s, master’s and doctoral degrees in mathematics. In addition to preparing a student to be a professional mathematician, an education in mathematics can provide an excellent preprofessional preparation or foundation for further work in other mathematically-oriented disciplines.

Undergraduate Program

No more than six hours of physical education course work may be counted toward graduation. Only free electives in the degree program may be taken under the pass/fail option and no more than 12 hours are allowed under this option.

In addition to the institutional requirement of at least a 2.0 grade point average for the entire academic program, the School of Mathematics requires a 2.0 grade point average in all mathematics courses at or above the 3000 level which are designated by number in the program.

Freshman Year

<table>
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<tr>
<th>Course No.</th>
<th>Subject</th>
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<tr>
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<td>Calculus I, II, III</td>
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<td>Engl. 1001-2</td>
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<tr>
<td>Phys. 2121</td>
<td>Particle Dynamics</td>
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Electives

Free

Physical Education

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Sophomore Year

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<th>3rd Q.</th>
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<td>Calculus IV, V</td>
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<td>Math. 3308</td>
<td>Differential Equations</td>
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<td>Elective</td>
<td>I.C.S. 1700 or E.E. 1010, Introduction to Computer Programming</td>
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<td>Math. 3110</td>
<td>Introduction to Higher Algebra</td>
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<td>Math. 3215</td>
<td>Probability and Statistics</td>
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<td>Phys. 2122</td>
<td>Electromagnetism</td>
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<td>Phys. 2123</td>
<td>Optics, Modern Physics</td>
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<td>Elective</td>
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Junior and Senior Years

1. Math. 4101, 4301, 4311, 4312, 4313, 4320 ........................................... 23 hours
2. Phys. 3121 ................................................................. 5 hours
3. Course work at or above the 3000 level in a degree granting school other than mathematics ........................................... 6 hours
4. Mathematics courses at or above the 4000 level, including at least two sequences and subject to the following restrictions. (a) At least 12 hours, including a sequence, shall be chosen from (i) probability, statistics and stochastic processes; (ii) differential equations; (iii) numerical analysis and optimization; and (iv) mathematical models. (b) Not all the courses in (a) shall come from the same area. (c) Math 4391 and 4392 may not be included ........................................... 21 hours
5. Humanities and social science courses. The degree program must include at least one year sequence in a modern language, or nine hours of English beyond Eng. 1001-2-3 ........................................... 24 hours
6. Free electives ................................................................. 18 hours

Total 97 hours

1 See “Curricula and Degrees,” Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.
Graduate Programs
A program of study for the master's degree should include Math. 6310, 6320, 6330 and at least one of the following courses: Math. 6510, 6520 or 6530. In addition, six hours of course work at the 3000 level or higher should be taken outside of the School of Mathematics. The program should also include either a thesis (17 hours) and seven additional hours of course work at the 4000 level or higher or 24 hours of course work at the 4000 level or higher, including nine hours of concentration in some field of mathematics, three hours in numerical analysis and three hours in probability, statistics or stochastic processes (provided that the student has not previously had such training) and a sufficient number of hours at the 6000 level or higher to insure that the program includes a total of at least 35 hours at this level.

A grade point average of at least 2.7 in the mathematics courses in the program of study and a grade of C or better in each mathematics course in the program of study are required.

Before admission to candidacy for the master's degree, each student should pass an oral comprehensive examination.

Most applicants holding the bachelor's degree are urged to enter the master's degree program before seeking admission to the doctoral program.

Prospective candidates for the doctoral degree are required to complete 77 hours of course work beyond the undergraduate degree. Of these 77 hours at least 30 hours must be taken in certain specified areas of mathematics including those subjects required for all students in the master's degree program. Fifteen of the 77 hours must be taken outside the School of Mathematics and constitute the student's minor field of study.

A grade of C or better is required in each course to be counted toward the total of 77 credit hours and a grade point average of 2.7 is required in the minor courses.

Prior to admission to candidacy for the doctoral degree, each student must pass comprehensive examinations in each of four areas of mathematics selected in part by the student.

Doctoral candidates must demonstrate a reading knowledge of two languages chosen from French, German and Russian, and satisfy the institute requirements with respect to the dissertation and final oral examination.

Department of Military Science
Established in 1917
Professor and Head—Colonel Wayne B. Davis; Assistant Professors—Major Arnold T. Bratcher, Michael A. Canavan, Captains Lawrence D. Hester, John C. Carson, Charles W. Stewart, Jr.

General Information
The purpose of the Army officer education program is to provide well educated leaders and decision makers for service as commissioned officers in the Army of the United States.

The program was designed to foster understanding of the Army role in national security and society; to provide a perspective of the officer's responsibility within that environment; and to provide the leadership and military management education required to function effectively in a competitive, highly technical, dynamic decision-making environment. Commissions are awarded upon graduation. Newly commissioned officers are ordered to active duty involving aviation, engineering, research and development, electronics-communications, or other selected specialties.

A graduate choosing a non-military career may be awarded a commission in the Reserve Forces with service in the vicinity of civilian employment. The Department of Military Science offers instruction in both the two-year and the four-year programs. The four-year program consists of the basic course and the advanced course, each of two years duration. The two-year program is open to both undergraduate and graduate students who may enter the advanced course directly after attending a six week basic camp in lieu of the basic course. The two-year program is also open to students who qualify for exemption from the basic course as a result of prior military service, adequate participation in a Junior ROTC program in high school or compression at Georgia Tech.

Students who have met the above requirements for the basic course or its equivalent may be selected by the professor of military science for entry into the advanced course if they demonstrate leadership potential, pass qualifying exams and have six academic quarters remaining. Once selected to the advanced course, the student must meet course requirements including attendance at a five week advanced camp and acceptance of a commission, if offered. Students in the advanced course are given a tax free subsistence allowance of up to $1000 per year and are paid while attending the five week advanced camp at the rate of one-half the basic pay of a second lieutenant. Active duty may be delayed to pursue an advanced degree. ROTC cadets who meet special requirements may apply for a commission in the regular army.

Army ROTC College Scholarship Program
College scholarships are available to highly qualified students enrolled in the program. Competition is based on SAT or ACT scores, academic record, extracurricular activities and leadership potential. Scholarships include full payment of tuition, fees, health services, text books and supplies, and up to $1000 per year for a period not exceeding four years.

The Basic Course Curriculum
The basic course consists of six military science courses selected from the following course offerings.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Credit Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S. 0110</td>
<td>Competitive Marksmanship (1-1-0)</td>
<td>0</td>
</tr>
<tr>
<td>M.S. 0120</td>
<td>Survival Techniques (1-1-0)</td>
<td>0</td>
</tr>
<tr>
<td>M.S. 0130</td>
<td>Ranger Company (1-1-0)</td>
<td>0</td>
</tr>
<tr>
<td>M.S. 0140</td>
<td>Drill Team/Honor Guard (1-1-0)</td>
<td>0</td>
</tr>
<tr>
<td>M.S. 0150</td>
<td>Orienteering (1-1-0)</td>
<td>0</td>
</tr>
<tr>
<td>M.S. 1040</td>
<td>Leadership Development (0-1-0)</td>
<td>0</td>
</tr>
<tr>
<td>M.S. 1100</td>
<td>Orientation: The Military Role in Perspective (1-1-1)</td>
<td>1</td>
</tr>
</tbody>
</table>

Required first course
The Advanced Course Curriculum

The advanced course consists of six military science courses and three elective courses. One each in physical education, history, and political science. The three elective courses may be taken at any time during the student's four years of study, but must be successfully completed for the student to receive credit for advanced course completion.

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Credit Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S. 1200</td>
<td>Terrain Analysis and Land Navigation (1-1-1)</td>
<td>1</td>
</tr>
<tr>
<td>M.S. 2020</td>
<td>Military Skills (1-1-0)</td>
<td>0</td>
</tr>
<tr>
<td>M.S. 2040</td>
<td>Leadership Development (0-1-0)</td>
<td>0</td>
</tr>
<tr>
<td>M.S. 2200</td>
<td>Seminar in Communications and Instructional Methods (2-1-2)</td>
<td>2</td>
</tr>
</tbody>
</table>

Total: 4

Department of Modern Languages

Established in 1904


General Information

The varied course offerings of the Department of Modern Languages provide students with opportunities for achieving reasonable fluency in writing, reading, speaking and understanding several foreign languages. Further, they instruct students in the technical and scientific literatures of those languages and in the civilizations and bellettristic literatures of the countries in which those languages are spoken.

Although the department does not offer a degree or "major," certificates or "minors" are available in French, German, linguistics and Spanish. Eighteen credit hours are required for a certificate in any of the four aforementioned options, fifteen hours of which must be on the 3000-level or above.

Students should consult the department for additional details. Students may take any courses for which they have the prerequisites as specified in the catalog descriptions. Counseling and placement examinations are available on request. Usually two years in high school equal one year at Tech. Each course is essentially a unit in itself, but beginning students are encouraged to pursue at least the elementary three-quarter sequence in order to achieve a minimum level of proficiency. Students are not permitted to enroll without departmental consent in 1000-level courses after the successful completion of any 2000, 3000 or 4000-level course. Students who take courses in their native language must schedule courses in no lower number than Fren. 3001, Ger. 3001 or Span. 3007.

Since 1001-2-3 courses are offered each quarter in French, German and Spanish, co-ops can select an elementary series in any of these languages without scheduling problems. Since each course on the 2000, 3000 and 4000-level is a unit in itself, students may omit a course in an apparent series without suffering academic disadvantages or penalties.

With minor exceptions students can fulfill their 36-hour humanities and social science requirements for graduation by taking courses, including linguistics courses, in the Department of Modern Languages. Students should consult the course catalog descriptions and the section of this catalog entitled "Humanities and Social Science Requirements" on p. 21, in order to determine which courses are classified as humanities and which are classified as social sciences in their respective colleges. With the approval of students' major departments any courses offered by the Department of Modern Languages may be taken on a pass/fail basis.

College Credit for High School Study

Nine hours of elective credit in French, German or Spanish, or 12 hours in Russian will be granted for high school study in a foreign language provided the student has two or more years of high school credit (or the equivalent) in the language in question and has completed nine quarter hours at the 2000, 3000 or 4000-level with a grade of C or better. Transfer students must complete at least three of the nine hours at Georgia Tech.

Credit for high school study in a foreign language will not be granted to students who speak the language in question as their native language or to
students who have taken 1000-level courses or the equivalent at Georgia Tech or at other college-level institutions.

To have this elective credit entered on their records, students must request that the appropriate form be submitted by the Department of Modern Languages to the registrar. This elective credit is not applicable toward fulfillment of the 36-hour social sciences and humanities requirements for graduation. No grade is attached to this credit.

Graduate Language Requirements

The Department of Modern Languages currently serves the institute by providing training in foreign languages and by administering, during each quarter of the regular academic year, the foreign language examinations that are among the options for satisfying the foreign language requirement of the Graduate Division. This training is available to all undergraduate and graduate students through the 1001-2-3 series of courses in the various disciplines offered by the department. It is also available to all graduate students, to all upper divisional undergraduates and—with the consent of the department—to exceptional lower divisional undergraduates, through the following five series of courses:

Fren. 4075-6-7—Intensive Readings in French,
Ger. 4075-6-7—Intensive Readings in German,
Russ. 4075-6-7—Intensive Readings in Russian,
Span. 4075-6-7—Intensive Readings in Spanish and
Ling. 4075-6-7—Comparative Analysis of Major European Languages.

For additional information, see page 46.

English for Foreign Students

The department also serves the institute by providing instruction in English as a foreign language, offered through programs in intensive English for international students (elementary, intermediate and advanced levels) usually under the auspices of the Department of Continuing Education. The prerequisite is two years of high school English or the equivalent. Included in the program are grammar, pronunciation, sentence patterns, vocabulary, building, spelling, reading, theme writing and group and individual practice in the language laboratory. These intensive courses of 25 hours per week are offered during all four quarters. Pursuant to specific requests, special programs and schedules are developed and offered to complement programs of study in engineering and science.

For further information write Dr. Louis J. Zahn, Department of Modern Languages, Georgia Institute of Technology, Atlanta, Georgia 30332.

Department of Music

Department Head and Director of Choral Activities—Gregory Colson; Director of Bands—Kenneth Durham; Conductor of the Jazz Ensemble—Douglas Richards.

General Information

Musical activities at Georgia Tech center around three enthusiastic and well-known performing groups: band, chorale and jazz ensemble. The band meets three afternoons a week, the chorale and jazz ensemble meet twice a week and all three organizations give academic credit. Planning is done with awareness of other demands upon Tech students so that a great amount of musical experience is concentrated into a limited time.

The marching band is known nationally as a result of its smart formations and dynamic sound in television performances at both bowl and regular season football games and trips for out-of-town games provide an extra reward for members. As a change of pace, during the winter and spring quarters the concert band studies and performs a broader instrumental repertoire with emphasis on basic theory, contrasting musical styles and periods, as well as baton technique of student conductors.

The chorale, an eighty-voice singing group which combines the well-known men’s glee club with the newer women’s chorus, undertakes an ambitious series of classical, sacred and popular-music performances on campus, in the Atlanta area and in neighboring states on a spring-break tour. They have recently been featured with the Atlanta Lyric Opera Company at the Fox Theatre, in concerts of sacred masterworks with members of the Atlanta Symphony and in Pops concerts with combos and the jazz ensemble. The thorough-going approach to music history, theory and vocal technique allows chorale members to earn humanities credit.

The jazz ensemble, although new at Georgia Tech, has shown tremendous growth and has established a strong reputation through numerous local appearances. After meeting the prerequisite of a satisfactory audition, members are involved in rehearsals, lectures and discussions, listening sessions and performances, resulting in a wide background of theory, history and literature within the jazz idiom.

Department of Naval Science

Established in 1926

Commanding Officer and Professor of Naval Science—Captain George M. Henson, USN; Associate Professor—Commander Hugh C. Embry, USN; Assistant Professors—Major U. S. Grant, USMC; Lieutenant William J. Willkie, USN; Lieutenant James D. Selman, USN; Lieutenant John A. Stockton, USN; Lieutenant David D. Pruett, USN; Lieutenant Keith R. Larson, USN.

General Information

The naval officer education program offers students the opportunity to qualify for service as a commissioned officer in the U.S. Navy or U.S. Marine Corps. The program consists of a standardized curriculum designed to complement and assist academic pursuits through imparting knowledge of the naval environment and fostering an understanding of the role of the Navy in national security. Upon graduation, the student is commissioned and ordered to active duty involving flying, nuclear propulsion, surface warfare or to a staff specialty.
Students in the program are enrolled in one of the three categories outlined below. The college program can be entered as a beginning freshman or, upon qualification, prior to April 1 of the sophomore year. Qualified sophomores attend eight weeks active duty schooling during the summer before their junior year so as to join on an equal footing their classmates in the junior year course in naval science. All college program students are under constant consideration for award of a scholarship. An orientation period for all new NROTC students is conducted during registration week prior to the fall quarter.

**Scholarship Students**

Scholarship students are appointed midshipman, USNR, after nationwide competition. They have their tuition, fees and textbooks paid for by the Navy for a period not exceeding four years, are uniformed at government expense and receive retainer pay at the rate of $100 per month. Students must obligate themselves to complete the prescribed naval science curriculum, to make a cruise of from six to eight weeks each summer, to accept a commission as Ensign, USN, or Second Lieutenant, USMC, upon graduation, and to serve on active duty for four years after commissioning unless released earlier by the Navy Department. At the end of this period their active duty obligation to the Navy or Marine Corps is fulfilled. If they do not desire to remain on active duty in the regular Navy or Marine Corps, they are ordered to inactive duty in the Navy or Marine Reserve.

**College Program Students**

College program students, enrolled under the provision of Public Law 88-647, are uniformed at government expense and, during their junior and senior years, receive retainer pay of $100 per month. They must complete the prescribed naval science curriculum, make a cruise of approximately six weeks during the summer after the junior year, and upon graduation accept a commission as Ensign, USNR or Second Lieutenant, USMC.

In consideration for the benefits accrued by reason of membership in the NROTC college program, prior to starting the junior year the student is required to enlist in the U.S. Naval Reserve for a period of six years. The student must agree to serve on active duty for not less than three years after appointment to commissioned rank in the U.S. Naval Reserve or Marine Corps Reserve and to retain that commission until the sixth anniversary of receipt of original commission. After receiving their commissions, college program students may apply for commission in the regular Navy or Marine Corps.

**Naval Science Students**

Any regularly enrolled undergraduate student may enroll as a naval science student. Those enrolled as naval science students take naval science courses as electives and have no contract with the Navy. They have no assurance of ultimate commissioning nor do they derive any of the financial benefits available to scholarship and college program students.

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### Selection Procedure

Scholarship students are selected in nationwide competition based on SAT or ACT scores. The NROTC at Georgia Tech has no part in this selection although information about the scholarship program is available.

The professor of naval science may annually nominate several college program students to the Chief of Naval Education and Training for a scholarship. To apply for the college program, a student must be enrolled at Georgia Tech or attending an accredited college or university in the near vicinity and be at least 17 and not over 21 years of age. Applicants are selected to fill the quota based on physical qualifications, interview by naval officers, score on SAT and high school record. Applicants for the college program should apply at the Naval Armory during the designated days of freshman orientation week for the fall quarter.

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### Curriculum

In addition to the required naval science courses, all navy option students must take calculus (Math. 1307-9 or Math. 1711-3), physics (Phys. 2111, 2121 or 2141 series) and if not majoring in engineering, math, physics or chemistry, one course from I.C.S. 1700, Phys. 2122 or Phys. 3141. All marine option students must take Pol. 3203 and Pol. 3204 or a substitute approved by the professor of naval science.

No more than six hours of credit in basic naval science courses and no more than nine hours of credit in advanced naval science courses will be applied toward a degree.

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### Department of Physical Education and Recreation

Established 1942

**Department Head and Professor**—James A. Reedy; **Associate Professors**—Bill D. Beavers, Byron A. Gilbreath, John C. Hyde, James H. McAuley, Tommy Plaxico; **Assistant Professors**—Carlos E. deCubas, James P. Culpepper, Jr., Douglas L. Fowlkes, David W. Houser; **Instructor**—Hoylene Noble.

### General Information

The Department of Physical Education and Recreation seeks to provide opportunities to develop new skills and gain information that will allow the student to lead a healthier and more productive life. Students who have completed their physical education requirement are encouraged to elect additional courses of interest.

The majority of activity and skills courses are scheduled on two alternate days per week, meeting two hours per day.

### The Physical Education Requirement

All students entering Georgia Tech are required to satisfactorily complete three credit hours of physical education courses. It is expected that this requirement will be completed during the student's freshman year. Unless
medically disqualified, all students will be required to complete swimming
(P.E. 1010) plus two additional courses. One of these must be selected from
the remaining courses at the 1000 level, and one must be selected from the
2000 level.

The health information record will determine any medical exemptions
from physical education courses. All certificates of disability from personal
physicians must be endorsed by the Student Health Services before they
will be accepted by the department.

Students who are exempt for medical reasons from all physical education
activity courses will be required to satisfactorily complete P.E. 1040 (Health
Education) to complete their physical education requirement. Students who
are medically exempt from a single 1000-level course including swimming
must substitute an additional 1000-level course in its place.

Transfer students will be granted credit for comparable physical education
courses completed at other institutions.

Students who are 25 years of age or older upon matriculation to the insti-
tute have the option of satisfying the physical education requirement for
graduation by completing the regular physical education requirements or
by satisfactorily completing P.E. 1040.

School of Physics
Established in 1939

Director and Professor—David Finkelstein; Associate Director and Regents'
Professor—Charles H. Braden; Regents’ Professors—Joseph Ford, Harold
A. Gersch, Earl W. McDaniel, L. David Wyal; Professors—R. Martin Ahrens,
Harold R. Brewer, Vernon Crawford, Martin R. Flannery, Ian R. Gatland, Don
S. Harmer, David W. Martin, Elliott W. Montroll (Adjunct), Eugene T. Patronis,
Jr., Edwin J. Schelbner, Augustus L. Stanford, James R. Stevenson, Edward
W. Thomas, Jr., Henry S. Valk, Thomas L. Weatherly, Michael K. Wilkinson
(Adjunct), J. Quitman Williams, R. A. Young; Associate Professors—Helmut
Birizt, Harry G. Dulaney, David B. Dusenberg, Ronald F. Fox, Nisbet S. Kendric,
Uzi Landman, Donald C. O’Shea, James M. Tanner, Roger M. Wartell,
LeRoy A. Williams, William E. Woot; Assistant Professors—David L. Fuller
(Adjunct), William A. Harter, Richard M. Williamson (Adjunct); Lecturer—Bar-
bara Levi.

General Information

Physics has been known primarily as a basic science and fundamental re-
search into the principles of physics continues to occupy the attention of
many physicists. But the study of physics has also become increasingly im-
portant as a basis for fundamental research in interdisciplinary areas such as
biophysics and chemical physics and as an applied science in govern-
ment and industry. Furthermore, as society becomes more technically ori-
ented, an education in physics may provide an advantageous pre-
professional foundation.

The School of Physics offers basic service courses to freshmen and
sophomores, some advanced service courses for students of engineering,
science or mathematics, and advanced work leading to the bachelor’s, mas-
ter’s and doctoral degrees in physics. The school seeks to provide elective
freedom in its undergraduate and graduate degree programs in order to
enable students with a wide variety of interests to work out suitable pro-
grams of study.

In addition to offering courses in the fundamentals of physics, the school
provides numerous specialized courses at the undergraduate and graduate
levels, especially in areas related to the research interests of the faculty.
Current faculty research interests include acoustics, atomic physics, com-
puter science, elementary particles, general relativity, many-body theory,
molecular physics, nuclear physics, quantum logic, solid-state physics, sta-
tistical mechanics, physics instruction and interdisciplinary areas in bio-
physics and materials science. Opportunities exist in these areas, as well as
in some other areas by collaboration with faculty members of other depart-
ments, for undergraduate and graduate special problems, master’s theses
and doctoral dissertations.

Information supplementary to this catalog that may be useful to students
in the planning of programs of study is available from the School of Physics.
A graduate brochure which further describes the opportunities for graduate
study and research is available upon request.

Undergraduate Programs

The School of Physics offers two undergraduate degrees, the Bachelor of
Science in Physics and the Bachelor of Science in Applied Physics. The
basis of the former degree program is the traditional preparation of a stu-
dent for graduate study in physics. The degree program in applied physics
may be better suited for entry into industry or government upon graduation,
presentation for further professional training (medicine, law, dentistry or
business) or preparation for graduate study in some other disciplines.
The two degree programs differ in that a few courses intended primarily as
preparation for graduate study in physics in the traditional program are re-
placed by courses oriented toward the applications of physics in the applied
physics program. Greater flexibility in the choice of technical electives is
available in the applied physics program.

Each of the baccalaureate programs comprises: (a) courses needed to
meet general institutional degree requirements, (b) a core of technical
courses intended to give a strong background in mathematics and in the
physical principles of mechanics, electricity and magnetism, thermody-
manics and the quantum theory which governs physical phenomena at the
microscopic level of molecules, atoms and nuclei, (c) technical electives
which enable the student to explore areas of his or her choice in greater
depth and (d) free electives, about one quarter of the total hours, which may
be employed to schedule additional technical or nontechnical courses.

The considerable flexibility inherent in the physics curriculum is advanta-
geous to students who wish to work out individual programs of study. At the
same time, this flexibility suggests the need for consultation with advisers
in order that good use may be made of the elective hours and in order to
avoid scheduling difficulties that may arise in later quarters.

Many students who earn a degree in physics have transferred from an-
other discipline. The degree programs have been planned to enable most
students to transfer into physics with little or no loss of credit.
A total of 190 credit hours is required for the bachelor's degree in physics. A grade point average of at least 2.0 in physics courses numbered 3000 and higher is a requisite for the degree.

Bachelor of Science in Physics Curriculum

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
<th>2nd Q.</th>
<th>3rd Q.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math. 1307-8-9</td>
<td>Calculus I, II, III</td>
<td>5-0-5</td>
<td>5-0-5</td>
<td>5-0-5</td>
</tr>
<tr>
<td>Chem. 1101-21</td>
<td>General Chemistry</td>
<td>4-3-5</td>
<td>4-3-5</td>
<td></td>
</tr>
<tr>
<td>Phys. 2121</td>
<td>General Physics</td>
<td></td>
<td>4-3-5</td>
<td></td>
</tr>
<tr>
<td>Engl. 1001-2-33</td>
<td>Analysis of Literature</td>
<td>3-0-3</td>
<td>3-0-3</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>Social Science or Humanities</td>
<td>3-0-3</td>
<td>3-0-3</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>Physical Education</td>
<td>0-4-1</td>
<td>0-4-1</td>
<td>0-4-1</td>
</tr>
</tbody>
</table>

Totals 15-7-17 15-7-17 15-7-17

Sophomore Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
<th>2nd Q.</th>
<th>3rd Q.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math. 2307-8</td>
<td>Calculus IV, V</td>
<td>5-0-5</td>
<td>5-0-5</td>
<td></td>
</tr>
<tr>
<td>Math. 2309-10</td>
<td>Differential Equations</td>
<td></td>
<td></td>
<td>5-0-5</td>
</tr>
<tr>
<td>Chem. 2113</td>
<td>Chemical Principles</td>
<td></td>
<td></td>
<td>3-3-4</td>
</tr>
<tr>
<td>Phys. 2122-3</td>
<td>General Physics</td>
<td>4-3-5</td>
<td>4-3-5</td>
<td></td>
</tr>
<tr>
<td>E.Gr. 1170-13</td>
<td>Introduction to Visual Communication</td>
<td>2-3-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electives</td>
<td>Computer Programming</td>
<td></td>
<td></td>
<td>0-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>Social Science</td>
<td>3-0-3</td>
<td>3-0-3</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>Humanities or Social Science</td>
<td>3-0-3</td>
<td>3-0-3</td>
<td>3-0-3</td>
</tr>
</tbody>
</table>

Electives 6

Totals 15-3-16 17-6-19 14-3-18

Junior and Senior Years

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>Credit Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phys. 3121-2-3</td>
<td>Classical Mechanics and Electricity and Magnetism (5-0-5 each)</td>
<td>15</td>
</tr>
<tr>
<td>Phys. 3141</td>
<td>Thermal Physics</td>
<td>5</td>
</tr>
<tr>
<td>Phys. 3143</td>
<td>Quantum Mechanics I</td>
<td>5</td>
</tr>
<tr>
<td>Electives</td>
<td>Physics electives which must include at least three laboratory courses. These electives must be approved by the School of Physics and must not include more than six hours below the 3000 level.</td>
<td>20</td>
</tr>
<tr>
<td>Electives</td>
<td>To bring total hours to 190.</td>
<td>45</td>
</tr>
<tr>
<td>Total, junior and senior years</td>
<td></td>
<td>90</td>
</tr>
</tbody>
</table>

Footnotes are listed following the program for the Bachelor of Science in Applied Physics.
Students who have demonstrated competence in mathematics should consider taking Phys. 2141-2-3 in lieu of Phys. 2121-2-3. Some students, e.g., biophysics students or premedical students, will find it advisable to commence upper level chemistry courses during their sophomore year. They should schedule Chem. 2113 in the third quarter of the freshman year and defer the start of the general physics sequence until the sophomore year.

Students whose scores on the College Board SAT-Verbal and the English achievement examinations are sufficiently high, in consultation with the Department of English, replace courses in the English 1001-2-3 sequence by other English courses.

See “Information for Undergraduate Students” for information relative to the 36 credit hour requirement in the humanities and the social sciences.

It is recommended that students who contemplate doctoral work in physics include study of the French, German or Russian languages in their programs.

See “Curricula and Degrees,” Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.

1 If ROTC is elected, the first course should be scheduled during the first quarter the student is in attendance. A student may schedule additional hours during the freshman year, or certain courses may be deferred in order to schedule ROTC. A maximum of 15 hours of ROTC courses may be counted as free electives, towards a degree in physics, of which no more than six hours may be in ROTC courses at the 1000-2000 level.

2 It is recommended that physics majors elect Phys. 1000 during the freshman year.

A course in computer programming is suggested, during the freshman or sophomore years, e.g., I.C.S. 1700, C.E. 2502, E.E. 1010, M.E. 3016 or Phys. 3263.

10 Students who have demonstrated competence in mathematics should consider taking Math. 3308 in lieu of Math. 2309.

Phys. 3141 or M.E. 3720 may be substituted for Chem. 2113, however, students who expect to take additional chemistry courses should schedule Chem. 2113.

This requirement may be met by scheduling one of the following courses: I.C.S. 1700, C.E. 2502 (plus one additional elective hour), E.E. 1010, M.E. 3016, Phys. 3263 or other computer course approved by the School of Physics.

12 E.Gr. 1170 may be replaced by another course, with the approval of the student’s academic adviser.

**Use of Elective Hours**

Students may utilize their elective freedom in the physics curricula to specialize in particular areas of physics, to prepare for careers in interdisciplinary areas of science, as a preprofessional program or to gain a background in other technical or nontechnical disciplines. For assistance to students in planning programs of study with emphasis directed towards a particular objective, the school has formulated suggestions for the use of elective hours. Supplementary material, available from the departmental office or from faculty advisers, includes suggestions relevant to the following areas of study: graduate study in physics, acoustics, applied optics, astrophysics, astrophysics, biophysics, computer applications, geophysics, instrumentation, measurement, materials science, nuclear science, prebusiness/management and premedical. A candidate for either baccalaureate degree in physics need not follow any one of these suggested areas of study. Features of several programs may be combined or individual programs of study may be devised.

Attention is also directed to the possibility of using elective hours for special problems (Phys. 3900-1-2 or 4900-1-2) conducted under the supervision of a faculty member.

**Graduate Programs**

**Master's Programs.** The school offers two master’s programs, a regular program leading to the Master of Science in Physics and an applied program leading to the Master of Science in Applied Physics.

The requirements for the degree Master of Science in Physics may be fulfilled on the basis of 50 hours of course work, or a master's thesis may be elected in lieu of 17 hours of courses. The course requirement is generally satisfied as a part of the doctoral program. Although there are no rigid course requirements for the regular master's degree, most students are advised to include the equivalent of Phys. 4143, at least three courses from Phys. 6121, 6122, 6123 and 6141 and mathematics equivalent to Math. 4347-8-9. If the master's degree is to be a terminal degree, a substantial research component should be included in the program either by election of a thesis or by including a number of hours of special problems (Phys. 8501-2-3 or 8511-2-3).

The program leading to the degree Master of Science in Applied Physics is designed for students who wish to terminate their study of physics with the master's degree as preparation for a career in industry, government, high school or junior college teaching, or as preparation for further study in another discipline. The program includes several courses of general significance in applied physics (e.g., Phys. 4143, 4262, 6131, 6132) plus the student's choice from a wide selection of specific programs in applied physics including acoustics, instrumentation, optics, physical characterization of materials and physics instruction. Students work out individual study programs in consultation with a guidance committee. Each program will include practical laboratory experience working with staff members who have active research programs in applied physics. The inclusion of one or more courses in the general areas of business principles or economics is encouraged.

**Doctoral Program.** The Doctor of Philosophy degree is directed toward the goal of attaining proficiency in the conduct of independent scholarly work. The degree program comprises course work in the principles of physics, additional specialized courses both in the area of the doctoral thesis and in one or two other areas, demonstration of reading competence in a foreign language, the passing of a comprehensive examination and an independent research investigation.

Except for a requirement that 15 credit hours must be earned in a minor field, which may be any technical or nontechnical field that the student chooses, there are no definite course requirements for the doctoral degree in physics. Most students find that they will schedule about 65 hours of courses and that completion of Phys. 8001-2-3, 6121-2-3 and 6141 is advisable prior to taking the comprehensive examination. Phys. 6143 and mathematics equivalent to Math. 6511-2-3 are recommended for most doctoral candidates. A grade point average of 2.9 in courses taken while a graduate student is required to register for the comprehensive examination and is a requisite for the degree.

Students are encouraged to commence participation in the departmental research programs early in their graduate careers. The undertaking of a doctoral thesis is usually reserved until the comprehensive examination is passed, which may occur during the second graduate year for a well-prepared student.
School of Psychology
Established in 1959
Professor and Director—Edward H. Loveland; Professors—E. Jo Baker, M. Carr Payne, Jr., William W. Ronan; Visiting Professor—Edward J. Rinalducci; Associate Professors—Terry L. Maple, M. Jackson Marr, Stanley A. Maiaik, Charles V. Riche, Anderson D. Smith, C. Michael York; Assistant Professors—J. Neil Bohannon, Gregory M. Corso; Lecturers—Scavria B. Anderson, O. Edmund Martin.

General Information
The School of Psychology serves a dual function in the institute. First, it offers training in the basic and applied aspects of the science of behavior for the student majoring in architecture, engineering, industrial management and natural sciences. It also offers programs of study leading to the Bachelor of Science in Applied Psychology, and the Master of Science and Doctor of Philosophy in Psychology.

The undergraduate curricula in psychology stress fundamentals, providing opportunity for broad training in mathematics, the natural sciences, humanities, social sciences and management. The large number of elective courses enables each curriculum to fulfill a wide variety of educational and vocational needs. Graduates have been able to engage successfully in postgraduate study in many fields including business administration, history, industrial management, labor relations, law, medicine, music, psychology and theology.

The program provides excellent preparation for graduate work in psychology and is especially adaptable to premedical education. Graduates of the program also have been employed successfully in a variety of positions relating to personnel subsystems (including human engineering), personnel research, personnel service, systems development, management and the administration of business, engineering and health programs.

Undergraduate Curricula
In order to serve the diverse educational needs of students who enter the institute, the School of Psychology offers three curricula leading to the degree Bachelor of Science in Applied Psychology. All three curricula options require 193 quarter hours.

Curriculum I provides maximum freedom to the student in building his or her course of study. Of the 193 quarter hours required for the degree only 91 hours are designated by course number. This option offers a choice of several chemistry or physics course sequences from among which the student elects one sequence in one of the two sciences. It offers the student the choice of two course sequences to satisfy the one-year basic mathematics requirement. Seven required psychology courses form a core around which the student, with the assistance of his or her adviser, builds his or her psychology major.

Curriculum II is technically oriented and stresses quantitative and experimental approaches to the study of behavior. Approximately 60 percent of the graduates of this curriculum have continued their studies in psychology graduate programs, medical and law schools, as well as in other graduate programs leading to degrees in such widely diverse fields as business, education, psychology, history, labor relations, marketing, music and religion. Other graduates have been employed upon graduation in a variety of positions including general management, personnel research, personnel services (e.g. personnel training and employment), personnel subsystems (including human factors engineering), engineering psychology research and systems engineering.

Both curricula I and II lend themselves to a special program intended to prepare students to teach behavioral science at the high school level. Through a cooperative arrangement with Georgia State University, interested students may enroll for required education courses at that institution while working toward their bachelor's degree at Georgia Tech. Upon completion of the program the student will be eligible to apply for a T-4 teaching certificate.

Curriculum III was developed to provide opportunities for those students who wish to combine a major in psychology with study of a coherent minor in linguistics and languages. This curriculum can provide a base for graduate study in linguistics and in those areas of psychology relating to the study of language. It can be particularly useful to those who seek postgraduate employment in positions involving work with cultural groups in which linguistic problems exist as significant variables in education or vocational preparation.

Curriculum I

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
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<tbody>
<tr>
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<td>Introduction to Literature</td>
<td>4-3-5</td>
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<td>Math. 1307-8-95</td>
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<td>5-0-5</td>
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<td>I.C.S. 1700</td>
<td>Digital Computer Programming</td>
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<td>Electives⁵</td>
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<td>17-7-19</td>
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<td>Totals</td>
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Sophomore Year

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<td>Biol. 1710-1112⁶</td>
<td>Principles of Biology</td>
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<td>Psy. 4401</td>
<td>Industrial Psychology</td>
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Sophomore Year (continued)

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</tbody>
</table>

Totals: 15-3-16 15-3-16 15-3-16

1 One complete sequence of chemistry courses (Chem. 1101-2 or Chem. 1111-2) or one complete sequence of physics courses (Phys. 2111-2-3 or 2121-2-3 or 2141-2-3). Hours in excess of 10 may be used for elective credit.

2 Math. 1711-2-3 may be substituted.

3 Choice of (1) two quarters of one of the following: American history, political science, philosophy and history of science, or sociology, with the third quarter selected from one of the three remaining areas, or (2) two quarters of one modern foreign language. Students electing modern language courses which total more than nine hours may use the excess hours for free elective credit.

4 See "Curricula and Degrees," Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.

5 These free elective courses may be taken at any time during a student's course of study. However, if six credit hours of basic ROTC are elected, ROTC should be scheduled the first quarter the student is enrolled.

6 Biol. 2210-11 and 2 hours of electives may be substituted.

7 A total of not more than nine hours of electives may be in advanced ROTC.

Junior and Senior Years

A total of 193 quarter hours is required for the degree. During the junior year, students will complete Math. 3710, Psy. 4403, 4406 and 4407. During the junior and senior years, students will complete Psy. 4410 and Engl. 3015. Twenty-seven hours of psychology electives are required in the curriculum, three in the sophomore year and 24 in the junior and senior years. At least one course must be selected from each of the following four areas:

Area I: Psy. 4411, 4412* and 4413
Area II: Psy. 4400, 4421, 4422, 4423, 4754
Area III: Psy. 4402, 4424, 4750
Area IV: Psy. 4404, 4405, 4409.

*The student should be aware that Psy. 4412 is a prerequisite to Psy. 4413.

Curriculum II

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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<th>2nd Q.</th>
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<tr>
<td>Chem. 1101-2</td>
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<td>Engl. 1101-2-3</td>
<td>Programming</td>
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<td>Math. 1307-8-9</td>
<td>Calculus I, II, III</td>
<td>5-0-5</td>
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Electives 1
Modern Language or Social Sciences
3-0-3 3-0-3 3-0-3

Electives 2
Physical Education
0-4-1 0-4-1 0-4-1

Electives 3
Free
2-0-2 2-0-2 2-0-2

Totals: 17-7-19 17-7-19 15-7-17

Sophomore Year

<table>
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<th>Subject</th>
<th>1st Q.</th>
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<th>3rd Q.</th>
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<tr>
<td>Engl. 2001-2-3</td>
<td>Survey of the Humanities</td>
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<td>Math. 2307</td>
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<td>Psy. 4401</td>
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Electives 4
Free
3-0-3 6-0-6

Totals: 15-3-16 15-3-16 15-0-15

Junior Year

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<th>Subject</th>
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<tr>
<td>Math. 3710</td>
<td>Introduction to Statistics</td>
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<td>Psy. 4403</td>
<td>Introduction to Psychological Testing</td>
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<td>3-0-3</td>
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<tr>
<td>Psy. 4405</td>
<td>Seminar in Organizational Psychology</td>
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<td>Psy. 4406</td>
<td>Psychological Statistics</td>
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<tr>
<td>Psy. 4407</td>
<td>Experimental Psychology I</td>
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<td>2-3-3</td>
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<td>Psy. 4410</td>
<td>Social Psychology</td>
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<td>3-0-3</td>
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<tr>
<td>Phys. 2121-2-3</td>
<td>Physics</td>
<td>4-3-5</td>
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Electives
Free
3-0-3 3-0-3 6-0-6

Totals: 15-3-16 12-6-14 15-6-17

Senior Year

<table>
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<th>Course No.</th>
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<tbody>
<tr>
<td>Psy. 4411</td>
<td>Experimental Psychology II</td>
<td>3-3-4</td>
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<tr>
<td>Psy. 4412</td>
<td>Psychology of Learning</td>
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<td>Psy. 4413*</td>
<td>Applied Experimental Psychology</td>
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<td>3-3-4</td>
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<tr>
<td>Psy. 4814</td>
<td>Special Problems</td>
<td>3-3-4</td>
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<td>Psy. 4815</td>
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<tr>
<td>Engl. 3015</td>
<td>Public Speaking</td>
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Electives
Free
7-0-7 9-0-9 8-0-8

Totals: 13-3-14 12-6-14 14-6-16

1 Choice of (1) two quarters of one of the following: American history, political science, philosophy and history of science, or sociology, with the third quarter selected from one of the three
remaining areas, or (2) three quarters of one modern foreign language. Students electing modern language courses which total more than nine hours may use the excess hours for free elective credit.

3 These free elective courses may be taken at any time during a student's course of study. However, if six credit hours of basic ROTC are elected, ROTC should be scheduled the first quarter the student is enrolled.

4 A total of not more than nine hours of electives may be in advanced ROTC.

5 Psy. 6602 may be substituted for Psy. 4413 with the approval of the School of Psychology and dean of the graduate school.

### Curriculum III

#### Freshman Year

<table>
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<tr>
<th>Course No.</th>
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</thead>
<tbody>
<tr>
<td>Chem.</td>
<td>Introduction to Literature</td>
<td>4-3-5</td>
<td>4-3-5</td>
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</tr>
<tr>
<td>Math.</td>
<td>Calculus I, II, III</td>
<td>5-0-5</td>
<td>5-0-5</td>
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</tr>
<tr>
<td>I.C.S. 1700</td>
<td>Digital Computer Programming</td>
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<td></td>
<td>2-3-3</td>
</tr>
<tr>
<td>Electives</td>
<td>Modern Language or Social Science</td>
<td>3-0-3</td>
<td>3-0-3</td>
<td>3-0-3</td>
</tr>
<tr>
<td>Electives</td>
<td>Physical Education</td>
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<td>0-4-1</td>
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<td>Electives</td>
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#### Sophomore Year

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<th>Subject</th>
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<tbody>
<tr>
<td>Engl. 2001-2-3</td>
<td>Survey of Humanities</td>
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<tr>
<td>Biol. 2210-11</td>
<td>Principles of Biology</td>
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<tr>
<td>Psy. 3303-4</td>
<td>General Psychology</td>
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</tr>
<tr>
<td>Psy. 4401</td>
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#### Junior Year

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<td>Psy. 4400</td>
<td>Developmental Psychology</td>
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<td>Psy. 4403</td>
<td>Introduction to Psychological Testing</td>
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1. One complete sequence of chemistry courses (Chem. 1101-2-3 or Chem. 1111-2-3) or one complete sequence of physics courses (Phys. 2111-2-3 or 2121-2-3 or 2141-2-3). Hours in excess of 10 may be used for elective credit.

2. In addition to the history and constitution requirements, this curriculum requires considerable modern language experience. The modern language requirement can vary from 15 to 21 hours. It consists of completing 21 hours in a single language or one upper level course in one language and one year of either Russian or Chinese as a second language.

3. See "Curricula and Degrees," Department of Physical Education and Recreation, for freshman physical education requirements for both men and women.

4. These free elective courses may be taken at any time during a student's course of study. However, if six credit hours of basic ROTC are elected, ROTC should be scheduled the first quarter the student is enrolled.

5. Biol. 1710-1-2 may be substituted.

6. A total of not more than nine hours of electives may be in advanced ROTC.

7. Six hours of linguistics electives are required.
Graduate Curricula

Doctoral and master’s candidates share a core curriculum of required courses which include three seminars in general psychology, nine additional course hours in psychology to be prescribed by the student’s faculty advisory committee with the approval of the director of the School of Psychology and 18 hours to be chosen by the student, with the approval of his or her advisory committee, from among courses in psychology and other fields. Permission to substitute another course for a required course may be granted if the student can demonstrate competence in course content by passing a written examination. Doctoral candidates are expected to complete all requirements for the master’s degree including a thesis and a demonstrated reading proficiency in one foreign language.

The master’s degree is viewed as a significant educational achievement in itself, and is not awarded routinely for completion of part of the doctoral program. Master’s programs are intended to prepare the student for continuation of graduate work toward the Ph.D., for professional work in business, industrial, government or educational positions, or for both. The master’s degree should require two calendar years for most students. A master’s thesis is required.

The doctoral program provides the student with an opportunity for advanced study in general-experimental, industrial-organizational or engineering psychology. Each of these curricula consists of additional courses and programs of individual study and research beyond the core curriculum, which contribute to a strong background in general experimental psychology and the student’s area of specialization. The doctoral program will ordinarily require four years for students who enter immediately after obtaining the bachelor’s degree.

Admission to graduate study in psychology with full graduate standing in the School of Psychology requires the equivalent of an undergraduate major in psychology or a related field with courses in general and experimental psychology, psychological statistics, testing and measurement and either industrial psychology or social psychology. Supplementary education in such areas as biology, chemistry, physics, engineering, foreign languages and particularly mathematics is strongly advised. Students who have considerable undergraduate preparation in one or more of these areas may, with the approval of the School of Psychology, forego some of the required psychology courses. All applicants should submit scores on the Miller Analogies Test and the Graduate Record Examination.

The psychology faculty encourages competent students in subjects other than psychology to apply for admission.

Department of Social Sciences

Established in 1948

Acting Department Head—Jon J. Johnston; Professors—John C. Gould, Patrick Kelley, Melvin Kranzberg (Callaway Professor of History of Science and Technology), Morris Mitzen, Willard E. Wight; Associate Professors—Ronald H. Bayor, James E. Brittain, Stanley R. Carpenter, Robert C. McMath, Jr., Daniel S. Papp, Germaine M. Reed, Frederick A. Rossini, Sandra W. Thornton, Jay A. Weinstein; Assistant Professors—Daryl E. Chubin, Lawrence W. Foster, August W. Giebelhaus, Timothy A. Hall, John J. Havick, John N. Hines, Thomas D. Philips, David H. Ray, Diana Velez, Dorothy C. Yancy.

General Information

The Department of Social Sciences offers course work in four disciplines: history, philosophy of science and technology, political science and sociology. Each of the disciplines has a dual function in the Georgia Tech academic community. On the one hand they perform their vital traditional roles of helping the student cultivate a critical awareness and perspective on the perennial evaluative issues that confront man, both as an individual and as a member of a complex social order. On the other, they reflect upon and contribute to the resolution of the scientific and technological issues that are Georgia Tech’s special province.

Certificate Programs in the Social Sciences

Seven certificate programs enable students to concentrate course work in areas of their particular interest. Each program is designed to possess thematic depth and unity and aims to meet two desirable student objectives: (1) the systematic acquisition of conceptual skills and perspectives that complement his or her professional major by enriching understanding of its social dimensions and cultural roots; and (2) strengthening the background of students planning graduate study in law, medicine, business, etc. by a systematically gained competence in an area additional to one’s major.

The跟踪 four of the seven certificate programs are in the following disciplines: history, philosophy, political science and sociology. The remaining three programs cut across discipline lines to provide a foundation in international affairs, the interaction of science, technology and society, and urban studies.

Students interested in planning a certificate program in one of these areas should contact the Department of Social Sciences for further information. A faculty adviser will be assigned to each student to plan a program of study to meet his or her needs and interests. Detailed information concerning these programs may be obtained in the Social Science Department Office.

U.S. and Georgia History and Constitution Requirements

The state of Georgia requires all students to display a knowledge of U.S. and Georgia constitutions and U.S. and Georgia history. To complete the requirement in U.S. and Georgia constitutions, a student must pass Pol. 1251 or 3200, or an examination on the U.S. and Georgia constitutions.

To complete the requirements in U.S. and Georgia history, a student must either pass Hist. 1001, 1002, 3010 or 3011, or pass an examination on U.S. and Georgia history.

Examinations for both requirements are administered each quarter (only to first quarter seniors) by the Department of Social Sciences. Students who do not take the exams or who are unsuccessful must then take the appropriate course(s) prior to graduation.
Courses of Instruction

How to Use This Chapter

Course descriptions are listed alphabetically by schools and departments of instruction. The specific degree requirements for each curriculum at both the undergraduate and graduate levels are listed alphabetically by colleges in chapter four of this catalog.

Course numbers below 3000 are lower division (freshman and sophomore) courses. Those numbered 3000-4999 are designated as upper division (junior and senior) courses. They are open to students of the lower and upper divisions with the proper prerequisites and to graduate students on approval of the individual student's major school. Courses designed for graduate students are numbered 5000 and above; the methods of presentation and quality of work expected make them generally unsuited to undergraduate participation. An upper-division undergraduate student is therefore permitted to enroll in a graduate level course only after consultation with and approval of his or her major school and the dean of the graduate division.

Figures entered below the course number and title of each course signify the number of class hours per week, the number of laboratory hours per week and the quarter hours credit for the completed course, in that order. Thus, the entry 4-3-5 in Chem. 1101 means that the course meets for four lecture hours per week, has three hours of laboratory work per week and is evaluated at five quarter hours credit upon completion of the quarter's work.

Aerospace Engineering

A.E. 1350. Introduction to Engineering
2-3-3.
Emphasizes creative imagination in engineering, rather than mathematics. The growth and behavior of biological systems are related to engineering problems.

A.E. 1750. Introduction to Bioengineering
3-0-3.
Introduction to aspects of science and technology pertinent to bioengineering. Also taught as E.E. 1750, E.S.M. 1750 and M.E. 1750.

A.E. 2100. Structures I
4-3-5. Prerequisite: E.S.M. 2201. Prerequisite or corequisite: Math. 2306.
Introduction to the elements of structural mechanics basic in the design of aircraft and missile structures.

A.E. 2603. Computer Applications in Aerospace Engineering
1-6-3. Prerequisite: Math. 1309.
Description of the components of a modern digital computing system. Elementary FORTRAN programming. Introduction to aerospace engineering applications.

Text: at the level of Murrill and Smith.
A.E. 3000. Fluid Mechanics I 4-3-5. Prerequisite: M.E. 3322, 2.0 average in math and in physics. Prerequisite or corequisite: Math. 2309. The principles of fluid properties, classification of flows and one-dimensional flows including isentropic flows, normal shock waves and duct flows with friction and heating. Text: Shapiro, Compressible Fluid Flow, volume one.

A.E. 3001. Fluid Mechanics II 4-3-5. Prerequisite: A.E. 3000. The physical equations for continuum flows and applications to laminar and turbulent boundary layers for incompressible and compressible flow. Text: at the level of Kuethe and Setzer, Foundations of Aerodynamics.

A.E. 3002. Fluid Mechanics III 4-3-5. Prerequisite: A.E. 3001. Two-dimensional incompressible flow theory, superpositioning and conformal transformations, with applications to flow around bodies and into airfoil theory. Text: at the level of Kuethe and Setzer, Foundations of Aerodynamics.


A.E. 3750. Introduction to Biofluid Dynamics 3-0-3. Prerequisite: Math. 2309, Phys. 2123. Study of blood flow in the cardiovascular system with emphasis on the modeling of such flows and the potential of flow studies for clinical research application. Also taught as E.S.M. 3750.

A.E. 4000. Fluid Mechanics IV 4-3-5. Prerequisite: A.E. 3002. Finite wing theory, two-dimensional subsonic and supersonic compressible flows, supersonic flow around bodies of revolution, and an introduction to transonic and hypersonic flows. Text: at the level of Kuette and Schetzer, Fundamentals of Aerodynamics.


A.E. 4350-1. Aerospace Engineering Design Project I, II 2-6-4 each. Prerequisite: A.E. 4000. Prerequisite or corequisite: A.E. 4410, A.E. 4500. Preliminary design or case study of an aerospace system such as a complete flight vehicle, a propulsion system, a structural system or a control system. Text: at the level of Perkins and Hage, Airplane Performance, Stability and Control.

A.E. 4400. Introduction to Propeller and Rotor Theory 3-0-3. Prerequisite or corequisite: A.E. 4000 or consent of school. A study of the theory and equations used in the design of propellers and helicopter rotors. Text: at the level of Gessow and Myers, Aerodynamics of the Helicopter.


A.E. 4550. Instrumentation for Experimental Research I 2-3-3. Prerequisite: consent of school. Laboratory treatment of major and ancillary instrumentation used in solid and fluid mechanics research, voltage, current, resistance measurement, amplifiers, oscilloscopes, recording equipment.

A.E. 4551. Instrumentation for Experimental Research II 2-3-3. Prerequisite: A.E. 4550 or consent of school. Advanced treatment of laboratory instrumentation for research, analysis and application of operational amplifiers, filters and signal conditioners, elementary digital circuits, computer systems for data acquisition.

A.E. 4760. Engineering Acoustics and Noise Control I 3-0-3. Prerequisite: senior standing. Study of acoustics related to noise and its control, acoustic terminology, wave propagation, solutions to the wave equation, instrumentation, sound field in large and small rooms, noise legislation. Also taught as E.S.M. 4760, M.E. 4760.


A.E. 4803-13-23-33-43-53. Special Topics 3-0-3 each. Prerequisite: consent of school. Course material devoted to special topics of current interest, treatment of new developments in various areas of aerospace engineering.

A.E. 4804-14-24-34-44-54. Special Topics 4-0-4 each. Prerequisite: consent of school. Course material devoted to special topics of current interest, treatment of new developments in various areas of aerospace engineering.

A.E. 4805-15-25-35-45-55. Special Topics 5-0-5 each. Prerequisite: consent of school. Course material devoted to special topics of current interest, treatment of new developments in various areas of aerospace engineering.

A.E. 4900-1-2. Special Problems in Aerospace Engineering Credit to be arranged. Prerequisite: third quarter junior or senior standing and approval of director. Research on a problem selected in consultation with a faculty member. A brief description, endorsed by the adviser, must be approved by the school director.


A.E. 6011. Viscous Flow II 3-0-3. Prerequisite: A.E. 6010 or consent of school. Transition from laminar to turbulent flow, equations of motion for turbulent flows, incompressible boundary layers, compressibility and heat transfer, semiempirical methods, wakes and jets.

A.E. 6020. Elements of Compressible Flow 3-0-3. Prerequisite: consent of school. Defining equations for inviscid compressible flows, method of characteristics for unsteady one-dimensional and steady two-dimensional and axially symmetric flows, nozzle design, conical flow.

A.E. 6021. Advanced Compressible Flow Theory I 3-0-3. Prerequisite: A.E. 6020 or consent of school. The linearized potential equation, thin airfoil theory, similarity rules, linear theory for axially symmetric and three-dimensional flows.

Mixed subsonic—supersonic flows, transonic similarity rule, two-dimensional and axially symmetric bodies in transonic flow, selected topics.

A.E. 6203. Hypersonic Flow Theory
3-0-3. Prerequisite: A.E. 6021 or consent of school.

Hypersonic similarity rule, hypersonic small disturbance theory, Newtonian flow theory, and other approximate methods, boundary layer interaction, the blunt body problem.

A.E. 6300. Advanced Potential Flow I
3-0-3. Prerequisite: A.E. 3002.

Development of the nonlinear and linearized irrotational potential flow equations. Solutions to incompressible flow problems of airfoils and wings undergoing steady, oscillatory and arbitrary motions.

A.E. 6301. Advanced Potential Flow II
3-0-3. Prerequisite: A.E. 6300.

Formulation of aerodynamic influence coefficients, solutions to subsonic and supersonic hypersonic flow problems of wings and bodies experiencing oscillatory and arbitrary motions.

A.E. 6500. Rarefied Gasdynamics I
3-0-3. Prerequisite: consent of school.

Mass, momentum and energy transfer in linearized rarefied gas flows, free molecular external and internal flows, statistical models for collision integral of Boltzmann equation.

A.E. 6501. Rarefied Gasdynamics II
3-0-3. Prerequisite: A.E. 6500.

Mass, momentum and energy transfer in nonlinear rarefied gas and plasma flows, statistical models for diatomic and ionized gases, and discussions of allied topics in ionospheric aerodynamics.

A.E. 6505. High-Temperature Gas Dynamics I
3-0-3. Prerequisite: A.E. 6260 or consent of school.

Real gas effects. Equilibrium properties and rate processes of high temperature gases. Equilibrium and frozen flows, normal and oblique shocks, nozzle flows, Prandtl-Meyer flows.

A.E. 6501. High-Temperature Gas Dynamics II
3-0-3. Prerequisite: A.E. 6505.

Acoustic equations and rate equations. Vibrational and chemical nonequilibrium flows, normal and oblique shock structures, theory of nonequilibrium characteristics, nonequilibrium acoustic waves, flow of rarefied gases, transition to turbulence.

A.E. 6100. Advanced Structural Analysis I
3-0-3. Prerequisite: A.E. 3101 or consent of school.

Stability of mechanical models, elastic bars and frames by kinetic and energy approaches, approximate methods, direct loadings, dynamic stability and inelastic effects.

A.E. 6101. Advanced Structural Analysis II
3-0-3. Prerequisite: A.E. 6100 or consent of school.

Buckling of plates, torsional instability of thin open-section beams, lateral buckling of beams, beams on elastic foundation, further discussion of dynamic stability.

A.E. 6102. Advanced Structural Analysis III
3-0-3. Prerequisite: A.E. 6100, E.S.M. 6372 or consent of school.

Vibrations of cables, cylindrical shells, edge effects, complete spheres and shallow spherical caps, recent developments.

A.E. 6103. Advanced Structural Analysis IV
3-0-3. Prerequisite: A.E. 3102 or consent of school.

Principle of virtual work. Concepts of potential energy and complementary energy, weighted residuals, applications in approximate solutions. Discussion of Hookan material, including thermal strains.

A.E. 6104. Advanced Structural Analysis V
3-0-3. Prerequisite: A.E. 6103 or consent of school.

Introduction to finite element analysis, with emphasis on the displacement analysis of structures. Applications to static equilibrium, vibration and stability. Nonlinear formulation, solution techniques.

A.E. 6105. Aerospace Structures Laboratory
1-0-3. Prerequisite: A.E. 6104 or consent of school.

Development of practical methods for experimental mechanics, design and execution of experiments, measurement of displacement, strain, force, acceleration, temperature, design of transducers and instrument systems.

A.E. 6120. Thermal Effects in Structures I
3-0-3. Prerequisite: Math. 4582.

Analysis of heat transfer in structural elements, development and use of approximate numerical and analytical solution procedures.

A.E. 6121. Thermal Effects in Structures II
3-0-3. Prerequisite: A.E. 6321 or consent of school.

Analysis of thermally induced stresses in beams, plates and shells, thermally induced instability in columns and plates, reduction in torsional rigidity.

A.E. 6122. Thermal Effects in Structures III
3-0-3. Prerequisite: E.S.M. 6231 or consent of school.

Phenomenological and mechanical interpretations of mechanical behavior of solids.

A.E. 6130. Structural Dynamics I
3-0-3. Prerequisite: A.E. 3101, E.S.M. 4210.


A.E. 6131. Structural Dynamics II
3-0-3. Prerequisite: A.E. 6130.


A.E. 6300. Advanced Aeronautical Dynamics
3-0-3. Prerequisite: A.E. 6130.

Static aeroelastic analyses of flight vehicles, lifting surface and panel flutter analyses with applications. Dynamic response and load analysis of flight vehicles using modal techniques.

A.E. 6301. Advanced Aeronautical Dynamics II
3-0-3. Prerequisite: A.E. 6200.

Formulation of aeroelastic analyses associated with discrete and random dynamic loads, aerothermoelastic and structural instabilities of fixed and rotating-wing flight vehicles.

A.E. 6203. Special Topics in Aeronautics and Flight Mechanics
3-0-3. Prerequisite: A.E. 6200.

Current topics in aeronautics, unsteady aerodynamics and structural dynamics are studied. The student presents both an oral and written report on two specialized current problems.

A.E. 6204. Special Topics in Aeronautics and Flight Mechanics II
3-0-3. Prerequisite: A.E. 6200.

Continuation of A.E. 6203. Advanced problems in aeronautics, unsteady aerodynamics or structural dynamics.

A.E. 6250. Rocket Propulsion I
3-0-3. Prerequisite: A.E. 6260.


A.E. 6260. Thermodynamics of Gases
4-0-4. Prerequisite: consent of school.

Thermodynamics of reacting gases, introductory quantum theory, statistical thermodynamics and chemical kinetics.

A.E. 6261. Combustion I
3-0-3. Prerequisite: A.E. 6260 or consent of school.

Introductory chemical kinetics, explosions, Schwab-Zeldovich formulation, Rankine-Hugoniot relations, detonations and deflagrations.

A.E. 6262. Combustion II
3-0-3. Prerequisite: A.E. 6261.

Laminar diffusion flames and droplet burning. Laminar flame in premixed gases, turbulent flames, ignition quenching and flammability limits. Chemical reactions in boundary layers.

A.E. 6400. Aerodynamics of the Helicopter I
3-0-3. Prerequisite: A.E. 4400.

Forward flight performance, derivation and study of the induced velocity relations and the flow field associated with helicopter rotors.

A.E. 6401. Aerodynamics of the Helicopter II
3-0-3. Prerequisite: A.E. 6400.

Vortex-wake theories for rotors with a finite number of blades, introduction to helicopter stability and control.

A.E. 6450. Aerodynamic Noise
3-0-3. Prerequisite: A.E. 6761.

Jet, boundary layer, combustion, propeller and fan noise. Sonic boom, noise propagation from engines and attenuation techniques.

A.E. 6500. Advanced Stability and Control
3-0-3. Prerequisite: A.E. 4500.

A study of feedback controls as applied to aircraft, root locus technique, and use of airframe transfer functions are emphasized. Survey of the load alleviation problem.

A.E. 6750. System Design Methodology
2-3. Prerequisite: graduate standing or consent of school.

Relationship of technological systems to society is studied using economic concepts. Emphasis on the use of engineering type analysis in resolving value laden problems. Examples. Also taught as E.E. 6732, M.E. 6750.

A.E. 6751-2. Complex Systems Design
2-4-3 each. Prerequisite: graduate standing.

This two-quarter sequence permits students from all schools to meet, form an interdisciplinary team and carry out a preliminary design task which is significant, complex system. Also taught as E.E. 6751-2 and M.E. 6751-2.

A.E. 6780. Engineering Acoustics I
3-0-3. Prerequisite: consent of school.
Transport of contaminants in environments, stratified and disturbed atmospheric boundary layer, free-convection layer, current problems. Also taught as Geo.S. 6794.

A.E. 6800. Numerical Fluid Dynamics I 3-0-3. Prerequisite: A.E. 6010 or consent of school.


Numerical methods of solution of boundary layer equation and Navier-Stokes equations for time-dependent and steady flows. Accuracy, stability and computational efficiency.

A.E. 7000. Master's Thesis 3-0-3.}


A.E. 7750. Bio-Fluid Mechanics 3-0-3. Prerequisite: A.E. 6000 or E.S.M. 6501-2 or consent school.

A unified treatment on hemorheology, hemodynamics, pulsatile flows, microcirculation, joint lubrication, pulmonary physiology, etc. with emphasis on a quantitative approach. Also taught as E.S.M. 7750.

A.E. 7760. Magnetogasdynamics I 3-0-3. Prerequisite: A.E. 6040 or equivalent.

Fundamental concepts of plasma dynamics, magnetogasdynamic regions motion of charged particles in electromagnetic fields. Debye shielding length, Maxwell transport equations and magnetogasdynamic equations. Also taught as E.S.M. 7760.


Transport properties of ionized gases, Hall effect, ion slip, electron runaway. Equilibrium and nonequilibrium ionization, magnetosonic and Alfven waves. Magnetogasdynamic shocks, magnetogasdynamic flow phenomena. Also taught as M.E. 7761.


Engineering applications of magnetogasdynamic phenomena. Also taught as M.E. 7762.


Theories and applications of plasma diagnostic methods-spectroscopy, microwave interferometry, Langmuir probe, etc. Field trips to representative facilities. Also taught as M.E. 7763.

A.E. 7999. Preparation for Doctoral Qualifying Exams Noncredit. Prerequisite: consent of director.


A.E. 8103-13-23-33-43-53. Special Topics 3-0-3 each. Prerequisite: consent of school.

Special topics of current interest, treatment of new developments in various areas of aerospace engineering.

A.E. 8104-14-24-34-44-54. Special Topics 3-0-4 each. Prerequisite: consent of school.

Special topics of current interest, treatment of new developments in various areas of aerospace engineering.

A.E. 8105-15-25-35-45-55. Special Topics 3-0-5 each. Prerequisite: consent of school.

Special topics of current interest, treatment of new developments in various areas of aerospace engineering.

A.E. 8106-16-26-36-46-56. Special Topics 3-0-6 each. Prerequisite: consent of school.

Special topics of current interest, treatment of new developments in various areas of aerospace engineering.

A.E. 8500-1-2. Special Problems in Aerospace Engineering Credit to be arranged. Prerequisite: consent of school.

A.E. 8503-4-5. Special Problems in Aerospace Engineering Credit to be arranged.


Air Force Aerospace Studies

A.S. 1610. Introduction to Today's Air Force 1-1-1.


A.S. 1640. Air Power, the Early Years 1-1-1.


A.S. 1660. Air Power, the Later Years 1-1-1.


Stresses differences and similarities between civil and military law.

**Architecture**

**Architecture**
Arch. 1001-2-3. Design Fundamentals 1-12-5 each.
Introduction studies in visual and structural expression emphasizing the processes of problem identification, design method and communication.
A study of man's architectural heritage from the beginning of recorded history to the present day. Open to all freshmen.
Design of simple buildings emphasizing technical subjects in corequisite courses.
Introduction to building frames, components and construction techniques, requirements and design of climate control systems, sound and lighting control.
Arch. 2361-2. Color Theory 1-3-2 each.
Lecture and laboratory experiments on the properties of color and its use in design.
Arch. 3001-2-3. Architectural Design 1-12-5 each. Prerequisite: Arch. 2003. Corequisite: Arch. 3401-2-1-4, respectively.
Site planning, community and urban design. Design of complex facilities, in association with corequisite courses.
Arch. 3201. History of Ancient Architecture 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
Historical survey of the architecture of antiquity from prehistoric times through the ancient Greek period to the twentieth century.
Arch. 3202. History of Medieval Architecture 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
Historical survey of architecture in Medieval Europe including the Early Christian, Byzantine, Dark Ages, Romanesque and Gothic eras.
Arch. 3203. History of Renaissance and Mannerist Architecture 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
Historical survey of European architecture in the Renaissance and Mannerist periods.
Arch. 3204. History of Baroque and Rococo Architecture 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
Historical survey of European architecture during the seventeenth and eighteenth centuries.
Arch. 3205. The Architect and Society 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
The role of the architect in society from the Classical Greek period to the twentieth century.
Arch. 3321-2-3. Structures and Materials I, II, III 4-3-5 each. Prerequisite for Arch. 3321: Arch 2301, ESM 3702; prerequisite for Arch. 3322 and 3323: Arch. 3321.
Survey of the historical background of urban planning in the United States: criteria for design and evaluation of buildings; economics of building development, construction and operation.
Arch. 3780. Introduction to Urban Engineering 3-0-3. Prerequisite: junior standing in engineering or architecture or consent of instructor.
Survey of the current status of scientific and technical contributions to urban socioeconomic problems and opportunities for increased participation by engineering architectural and related disciplines.
Arch. 3811-2. Visual Communications Studio 0-3-1 each.
Introductory studio work in drawing and painting, sculpture and three-dimensional concepts.
Arch. 3815-6. Visual Communications Studio 0-6-2 each.
Introductory studio work in drawing and painting, sculpture and three-dimensional concepts.
Arch. 3911-2-3-4. Visual Communication Studies 0-3-1 to 0-15-5.
Introductory studio work in: (1) drawing and painting, (2) sculpture and three-dimensional concepts, (3) photography, (4) graphic design and rendering.
Arch. 4001-2. Architectural Design 1-12-5 each. Prerequisite: Arch. 3003.
Architectural design synthesizing material presented in previous years. Large scale building projects in an urban context.
Arch. 4003. Architectural Design 1-12-5 each. Prerequisite: Arch. 4001.
Terminal project. Selection of a facility for study by the individual student, with approval by the faculty. Research, programming, schematic and final design and preparation of documents. Undergraduate exit exam.
Arch. 4204. History of Architecture in England I 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
Historical survey of architecture in England from Roman times to 1715. Focus is on cathedrals and on domestic architecture from castles and fortified manor houses to Tudor, Elizabethan, Jacobean and Baroque country houses.
Arch. 4205. History of Architecture in England II 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
Historical survey of architecture in England from Wren to the present, concentrating on the eighteenth and nineteenth centuries.
Arch. 4206. History of Architecture in the U.S. 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
Historical survey of architecture in America from colonial times to the present.
Arch. 4207. History of Modern Architecture I: Nineteenth Century 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
Historical survey of architecture in the nineteenth century focusing upon currents of romanticism, classicism, eclecticism, vernacular styles and the advances in engineering and building technology.
Arch. 4208. History of Modern Architecture II: 1890-1950 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of the college.
Historical survey of architecture during the early modern movement. Focuses upon the old masters (Gaudi, Gropius, Le Corbusier and Mies van der Rohe) and introduces such modern movements as Art Nouveau, DeStijl, International Style and Art Deco.
Arch. 4209. History of Modern Architecture III: 1945-present 3-0-3. Prerequisite: Arch. 1201-2-3 or consent of college.
Historical survey of architecture since World War II, focusing upon the influence of the old masters of modern architecture upon architects active after 1945. Introductory coverage of such trends as the Miesian Aesthetic, New Formalism and New Brutalism and Post-Modernism.
Arch. 4247-8-9. History of Art I, II, III 3-0-3 each.
A survey in the history of artistic manifestations from primitive times to our own day. First quarter of sequence: prehistoric through Roman; second quarter: Early Christian through Baroque; third quarter: nineteenth and twentieth centuries.
Arch. 4301. Building Materials I 3-0-3. Prerequisite: Arch. 3323.
Relevant physical properties, manufacturing processes, utilization within the building industry, and methods for controlling the quality control of masonry, concrete and metallic building materials.
Arch. 4302. Building Materials II 3-0-3. Prerequisite: Arch. 3323, 4301.
Arch. 4321. Structural Integration 3-3-4. Prerequisite: consent of college.
Study of structural systems for buildings, and of methods used in their design and analysis.
Arch. 4751-2. Psychology of Environmental Design 3-3-4 each. Prerequisite: consent of college. Course listing and description under Psy. 4751-2.
Arch. 4771-2. Urban Systems Design 2-3-3. Prerequisite: Arch. 3780 or consent of college.
Analysis of an unstructured urban problem situation by multidisciplinary group. Groups identify, structure and analyze a specific local off-campus urban problem and propose a solution to that problem.
Arch. 4775. Sociotechnical Problems in Energy Engineering 3-0-3. Prerequisite: senior standing or consent of the college.
The examination of problems and opportunities in the area of energy from social and technical viewpoints. The analysis is presented to develop a multidisciplinary perspective.
Arch. 4776. Impact of Energy Problems
3-0-3. Prerequisite: senior standing or consent of the college.
Provides a working knowledge of the interaction and impact of energy on the individual and society.

Arch. 4777. Energy Flow in a Systems Context
3-0-3. Prerequisite: senior standing or consent of the college.
The study of energy and energy flow in a systems context.

Arch. 4778. Energy Lab
0-0-3. Prerequisite: senior standing or consent of the college.
Individual and group projects dealing with development and application of energy systems.

Arch. 4811-2. Visual Communications Studio
0-3-1 each.
Intermediate studio work in drawing and painting, sculpture and three-dimensional concepts.

Arch. 4815-6. Visual Communications Studio
0-6-2 each.
Intermediate studio work in drawing and painting, sculpture and three-dimensional concepts.

Arch. 4821-2-3. Special Topics in History and Theory
3-0-3 each. Prerequisite: consent of college.
Research in advanced areas of history and theory of architecture.

Arch. 4851-2-3. Special Topics
3-0-3 each.

Arch. 4911-2-3.4. Visual Communications Studios
0-3-1 to 0-15-5. Prerequisite: Arch. 3911-2-3-4.
Intermediate studio work in: (1) drawing and painting, (2) sculpture and three-dimensional concepts, (3) photography, (4) graphic design and rendering.

Arch. 4915-6-7-8. Visual Communications Studios
Credit to be arranged. Prerequisite: consent of college.
Self-directed studies in visual communications arts.

Arch. 4941-2-3. Special Problems
Credit to be arranged.

Arch. 4951-2-3-4. Special Problems
Credit to be arranged.

Arch. 4994-5. Special Problems
Credit to be arranged.

Arch. 6001-2-3. Architectural Design
3-18-9 each. Prerequisite: graduate standing.
Problems in design applied to related theory in urban design, architecture and behavioral studies in architecture.

Arch. 6004-5-6. Architectural Design
3-18-9 each. Prerequisite: graduate standing.
Design of complex building facilities and their environment.

Arch. 6302. Building Performance I
3-0-3. Prerequisite: graduate standing.
Introduction to methods used to evaluate the performance of buildings, building systems and components. Criteria and basis to formulate performance specifications.

Arch. 6322. Prestressed Concrete Structures in Architecture
3-0-3.
Structural characteristics of prestressed concrete structures, manufacturing techniques, application to architectural problems, economic factors, principles of analysis and design.

Arch. 6351. Advanced Architectural Acoustics
3-0-3. Prerequisite: Arch. 2303 or equivalent.
Design requirements for noise control and acceptable acoustic conditions. Practical design problems, materials selection and calculation of sound propagation parameters.

Arch. 6401. Landscape Resource Analysis
3-0-3. Prerequisite: graduate standing.
Analysis and design methods for solving large scale or complex site development problems in both the public and private sectors.

Arch. 6402. Introduction to the Preservation and Conservation of Cultural Resources
3-0-3. Prerequisite: graduate standing.
Review of preservation and conservation as social attitudes, as public policy concerns and as discrete areas of knowledge. Emphasis will be given to historic preservation as a specialty within the general context of the built environment.

Arch. 6421. Industrialized Housing
3-0-3.
An examination of the problems and proposed solutions to the design, manufacture, marketing and utilization of industrialized building systems to provide housing.

Arch. 6431. Architectural Settings for Health Related Activities
3-1-3. Prerequisite: consent of instructor.
The planning and design of architectural settings for health related activities (excluding hospitals). Analysis of user needs. Programmatic, environmental and construction requirements.

Arch. 6432. Medical Center Process and Planning
3-1-3. Prerequisite: consent of instructor.
Programming and planning of medical centers, location analysis and site planning, identification and analysis of major functional subsystems. Investigation of activity linkages. Space allocation programming.

Arch. 6433. Activity Settings in Medical Centers: Planning and Design
3-1-3. Prerequisite: consent of instructor.
The architectural settings for opus governmental activities in the contemporary medical center. Detailed analysis of user needs and the programmatic design and construction requirements.

Arch. 6441. Housing Economics
3-0-3. Prerequisite: graduate standing.
Economics of the housing delivery process in the private sector. Planning, developmental marketing and management of housing.

Arch. 6442. Construction Cost and Valuation
3-0-3. Prerequisite: graduate standing.
Cost and valuation approaches to building construction, project development and design from an economic valuation viewpoint. Income producing properties are studied in depth.

Arch. 6443. Economics of Building Development
3-6-9. Prerequisite: Arch. 6442.
Case studies of economic success of student designs and existing projects. Income statements are constructed, pro formas prepared and rates of return determined.

Arch. 6444. Building Life Cycle Costing
2-4-3. Prerequisites: Arch. 3441; graduate standing.
This course explores the concepts and application of life cycle costing as a basis for architectural design evaluation. The effects of capital investment and annual costs including energy consumption are explored.

Arch. 6451. Professional Practice of Architecture
3-0-3. Prerequisite: graduate standing.
Provides the student with the principles of architectural office organization and personnel management, the legal framework of architectural practice and contracts, and the techniques of contract administration.

Arch. 6741. Environmental Awareness
5-0-5.
A course for high school teachers designed to acquaint them with environmental problems, planning and control. No credit for Georgia Tech students.

Arch. 6751-2. Complex Systems Design
2-4-3 each. Prerequisite: graduate standing.
Students from various disciplines analyze and design a major complex urban system.

Arch. 6781-2. Projects in Urban Systems Design
0-9-3 each.
Analysis of an unstructured urban problem situation by a multidisciplinary group. Groups identify, structure and analyze a specific local off-campus urban problem and propose a solution for that problem.

Arch. 7000. Thesis
Arch. 7004-5-6. Architectural Design
2-21-9 each. Prerequisite: Arch. 6003 or equivalent.
Design of complex building facilities and their environment.

Arch. 7221. Origin and Evolution of Cities
3-0-3.
Morphological analysis of urban physical settlement patterns. Ecological, social, economic and cultural characteristics as determinants of urban form and structure from prehistory to present.

Arch. 7222. Theories and Principles of Urban Design
3-0-3.
Theories and principles of design revealed through pathological analysis of cities, proposed designs for ideal cities, relevance of psychology and aesthetics as base for urban design.

Arch. 7402. Urban Design Research
1-6-3.
Independent research for means to improve urban environment. Detailed statement of problem, hypothesis, research methodology and products to be submitted must be approved by staff before enrollment.

Arch. 7804-5-6. Problems in Urban Design I, II, III
3-18-9 each. Prerequisite: graduate standing.
Wide range of contemporary urban problems, considerations and judgments at regional, metropolitan/city and suburban scales. Survey and analysis of new and built environments. Formulation and design of comprehensive land use systems, transportation systems, education, health and open space/ recreation systems, and urban services systems. Current and emerging means of plan implementation.
Arch. 8143-53-63-73-83-93. Special Topics 3-0-3 each.
Arch. 8151-2-4-5-6. Special Topics 1-0-1 through 6-0-6, respectively.
Arch. 8521-2-3. Special Problems in Architectural History
Credit to be arranged.
Individual study of selected periods, architects, schools or building types.
Arch. 8531-2. Special Problems
Credit to be arranged.
Only for students majoring in structures.
Credit to be arranged.
Independent study of advocacy planning as a force for improving the quality of the urban environment. Admission to courses permitted upon approval by instructor of applicant's proposed study program.
Arch. 8550-1-2-3-4-5-6. Special Problems
Credit to be arranged.

Building Construction
B.C. 1851. Building Construction Seminar 0-3-1
Introduction to the construction industry. Sources, properties and uses of construction materials.
Corequisite: Arch. 2301, Phys. 2111.
Study and analysis of job planning required, work methods, materials, systems and equipment employed on light construction projects which include residential and small commercial buildings.
Continuation of B.C. 2001 with emphasis on medium sized commercial and industrial projects.
Classification of work and quantity survey techniques. Analysis and determination of costs of construction operations including preparation of bid proposals.
Principles, methods, organizations and problems related to construction management.
B.C. 3302. Construction Practice II 3-0-3. Prerequisite: B.C. 3301, Mgt. 3280.
Managers, contractors, designers and insurance agents interested in the legal aspects of construction management.
Financial consideration and cash flow requirements for construction projects and organizations.
Methods and analysis and human factors in construction project management. Processes by which building facilities are produced and delivered.
Review and examination of major component building systems in use today. Discussion of anticipated future requirements for systems and potential impacts on the construction process.
B.C. 4441. Land Development 3-0-3.
Fundamentals underlying the economics and political determinants of land use, ecological considerations and the techniques for implementing the development of land.
Analysis of material, equipment, facilities, procedures and supplies to achieve lowest cost consistent with performance requirements to attain optimum quality in building.
The 1970 Occupational Safety and Health Act applies to the building contractor to provide safe working conditions and to the designer to provide safety in buildings.
B.C. 4444. Real Estate Investment 3-0-3.
Fundamentals underlying the economic structure of physical development. A study of the matrix of development processes and investment decisions.
B.C. 4446. Construction Management 3-0-3.
Management of construction processes including the pre-design, design and construction phases. Services and methods used by architects, contractors and independent consultants performing construction management.

City Planning
C.P. 1100. Introduction to City Planning 3-0-3. Fall quarter.
An orientation to urban and regional planning including organization, functions, techniques and methods of implementation.
C.P. 6000. Urban Community Planning 3-0-3.
An orientation to urban and regional planning including organization, functions, techniques and methods of implementation.
C.P. 6010. Land Use Planning 3-0-3.
Factors determining land use, location and interrelationships of various land uses, land use studies and plan preparation, implementation of land use policies and plans.
C.P. 6020. Planning Legislation and Regulation 3-0-3.
Theory and use of eminent domain, taxing and police powers, enabling acts, charters, official maps, codes, restrictive covenants, controlled highway access legislation.
C.P. 6030. Planning Legislation and Regulation 3-0-3.
An intensive study of zoning—its history, principles, uses and limitations through review of significant court cases and subdivision regulations.
C.P. 6050. Housing and Urban Renewal 3-0-3.
Urban renewal problems, programs and techniques including legislation, identification of renewal areas, planning, administration, relocation, financing and real estate problems.
C.P. 6060. State and Regional Planning 3-0-3.
Basic concepts and theories of state and regional planning examined in detail. The history, background, organization and techniques and methods are studied.
Planned change in context of public works planning and development, plan implementation, population analysis, public participation, conflict value assessment and information transfer.
The institutional setting in which public works planning takes place, elements of the planning process and techniques for the assessment of economic, social and environmental impact.
Survey of public sector financial planning and management techniques, emphasis on comprehensive planning inputs to public financial policy and operations.
C.P. 6100. Problems in City Planning 2-12-6.
Development of a new town, organization of its government, public and private programs to meet citizen needs, design of new towns, preparation and evaluation of plans for specific sites.
C.P. 6110. Problems in City Planning 2-12-6.
Study of existing urban area, preparation of land use and thoroughfare plans including traffic volume estimates, fringe area annexation study, neighborhood conservation plans and programs.
C.P. 6120. Problems in City Planning 2-12-6.
An in-depth study of a class basis of a specific urban or regional planning problem prepared for a client agency or citizens organization.
C.P. 6140. Environmental Aspects of City and Regional Planning I 3-0-3.
Identification and quantitative analysis of air, water, noise, spatial pollution and its influence on urban development, health and wellbeing. Solutions, environmental controls and management programs evaluated.
C.P. 6150. Environmental Aspects of City and Regional Planning II 3-0-3.
Field analysis of noise, air, water and spatial pollution. Students identify, evaluate and apply city planning solutions to environmental problems.
C.P. 6160. Environmental Noise Management 3-0-3.
Management and administration of environ-
C.P. 6170. Economics of Environmental Quality
3-0-3.
Topics included are the causes of market failure to provide a high quality environment, amenity resources and extra-market values.

3-0-3. Fall quarter.

C.P. 6210. Community Facilities Planning
3-0-3. Prerequisite: senior or graduate standing.

C.P. 6260. Economics of Urban Development
3-0-3.
Economic function of urban communities, location of cities, market analysis and economic feasibility studies of retail stores, offices, hotels, housing and industrial developments and new communities.

C.P. 6270. Economic Analysis of Urban Areas
3-0-3.
An examination of methods and techniques for analyzing the economic base of urban communities, special emphasis on problems of regional population, employment and income data.

C.P. 6280. State and Local Finance
3-0-3.
Extension of C.P. 6090 with emphasis on program design, analysis, operation, evaluation, expenditure and revenue estimates, capital and operating budgets.

C.P. 6290. Economics of Urban Problems
3-0-3.
Seminar on economic and planning aspects of contemporary urban problems, emphasis on student research in particular areas of interest.

C.P. 6350. Introduction to Scientific Methods in Urban and Regional Planning
2-6-4.

C.P. 6360. Intermediate Scientific Methods in Urban and Regional Planning
2-6-4. Prerequisite: C.P. 6350 or consent of department.

C.P. 6370. Systems Planning Methods in Urban and Regional Planning
2-6-4. Prerequisite: C.P. 6360 or consent of department.

C.P. 6753. Economic Aspects of Urban and Regional Planning I
3-0-3. Prerequisite: senior or graduate standing.

C.P. 6754. Economic Aspects of Urban and Regional Planning II
3-0-3. Prerequisite: C.P. 6753.

C.P. 7000. Master’s Thesis
Credit to be arranged.

C.P. 8010-20-30-40-50. Seminar
1-0-0.

C.P. 1261-2-3. History of Design
3-0-3 each.
A history of design, technology and innovation, with emphasis on their influence in historic cultures. Open to all students.

I.D. 2201-2-3. Industrial Design
1-3-3 each. Prerequisites: I.D. 2301-2-3.

1-3-2 each. Use of materials and processes designers use to communicate the idea. Graphical techniques. Use of hand and power tools with wood, metals and plastics. Modeling techniques. Use of working drawings.

I.D. 3001-2-3. Industrial Design

I.D. 3002-3-3. Materials and Process Design
1-2-3 each. Introduction to cash-flow and discounting techniques. Micro-economics in project formulation and evaluation. Applications from welfare economics, project analysis, cost allocation.

I.D. 3004-2-3. Industrial Design
1-18-8 each. Prerequisite: I.D. 3003.

Biological and environmental sciences and public health.

Biological Sciences.

Scientific methods that are relevant and applicable to planning practice and theory.

Methods useful in ecological studies.

Classified as biology and their role in soil, water, foods and air.

Text: at the level of Frobisher et al, Fundamentals of Microbiology.

Chemical, physical and biological properties of cells. Biological macromolecules, their transformations, metabolism and enzymes. Photosynthesis, protein synthesis and ion transport in cells.

Text: at the level of Dowben, Cell Biology and selected references.

An introduction to statistical methods and their use in the preparation and interpretation of biological experiments.

Text: at the level of Sokal and Rohlf, Introduction to Biostatistics.

An introduction to the principles of heredity.

Biological Science majors but appropriate for interested nonmajors. Emphasizes structure and function of natural populations, communities and ecosystems.


Designed to be taken with Biol. 3035. Important aspects of ecological theory, analytical techniques and physical and chemical methods useful in ecological studies.


Biological Sciences majors but appropriate for interested nonmajors. Emphasizes structure and function of natural populations, communities and ecosystems.


Biological and environmental sciences and public health.

Methods useful in ecological studies.

Classified as biology and their role in soil, water, foods and air.

Text: at the level of Frobisher et al, Fundamentals of Microbiology.

Chemical, physical and biological properties of cells. Biological macromolecules, their transformations, metabolism and enzymes. Photosynthesis, protein synthesis and ion transport in cells.

Text: at the level of Dowben, Cell Biology and selected references.

An introduction to statistical methods and their use in the preparation and interpretation of biological experiments.

Text: at the level of Sokal and Rohlf, Introduction to Biostatistics.

An introduction to the principles of heredity.

Biological Science majors but appropriate for interested nonmajors. Emphasizes structure and function of natural populations, communities and ecosystems.


Biological Science majors but appropriate for interested nonmajors. Emphasizes structure and function of natural populations, communities and ecosystems.


Biological and environmental sciences and public health.

Methods useful in ecological studies.

Classified as biology and their role in soil, water, foods and air.

Text: at the level of Frobisher et al, Fundamentals of Microbiology.

Chemical, physical and biological properties of cells. Biological macromolecules, their transformations, metabolism and enzymes. Photosynthesis, protein synthesis and ion transport in cells.

Text: at the level of Dowben, Cell Biology and selected references.

An introduction to statistical methods and their use in the preparation and interpretation of biological experiments.

Text: at the level of Sokal and Rohlf, Introduction to Biostatistics.

An introduction to the principles of heredity.

Biological Science majors but appropriate for interested nonmajors. Emphasizes structure and function of natural populations, communities and ecosystems.


Biological and environmental sciences and public health.

Methods useful in ecological studies.

Classified as biology and their role in soil, water, foods and air.

Text: at the level of Frobisher et al, Fundamentals of Microbiology.

Chemical, physical and biological properties of cells. Biological macromolecules, their transformations, metabolism and enzymes. Photosynthesis, protein synthesis and ion transport in cells.

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Text: at the level of Dowben, Cell Biology and selected references.

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Biological and environmental sciences and public health.

Methods useful in ecological studies.

Classified as biology and their role in soil, water, foods and air.

Text: at the level of Frobisher et al, Fundamentals of Microbiology.

Chemical, physical and biological properties of cells. Biological macromolecules, their transformations, metabolism and enzymes. Photosynthesis, protein synthesis and ion transport in cells.

Text: at the level of Dowben, Cell Biology and selected references.

An introduction to statistical methods and their use in the preparation and interpretation of biological experiments.

Text: at the level of Sokal and Rohlf, Introduction to Biostatistics.

An introduction to the principles of heredity.

Biological Science majors but appropriate for interested nonmajors. Emphasizes structure and function of natural populations, communities and ecosystems.

Advanced study of bacteria of significance in human disease and of immunity. Text: at the level of Burrows, Textbook of Microbiology and Joklik and Smith, Microbiology.

**Biol. 4408. Microbial Genetics**
3-6-5. Prerequisite: Biol. 3310 or consent of school.
Microbial genetics, with special emphasis on the integration of genetic studies with biochemical and physical analysis of synthesis, structure and function of nucleic acids and proteins.
Text: at the level of Hayes, The Genetics of Bacteria and Their Viruses and selected references.

**Biol. 4409. Microbial Physiology**
3-5-5. Prerequisite: Biol. 3310, Chem. 3511 or consent of school.
Discussions and laboratory investigations on the physiology of growth and metabolic activities of microorganisms. Text: at the level of Burrows, Textbook of Microbiology, XX edition and selected references.

**Biol. 4410. Microbial Ecology**
3-0-3. Prerequisite: Biol. 4408 or 4409 or consent of school.
Advanced discussions on microorganisms occupying key roles in recycling processes, microbial ecosystems and microbial evolution. Text: at the level of Ankelsteter, Microbial Ecology and selected references.

**Biol. 4411. Industrial Microbiology**
3-0-3. Prerequisite: Biol. 3310.
The biochemistry, genetics and technological applications of microorganisms used in commercial processes.

**Biol. 4412. Introductory Aerobiology**
3-0-3. Prerequisite: Biol. 3310 or consent of school.
Physical and biological factors involved in the dissemination, survival and transport of living microorganisms by the aerial route.

**Biol. 4413. Air and Water Pollution**
3-0-3.
An introduction to the technical and legal problems of air and water pollution by industry and its control, for those engineers working in industry.

**Biol. 4415. Introductory Radiation Biology**
3-3-4. Prerequisite: consent of school.
A general survey of biological systems and their responses to various kinds of radiations. Text: at the level of Casarette, Radiation Biology.

**Biol. 4416. Industrial Hygiene**
3-0-3.

**Biol. 4420. Limnology**
3-6-5. Prerequisite: Biol. 3335 or consent of school.
Physical, chemistry and ecology of fresh water. Aquatic communities and ecosystems. Chemical and biological investigations of lakes and streams, including several field trips.
Text: at the level of Reid, Ecology of Inland Waters and Estuaries.

**Biol. 4423. Population Biology**
3-0-3. Prerequisite: Biol. 2212 or consent of school.
Population ecology: dynamics and evolutionary and environmental modification of genetic systems. Text: at the level of Wilson and Bossert, A Primer of Population Biology.

**Biol. 4425. Marine Population Biology**
3-6-3. Prerequisite: Biol. 4423.
This course will cover, by introductory courses in ecology, genetics, calculus and biostatistics, or consent of school.

**Biol. 4426. Estuarine Ecology**
3-6-5. Prerequisite: Biol. 3334 or consent of school.
A multidisciplinary field-oriented course, concerned with the biology, physics, chemistry and biology of estuaries, and the dynamics of the estuarine ecosystem. To be offered at Marine Science Center, Skidaway Island, Georgia.

**Biol. 4427. Ichthyology**
3-6-5. Prerequisite: one year of general biology or general zoology and junior standing or consent of school.
Taxonomy, distribution, ecology and evolution of fishes with special reference to the marine and freshwater fishes of eastern North America. To be offered during summer term at the Marine Science Center, Skidaway Island, Savannah, Georgia.

**Biol. 4432. Cytology**
3-3-4. Prerequisite: Biol. 3320 or consent of school.
Modern aspects of the morphologic, functional and cytotoxicity of the cell. Preparative techniques and principles for observations in light, phase and electron microscopy.

**Biol. 4435-6. Applied Biology**
3-0-3 each. Prerequisite: consent of school.
Selected topics in modern biology.

**Biol. 4433. General Animal Physiology I**
4-3-5. Prerequisite: Biol. 3320, Chem. 3312 or consent of school.
Vertebrate systems physiology to include: muscles, nerves, circulation, respiration and body fluids.

**Biol. 4444. General Animal Physiology II**
3-6-5. Prerequisite: Biol. 3320, Chem. 3312 or consent of school.
Continuation of Biol. 4443, to include the following: renal systems, special senses, digestion, absorption, reproduction and the endocrine system. It is recommended but not mandatory that Biol. 4443 be taken prior to Biol. 4444.

**Biol. 4445. Plant Physiology**
3-6-5. Prerequisite: Biol. 3330, Chem. 3312 or consent of school.
Chemical transformations in photosynthesis, photophysiology and water relationships in organic nutrition and effect of hormones on growth and development.

**Biol. 4450. Seminar**
Student and staff presentations of reports on laboratory or literature searches.

**Biol. 4461. Cyto­ genetics**
3-6-5. Prerequisite: Biol. 3334, 4432.
A correlated study of genetics and cytology primarily concerned with the chromosomal basis of genetics. Laboratory experience in methodology of chromosome study including humans. Texts: at the level of Brown, Textbook of Cytogenetics and Burnam, Discussions in Cytogenetics.

**Biol. 4464. Developmental Genetics**
3-0-3. Prerequisite: Biol. 3334 or consent of school.
Transcriptional, translational and posttransla­tion control of gene expression in cell differ­ entiation, mechanisms of genomic regulation in eukaryotes, nucleocytoplasmic interac­tions, genetic aspects of morphogenesis.

**Biol. 4466. Genetics of Populations**
3-0-3. Prerequisite: Biol. 3334 or consent of school.


Biol. 4476. Supramolecular Biology 3-0-3. Prerequisite: Biol. 2211, Chem. 3313 and Phys. 2123 or consent of school. Structure, formation and properties of biological objects at a level of organization between single molecules and cells.

Biol. 4478. Physical Biology 4-0-4. Prerequisite: Phys. 2121, Chem. 3312 or consent of school. Use of physics and biochemistry in explaining structure and function of biological systems at atomic and molecular levels. Approach mathematical, quantum mechanics introduced as needed. Text: at the level of Setlow and Pollard, Molecular Biophysics.

Biol. 4477. Applications of Microbiology in Sanitary Engineering 3-3-4. Prerequisite: senior standing, fall quarter. Microbiology in environmental engineering. Relationships of protozoa, algae, bacteria and viruses to water borne disease, the treatment of wastes and the deterioration of aquatic habitats.

Biol. 4801-3-3-4-5. Special Topics 1-0-1 to 5-0-5 respectively. These courses enable the School of Biology to provide offerings dealing with areas of particular current interest in biological science.

Biol. 4960. Molecular Biophysics 3-3-4. Prerequisite: Biol. 2211. Special laboratory problems in biology, to be given any quarter with credits (not to exceed six) to be arranged.

Biol. 5608. Advanced Microbial Genetics 3-0-3. Prerequisite: Biol. 4408 or 4468 or consent of department. Genetics of bacteria, plasmids and viruses. Organization and regulation of expression of genetic material, with special emphasis on new techniques such as genetic engineering.

Biol. 5609. Advanced Microbial Genetics Laboratory 0-0-2. Prerequisite: Biol. 4408 or consent of department. Production, isolation and characterization of mutants. Testing for mutants. Text: at the level of Stent, Molecular Genetics, (2nd Ed.).

Biol. 5619. Ecological Systems 3-0-3. Prerequisite: graduate standing or consent of school. Fundamentals of ecology with emphasis on the structure and function of ecosystems. Application of ecosystem concepts to environmental impact analysis and environmental management. Designed primarily for planners and engineers; suitable for biologists.

Biol. 6222. Special Topics In Ecology 1-2-2. Prerequisite: Biol. 6619 or consent of school. Topics of current interest in environmental science such as systems analysis, indicators of pollution, environmental impact evaluation and environmental monitoring.


Biol. 6225. Communities and Ecosystems 3-0-3. Prerequisite: Biol. 3335 or consent of school. Theoretical and practical aspects of the description, classification and current understanding of the functional processes in major communities and ecosystems of North America. Text: Literature, references and review articles.

Biol. 6226. Physiological Ecology 3-3-4. Prerequisite: Biol. 4444 or 4445 or consent of school. Physiological adaptations of plants and animals to their environments. Measurements and analysis of environmental factors as well as organismal physiological responses to light, temperature, water and mineral nutrients will be emphasized. Text: Literature, references and review articles.

Biol. 6632. Design of Experiments in Quantitative Biology 3-3-4. Prerequisite: Biol. 3332. Statistical analysis of data. Sampling strategies and statistical basis for design of experiments in biology. Selected examples from the research of individual staff members will serve to demonstrate the basic principles. Text: at the level of Wilson, An Introduction to Scientific Research.

Biol. 6633. Selected Topics in Radiobiology 3-3-4. Prerequisite: Biol. 4415. High-energy radiation as an investigative tool including determination of cell structure and function, target theory and multit hit phenomena.

Biol. 6634. Selected Topics in Experimental Cell Biology 3-0-3. Prerequisite: Biol. 6633. Research areas in microbiology and mammalian cell culture, including permeability of cell membranes, cytogenetics and selection pressures in cell cultures.

Biol. 6635. Air Pollution Biology 3-0-3. Prerequisite: consent of school. Designed to acquaint engineers and scientists with the biological aspects of air pollution and its effects in the total environment of living animals and plants.

Biol. 6640. Instrumental Methods in Biology 3-6-5. Prerequisite: consent of school. Biophysical and biochemical methods for the study of macromolecules, cell components, multiscalar and organism level organization. Analysis by electron microscopy, spectroscopy, centrifugation and other methods.


Biol. 6645. Photobiology 3-0-3. Prerequisite: graduate standing or consent of school. The interactions of light with biomolecules and the roles of light in the environment, in biology and medicine will be considered. Processes of vision, photomorphogenesis, photosynthesis and photoperiodism will be included. Text: at the level of Mitra and Science of Photobiology, K. C. Smith, Ed.

Biol. 6646. Mammalian Physiology 3-3-4. Prerequisite: Biol. 4444 or equivalent or consent of instructor. Physical, biochemical and biological phenomena underlying physiological functions. Integration of physiological processes and basic techniques of physiological analysis.

Biol. 6647. Developmental Physiology 3-6-5. Prerequisite: Biol. 3343, 4444 or equivalents or consent of instructor. Fetal and maternal organ functions, vertebrate organogenesis. Investigations of organogenesis in laboratory animals and of abnormal development induced by teratogenic agents.


Biol. 6649. Neurobiology 3-0-3. Prerequisite: Chem. 3313, Phys. 2123, Biol. 2211 or consent of school. A survey of some of the basic mechanisms of neural function and methods used to study them, with particular reference to the visual system. Text: at the level of Katz, Nerve, Muscle, and Synapse, selections from Schmitt, The Neurosciences, Second Study Program, and references.

Biol. 6664. Selected Topics in Regulatory Biology 3-0-3. Prerequisite: Biol. 3334, Chem. 3351 or consent of school. Two courses (one 5-0-5, one 3-0-3) to be offered in an interdisciplinary area where the life sciences. Credit not available for biology majors. Text: at the level of Ganong, William F., Review of Medical Physiology.

Biol. 6711. Medical Physiology 5-0-5. Prerequisite: graduate standing, introductory biology or consent of school. Systematic study of mammalian and particularly of human physiology and essential anatomy, designed for advanced students in fields interdisciplinary with the life sciences. Credit not available for biology majors. Text: at the level of Ganong, William F., Review of Medical Physiology.

Biol. 6730. Biological Effect of Radiations 3-3-4. Prerequisite: Biol. 3335 and Biol. 4444. An introduction to the effects of nuclear radiations upon biological systems for graduate students in the nuclear science and engineering curriculum.

Biol. 7000. Thesis

Biol. 8013-4-5. Seminar in Microbiology 2-0-2 each. Prerequisite: graduate standing. Recent advances in microbial physiology.
and metabolism, industrial and applied microbiology, microbial ecology, medical microbiology and immunology.

Biol. 8023-4-5. Seminar in Ecology
2-0-2 each. Prerequisite: graduate standing. Topics of current interest and recent advances in the general areas of population growth and limitation, interspecific relationships and the structure, productivity and stability of ecosystems.

Biol. 8043-4-5. Seminar in Physiology
2-0-2 each. Prerequisite: graduate standing. Current concepts of membrane structure, molecular and ionic transport mechanisms, endocrinology, cardiac, nervous and muscular function, physiology of development. Student and faculty presentations.

Biol. 8063-4-5. Seminar in Genetics
2-0-2 each. Prerequisite: graduate standing. Topics of current interest in the areas of cytogenetics, developmental genetics, molecular genetics, mutagenesis and the genetics of man and populations. Student and faculty presentations.

Biol. 8101-2-3-4-5. Special Topics
1-0-1 to 3-0-5 respectively. These courses enable the School of Biology to provide offerings dealing with areas of particular current interest in biological science.

Biol. 8504-5-6. Special Problems
Credit to be arranged.

Building Construction
See Architecture.

Ceramic Engineering

Cer. E. 1010. Introduction to Ceramic Engineering
2-3-3. Elective for freshmen. A comprehensive survey of ceramic materials, raw materials and the industrial processes used in their production. Text: at the level of Mitchell, Ceramics—Stone Age to Space Age.

Cer. E. 3001. Ceramic Data Handling
2-3-3. Study of testing, rational economic value of test results, basis of test selection, interpretation of results, data analysis, statistical methods, computer methods, reporting. Text: at the level of Bivington, Data Reduction and Error Analysis for the Physical Sciences and Holscher, Simplified Statistical Analysis.

2-3-3. Prerequisite: Chem. 1101 or equivalent. Introduction to types of materials available to engineers, their properties, the causes of these properties and how these properties determine their utilization and service life.

Cer. E. 3003. Ceramic Processing I
3-3-4. Prerequisite: Chem. 1102 or equivalent. Processing of ceramic articles based on clay minerals or plastic forming processes. Text: at the level of Jones, Ceramics.

Cer. E. 3004. Ceramic Processing II

Cer. E. 3005. Phase Equilibria for Ceramists
3-0-3. Prerequisite or corequisite: Chem. 3412. Interpretation of phase equilibria in nonmetallic high temperature one, two and three component systems. Usefulness of phase diagrams in the processing of ceramic materials considered. Text: at the level of Levin, Robbins and McMurdie, Phase Diagrams for Ceramists (monograph by the American Ceramic Society).

Cer. E. 3006. Physical Ceramics I
3-0-3. Prerequisite: Cer. E. 3002. Crystal chemistry concepts are developed and used to characterize silicate, oxide and nonoxide ceramic materials. Text: at the level of Kingery, Introduction to Ceramics.

Cer. E. 3007. Pyrometry and Thermal Analysis
2-3-3. Prerequisite: Phys. 2122. Temperature measurement using thermocouples, optical pyrometers and radiation pyrometers is emphasized. Differential thermal analysis and thermogravimetric analysis in characterizing ceramic materials is presented. Text: at the level of Decision Measurement and Calibration: volume two, Temperature, NBS Special Publication 300.

Cer. E. 3008. Glass Technology I
2-3-3. Prerequisite: Cer. E. 3005 or consent of school. The fundamentals of glass structure, composition, manufacturing, properties and applications are described. In the laboratory many glass batches are made, fired and analyzed. Text: at the level of Hutchins and Harrington, Glass, (reprint from volume 10, Encyclopedia of Chemical Technology, second edition, pp. 533-604, J. Wiley, 1966).

Cer. E. 3080. Survey of Ceramics
2-0-2. General elective for nonmajors. A survey of the classifications and physical properties of ceramic products, the materials and manufacturing processes. Text: at the level of Mitchell, Ceramics—Stone Age to Space Age.

Cer. E. 3090. Ceramic Survey Laboratory
0-3-1. Prerequisite or corequisite: Cer. E. 3080. General elective. Plant trips to local ceramic plants, flow lines, processes, production of pottery and ceramic pieces.

Cer. E. 4002. Refractories and Combustion

Cer. E. 4003. Physical Ceramics II
3-3-3. Prerequisite: Cer. E. 3006, Phys. 2123, Chem. 3413. Densification sintering and reaction kinetics in ceramic materials are considered. The resultant physical, mechanical, electrical and magnetic properties are related to the atomic and macroscopic structure representative of ceramic properties. Text: at the level of Kingery, Introduction to Ceramics.

Cer. E. 4004. High Temperature Thermodynamics
2-0-2. Prerequisite: Chem. 3412. Chemical thermodynamics data is used to predict reaction directions and study vaporization processes. The use of various gas mixtures to control oxygen pressures is also described. Text: at the level of Wicks and Block, Thermodynamic Properties of 65 Elements—Their Oxides, Halides, Carbides and Nitrides, Bureau of Mines Bulletin No. 605 (1963).

Cer. E. 4005. Glass Technology II
2-3-3. Prerequisite: Cer. E. 3008. Compositions of low, moderate and high temperature glass systems are studied to learn basic of glass properties, adherence, color, opaqueness and texture. Text: at the level of C. W. Parrmelee, Ceramic Glasses.

Cer. E. 4010-1-2. Technical Management and Design
1-3-2, 0-6-2, 0-3-1. Prerequisite: consent of school.

Major experimental or equipment design is selected by class from a number of areas presented by industry.

Cer. E. 4015. Independent Research Project I
1-0-1. Prerequisite: senior standing in ceramic engineering. The object of this course is to place the student on his or her own initiative and to coordinate the knowledge previously received.

Cer. E. 4016. Independent Research Project II
1-3-2. Prerequisite: Cer. E. 4015. The senior student formulates an experimental plan under supervision of a professor, assembles equipment and materials and begins actual laboratory experimentation.

Cer. E. 4017. Independent Research Project III
0-6-2. Prerequisite: Cer. E. 4016. Completion of all laboratory work on investigation, submission of an approved write-up in acceptable format one week before examination week.

Cer. E. 4018. Drying and Psychrometry

Cer. E. 4042-3-4. Seminar
1-0-1. Prerequisite: junior standing. Discussion of current ceramic and scientific literature and reports of investigations.

Cer. E. 4051. Cements
2-3-3. Prerequisite: Cer. E. 3005. Includes the required properties of raw materials, processing and the hydraulic properties of cements. Portland, magnesia, high alumina, dental and gympsy cements are included. Text: at the level of Bogue, The Chemistry of Portland Cement or Lea, The Chemistry of Cement and Concrete.

Cer. E. 4052. Inorganic Phase Analysis and Identification
3-3-4. Prerequisite: Phys. 2122. Provides the student with the tools to identify a ceramic material using both atomic structure related techniques and elemental identification. Use of optical crystallography, X-ray diffraction, transmitted and reflected light microscopy and electron microscopy are emphasized as tools to identify ceramic material phases and elemental composition. Text: at the level of Blos, An Introduction of the Methods of Optical Crystallography and Cullity, Elements of X-ray Diffraction.
Equilibria.

3-0-3. Prerequisite: consent of school.

New developments in ceramic materials, specialized independent study on topics of current interest.

Cer.E. 4053. Technical Ceramics
2-3-3. Prerequisite: Cer.E. 3006, Phys. 2122.

Fabrication requirements, property control and structure—property—processing relationship, ceramic dielectrics, ferrites, ferroelectrics, piezoelectrics emphasized.


Cer.E. 4801-2-3-4-5-6. Special Topics
Credit by arrangement (1, 2, 3, 4 or 5 hours). Prerequisite: consent of school.

An introduction to chemical engineering design in which simplified problems of current interest are used as a basis for a design project.

Text: at the level of Peters, *Elementary Chemical Engineering*.

Ch.E. 101. Introduction to Chemical Engineering
1-0-1. Prerequisite: Math. 1100.

An orientation to chemical engineering. Nature of chemical engineering, the types of opportunities available and the requirements for graduation and a successful career.

Ch.E. 1110. Elements of Chemical Engineering Design
3-3-3. For freshmen only or consent of school.

Basic crystal structures and relation of different crystal compounds with similar crystal structures. Structures of various clays and complex oxides.

Text: at the level of Evans, *Crystal Chemistry and Wells, Structural Inorganic Chemistry*.

Ch.E. 3601. Crystal Structure of Materials
3-3-3. Prerequisite: consent of school.

Relationship of crystal structure to chemical, physical and optical properties of high temperature inorganic materials.

Text: at the level of Wilson, *Introduction to Scientific Research and Ackoff, Scientific Method*.

Cer.E. 4061. Crystal Studies
2-6-4. Prerequisite: Cer.E. 4003 or consent of school.

Basic surface properties are studied for application to gas absorption surface area measurements and mineral flotation processes.

Cer.E. 6014-5. Ceramic Applications to the Phase Rule
3-3-3 each. Prerequisite: Cer.E. 3005 or consent of school.

Phase equilibria in one, two and three-component systems reviewed. Melting and solidification behavior in complex three-component systems examined. Effect of oxygen pressure on phase relations in multicomponent systems surveyed. Applications of thermodynamics to phase diagrams.

Text: at the level of Prince, *Alloy Phase Equilibria*.

Cer.E. 6017-8. Glass Technology
3-3-3 each.

Constitution of glass is studied using dynamic considerations. The reasons for the failure of oxide melts to crystallize on cooling are emphasized. Mutual polarization of ions is utilized in analyzing the various glass structures. The different experimental techniques available to study glasses are reviewed.

Cer.E. 4005. Technical Ceramics
2-3-3. Prerequisite: Cer.E. 3006, Phys. 2122.

Fabrication requirements, property control and structure—property—processing relationship, ceramic dielectrics, ferrites, ferroelectrics, piezoelectrics emphasized.


Cer.E. 4801-2-3-4-5-6. Special Topics
Credit by arrangement (1, 2, 3, 4 or 5 hours). Prerequisite: consent of school.

An introduction to chemical engineering design in which simplified problems of current interest are used as a basis for a design project.

Text: at the level of Peters, *Elementary Chemical Engineering*.

Ch.E. 1750. Introduction to Bioengineering
3-3-3.

An introduction to the aspects of science and technology pertinent to the engineering analysis of biological systems. Also taught as E. 1750. E.E. 1750, E.S.M. 1750, M.E. 1750.

Ch.E. 2207. Chemical Process Principles I
3-3-3. Prerequisite: Chem. 2113, Corequisite: Math. 2307.

The material balance is developed. Gas behavior, systems of units, and material and thermodynamic properties are discussed. Emphasis is on the application of material balances to steady state physical and chemical processes.

Text: at the level of Felder and Rousseau, *Elementary Principles of Chemical Process*.

Ch.E. 2208. Chemical Process Principles II
3-3-3. Prerequisite: Ch.E. 2207.

A continuation of Ch.E. 2207. The energy balance is developed. Thermophysical and thermochromical concepts are discussed. Emphasis is on the application of combined material and energy balances to steady and unsteady state physical and chemical processes.

Text: at the level of Azzaro, *Elements of X-ray Crystallography*.

Cer.E. 7000. Master's Thesis

Cer.E. 8001-2-3-4-5-6. Seminar 1-0-0.

Current ceramic developments.

Ch.E. 8102 through 8119. Special Topics
Credit to be arranged.

Specific, well-defined study and measurement problems will be considered and approved for credit upon completion.

Ch.E. 8501-2-3. Special Problems
Credit to be arranged.


Chemical Engineering

Chemical Engineering

Ch.E. 1101. Introduction to Chemical Engineering
1-0-1. For freshmen only or consent of school.
Elementary heat and mass transfer primarily designed for textile students. Not open to students in the School of Chemical Engineering.

Text: At the level of McCabe and Smith, Unit Operations of Chemical Engineering.

Ch.E. 4111. Mineral Engineering: Fossil Fuels 3-0-3
An introductory course in fossil fuels. Gives majors in engineering a background in fuels as raw materials.

Ch.E. 4407. Chemical Process Analysis 3-0-3
Prerequisite: Ch.E. 3307, Chem. 3313, 3413
Introduction to the engineering of chemical reactions involving colloidal and amorphous materials.

Text: At the level of Adamson, Physical Chemistry of Surfaces, second edition, and Rodriguez, Principles of Polymer Systems.

Ch.E. 4414. Air Pollution Control 3-0-3
Application of mass transfer principles to the design of pollution control systems utilizing adsorption, absorption, filtration and precipitation. Other topics are process optimization, fuel pretreatment.

Text: At the level of Wark and Warner, Air Pollution—Its Origin and Control.

Ch.E. 4415. Reactor Design 3-0-3
Prerequisite: Ch.E. 4438, Chem. 3313, 3413
Kinetics and mechanisms of industrial chemical reactions. Effects of temperature, pressure and concentrations on the rates of chemical reactions. Design of batch backmix, tubular and semibatch reactors.

Text: At the level of Levenspiel, Chemical Reaction Engineering.

Ch.E. 4416. Process Control 3-0-3
Prerequisite: E.E. 3700. Corequisite: Ch.E. 4415
Dynamics of chemical processes and theory of control techniques. Mathematics using primarily Laplace transforms is applied with instrumentation and process constraints to system design.

Text: At the level of Weber, An Introduction to Process Dynamics and Control.

Ch.E. 4431. Chemical Engineering Economics 3-0-3
Prerequisite: Ch.E. 3307
A study of techniques required in project analysis in areas of systems cost analysis and the use of the economic balance for design and optimization.

Text: At the level of Peters and Timmerhaus, Plant Design and Economics for Chemical Engineers.

Ch.E. 4432. Process and Equipment Design 2-3-3
Prerequisite or corequisite: Ch.E. 4431, Met. 3301
Comprehensive problems for each of the basic types of chemical process equipment solved. Pressure vessels, heat exchangers, mass transfer equipment and materials handling equipment.

Text: At the level of Peters and Timmerhaus, Plant Design and Economics for Chemical Engineers.

Ch.E. 4434. Chemical Plant Design 1-6-3
Prerequisite: Ch.E. 3398, 3308, 4415, 4416, 4431, 4432, 4438
A comprehensive problem in plant design.

Ch.E. 4438. Chemical Engineering Thermodynamics 4-0-4
Prerequisite: Chem. 3411, Ch.E. 3307
Principles of thermodynamics with industrial applications. Flow of compressible fluids, thermodynamic properties, charts, tables, power and refrigeration cycles and processes, phase equilibrium, chemical equilibrium.

Ch.E. 4449. Computer Aided Process Design 2-3-3
Prerequisite: Ch.E. 2209, 4438 or consent of school.
A study of the synthesis and operation of large-scale computer systems for steady-state simulation of chemical processes as a design tool.

Text: At the level of Seader, Flowsheet Simulation—An Introduction.

Ch.E. 4453. Polymerization Process Analysis 3-0-3
Prerequisite: Met. 3301, Ch.E. 4415 or consent of school.
Polymerization processes are analyzed with regard to reaction mechanisms, kinetics and reactor design. Methods of controlling polymer structure during polymerization are emphasized.

Ch.E. 4455. Plastics Industry Manufacturing Policy 3-0-3
Prerequisite: consent of school.
Case studies of practical problems contributed by industry concerning plastics manufacturing, marketing and management. Decision-making processes in the plastics industry are emphasized.

Text: At the level of Skinner and Rogers, Manufacturing Policy in the Plastics Industry.

Ch.E. 4750. Polymer Science and Engineering I 3-0-3
Prerequisite: Chem. 1102, Phys. 2123
An introduction to the chemistry and structure of polymers. Polymerization processes, major polymer systems and methods of polymer identification are presented. Also taught as Text. 4750.

Text: At the level of Rodriguez, Principles of Polymer Systems.

Ch.E. 4751. Polymer Science and Engineering II 3-0-3
Prerequisite: Chem. 1102, Phys. 2123
An introduction to the physical states and transitions, fabrication processes and mechanical properties of polymers. Also taught as Text. 4751.

Text: At the level of Rodriguez, Principles of Polymer Systems.

Ch.E. 4752. Polymer Science and Engineering Laboratory 3-0-3
Corequisite: Ch.E. 4751
Experiments in polymerization, processing and property evaluation of polymers. Also taught as Text. 4752.

Ch.E. 4753. Survey of Pulp and Paper Technology 3-0-3
A survey is made of the mechanical systems used in paper manufacture. The chemistry of pulp preparation and nonfibrous additives is outlined. Also taught as Text. 4753.

Ch.E. 4771. Pulp and Paper Processes I 3-0-3
Prerequisite: consent of school.
A survey of the processes in a Kraft pulp mill necessary to convert raw material to sulfate pulp. Wood preparation chemistry and morphology. The chemical and mechanical characteristics of Kraft pulp and chemical recovery processes. Also taught as M.E. 4771.

Ch.E. 4772. Pulp and Paper Processes II 3-0-3
Prerequisite: consent of school.
The major pulping processes other than Kraft pulping. General knowledge of the various factors affecting each pulping process and pulp bleaching advantages and disadvantages of each pulping and bleaching process. Also taught as M.E. 4772.

Ch.E. 4773. Paper Formation and Properties 3-0-3
Prerequisite: consent of school.
The processes in the fabrication of paper and paper products from pulp. The effects on paper properties of chemical and mechanical pretreatment of pulp. The measurement of paper properties. Also taught as M.E. 4773 and Text. 4773.

Ch.E. 4774. Pulp and Paper Mill Emission Control 3-0-3
Prerequisite: consent of school.
Methods for control of gaseous, liquid and solid wastes from pulp and paper mill operations. Major biological, chemical and physical methods for treatment of waste streams.

Ch.E. 4800. Special Topics 3-0-3
Prerequisite: consent of school.
Topics relevant to chemical engineering are presented as demand or interest warrants.

Ch.E. 4901-2. Special Problems Credit to be arranged. Prerequisite: Ch.E. 3301.

The student is given an opportunity to develop initiative and to apply fundamental principles by doing seminal laboratory investigations of a chemical engineering research nature.

Ch.E. 6601. Chemical Engineering Thermodynamics I 3-0-3
Prerequisite: Ch.E. 4438 or consent of school.
The laws of thermodynamics with particular application to pure substances. Equations of state, thermodynamic functions of gases and liquids, thermodynamic charts and networks, engineering applications.

Ch.E. 6602. Chemical Engineering Thermodynamics II 3-0-3
Prerequisite: Ch.E. 6601 or consent of school.

Ch.E. 6603. Chemical Engineering Thermodynamics III 3-0-3
Prerequisite: Ch.E. 6602 or consent of school.
The thermodynamics of solutions, including chemical equilibria and statistical thermodynamics. Third law of thermodynamics. Heat capacities at low and high temperatures. Ionic solids and solutions. Engineering applications.

Ch.E. 6604-5-6. Organic Chemical Technology 3-3-3 each
Prerequisite: Chem. 3313.
Important organic chemical processes and their combinations are studied with emphasis on more recent developments.

Ch.E. 6610. Aerosol Technology 3-0-3
Prerequisite: consent of school.
Presents basic concepts describing the behavior of dispersed particles. Includes generation, sampling and size analyses, diffusion, coagulation, settling, kinetics and dynamics, electrostatic and optical properties.

Text: At the level of Mercer, Aerosol Technology.

Ch.E. 6611. Industrial Emission Control 3-0-3
Prerequisite: consent of school.
Air quality criteria, ambient and emission standards and industrial sources are analyzed. Recovery and utilization of waste gases and particulate matter is presented.

Text: At the level of Crawford, Air Pollution Control Theory.

Ch.E. 6612. Atmospheric Reactions 3-0-3
Prerequisite: consent of school.
The principles of atmospheric chemical and photochemical reactions, including primary
and derived air pollutants, sources and sinks of carbon, nitrogen, sulfur and oxygen compounds.

Text: At the level of Seinfeld, Air Pollution, Physical and Chemical Fundamentals.

Ch.E. 6513. Technology of Fine Particles
3-0-3. Prerequisite: Ch.E. 3301 or consent of school.

An examination of the properties of finely divided materials. Size, surface, pores are treated in relation to reactivity, adsorptivity, catalytic behavior and process engineering operations.

Text: At the level of Allen, Particle Size Measurement.

Ch.E. 6615. Transport Phenomena I
3-0-3. Prerequisite: Ch.E. 3301 or consent of school.

Advanced theory and applications of momentum transport.

Text: At the level of Bird, Stewart and Lightfoot, Transport Phenomena.

Ch.E. 6616. Transport Phenomena II
3-0-3. Prerequisite: Ch.E. 6615 or consent of school.

Advanced theory and applications of energy transport.

Text: At the level of Bird, Stewart and Lightfoot, Transport Phenomena.

Ch.E. 6617. Transport Phenomena III
3-0-3. Prerequisite: Ch.E. 6616 or consent of school.

Advanced theory and applications of mass transport.

Text: At the level of Bird, Stewart and Lightfoot, Transport Phenomena.

Ch.E. 6619. Chemical Engineering Calculations I
3-0-3. Prerequisite: Ch.E. 3308, Math. 2308.

A study of the application of classical mathematical methods (including Laplace transforms and Bessel functions) to the solution of typical chemical engineering problems.

Text: At the level of Jensen and Jeffreys, Mathematical Methods in Chemical Engineering.

Ch.E. 6620. Chemical Engineering Calculations II
3-0-3. Prerequisite: Ch.E. 6619 or consent of school.

A study of the application of modern mathematical techniques (including numerical methods and optimization procedures) to the solution of typical chemical engineering problems.

Text: At the level of Jensen and Jeffreys, Mathematical Methods in Chemical Engineering.

Ch.E. 6622. Advanced Reactor Design
3-0-3. Prerequisite: Ch.E. 4415.

A study of chemical kinetics and mechanisms in complex homogeneous and heterogeneous reaction systems. Design of chemical reactors for such systems.

Text: At the level of Smith, Chemical Engineering Kinetics.

Ch.E. 6624. Introduction to Cryogenics
3-0-3. Prerequisite: Ch.E. 6603 or consent of school.

Thermal, mechanical, electrical, magnetic and chemical properties of matter from room temperature to 0K. Applications to cryogenic processes. The emphasis will vary from year to year.

Ch.E. 6628. Advanced Unit Operations I
3-0-3. Prerequisite: Ch.E. 3308.

Flow through conduits, metering of fluids, mixing of liquids, flow and heat transfer in heat exchangers, packed columns and fluidized beds.

Ch.E. 6629. Advanced Unit Operations II
3-0-3. Prerequisite: Ch.E. 3308.

Thermal radiation in furnaces, measurement of elevated temperatures, condensation of mixed vapors and evaporation.

Text: At the level of McdAms, Heat Transmission.

Ch.E. 6633. Inorganic Chemical Technology
3-0-3. Prerequisite: consent of school.

Technology of selected inorganic processes and industries, especially the ammnonia, nitric acid, ammonium nitrate, urea, phosphoric acid, ammonium phosphate, superphosphate and potash industries.

Ch.E. 6635. Advanced Unit Operations III
3-0-3. Prerequisite: Ch.E. 3308.

Vapor liquid equilibrium and separation by distillation of binary and multicomponent mixtures. Factors influencing design and performance of fractionating equipment. Application of azeotropic and extractive distillation.

Text: At the level of Robinson and Gilliland, Elements of Fractional Distillation.

Ch.E. 6637. Advanced Unit Operations IV
3-0-3. Prerequisite: Ch.E. 3308 or consent of school.


Ch.E. 6646. Economic Analysis of Chemical Engineering Processes
3-0-3. Prerequisite: graduate standing.

Analysis of chemical engineering problems from the economic standpoint. Economic balance as a controlling factor in equipment design and operation.

Ch.E. 6648-9. Chemical Plant Design
1-0-3 each. Prerequisite: Ch.E. 4434 or consent of school.

Selected methods of chemical plant design.

Ch.E. 6650. Project Engineering
1-0-3. Prerequisite: Ch.E. 4431-2. Prerequisite or corequisite: 4434.

Selected topics on the various stages of a chemical plant design through which a process flow sheet is transformed into an operating plant.

Ch.E. 6750. Polymer Structure and Physical Properties I
3-0-3. Prerequisite: consent of school.

Morphology and structure, linear and non-linear viscoelasticity, anisotropic mechanical properties and yield and fracture behavior of polymers with applications to textile fibers and plastic products. Also taught as Text. 6750.

Text: At the level of Ward, Mechanical Properties of Solid Polymers.

Ch.E. 6751. Polymer Structure and Physical Properties II
3-0-3. Prerequisite: consent of school.

Structure-property relationships of elastomers, reinforced plastics, fibers, foams and natural polymers with emphasis on proteins and the composite nature of all polymers and polymer products. Also taught as Text. 6751.

Text: At the level of Ward, Mechanical Properties of Solid Polymers.

Ch.E. 6753. Surface Science and Technological Laboratory
3-18-9. Prerequisite: consent of school.

A highly specialized laboratory course using modern analytical and research instrumentation to characterize and study the surface properties of materials. Also taught as Text. 6753.

Ch.E. 6775. Advanced Engineering Programming Methods
3-3-4. Prerequisite: FORTRAN programming knowledge.

Advanced engineering programming concepts and their implementation on large scale digital computers at characterizing and using data, dynamic programs, engineering data management, primary memory management, engineering problem-oriented language development and I.C.E.S.

Ch.E. 6787. Heterogeneous Catalysis
3-0-3.

Physical chemistry of surfaces; thermodynamics, kinetics, mechanism of chemical surface and solid reactions; industrial catalysis. Also taught as Met. 6787.

Text: At the level of Gates, Katzer and Schult, Chemistry of Catalytic Processes.

Ch.E. 7000. Master's Thesis
3-0-3.


Ch.E. 7736. Chemically Reacting Flow Processes I
3-0-3. Prerequisite: Ch.E. 6603, 6617, 6622.

The development of a generalized approach to chemically reacting flow processes. Chemical vapor deposition and catalysis will be considered.

Ch.E. 7737. Chemically Reacting Flow Processes II
3-0-3. Prerequisite: Ch.E. 7736.

A continuation of Ch.E. 7736 to include catalytic and noncatalytic flow reactors, flame reactor and combustion processes.

Ch.E. 7738. Advances In Transport Phenomena
3-0-3. Prerequisite: Ch.E. 6617 or consent of school.

Topics such as multicomponent diffusion, compressible flow with simultaneous heat and mass transfer, flow processes and various approximate solution techniques.

Ch.E. 7750. Surface and Solution Properties of Polymers
3-0-3. Prerequisite: consent of school.

Study of plasticized polymers, solutions and colloids: sorption, polymer characterization, interfacial phenomena and coagulation using thermodynamics, statistical mechanics, information and fluctuation theories and relaxation methods. Also taught as Text. 7750.

Ch.E. 7751. Energetics
3-0-3. Prerequisite: consent of school.

Energetics applied to polymers and fibers using Newtonian mechanics, thermodynamics, statistical thermodynamics and quantum mechanics to relate macroscopic and molecular descriptions of processes and materials. Also taught as Text. 7751.

Ch.E. 7752. Kinetics
3-0-3. Prerequisite: consent of school.

Kinetics applied to polymers and fibers including fluid flow, heat transfer, diffusion, electrical conductivity, rates of chemical reactions and phase changes and irreversible thermodynamics. Also taught as Text. 7752.
Ch.E. 7753. Polymer Flow
3-0-3. Prerequisite: Ch.E. 6750 or Text. 6750 or consent of school.
   The fluid mechanics, heat transfer and mixing of non-Newtonian fluids. Experimental methods for characterizing fluids and the extraction and polymer melts are emphasized. Also taught as Text. 7753.
Ch.E. 7999. Preparation for Doctoral Qualifying Examinations
Noncredit. Prerequisite: consent of director.
   Students who are preparing for their qualifying examinations will be expected to register for this course. Occasionally this may be the only course for which a student is registered.
Ch.E. 8001-2-3. Seminar
1-0-2.1. A discussion group composed of staff and graduate students, where assigned topics from the literature are discussed as well as research problems in progress.
Ch.E. 8100. Special Topics In Chemical Engineering
3-0-3. Prerequisite: consent of school.
   Lectures on special topics of current interest in chemical engineering.
Ch.E. 8500. Special Problems In Chemical Engineering
3-0-3. Prerequisite: consent of school.
   Lectures, laboratory and library work on special problems of current interest in chemical engineering.
Ch.E. 9000. Doctoral Thesis
Credit to be arranged.

Metallurgy
Met. 3301. Principles and Applications of Engineering Materials
3-3-3. Prerequisite: Chem. 1101 and 1102 or 1111 and 1112, Phys. 2113, Phys. 2123.
   The principles of engineering materials directed toward their application in engineering design. Equilibrium and nonequilibrium structures and properties. Corrosion. Engineering application and failure analysis.
Text: At the level of Barrett, Hix and Tetelman, Principles of Engineering Materials.
Met. 3325. General Metallurgy
3-0-3. Prerequisite: Chem. 1102, Phys. 2121.
   Introductory physical metallurgy and characteristics and engineering applications of cast irons and steels. Static and dynamic properties of metals and alloys. Not open to students in the School of Chemical Engineering.
Text: At the level of Guy, Physical Metallurgy for Engineers.
Met. 4110. Mineral Engineering: Introduction to Formation and Accumulation of Mineral Resources
3-0-3. The processes of formation and accumulation of ores, industrial minerals and rocks and fuels and an introduction to mining and beneficiation.
3-0-3. Factors pertaining to the economics of the mineral industries and theoretical and practical concerns in the utilization of mineral resources.
Met. 4114. Mineral Engineering: Introduction to Mining
3-0-3. Prerequisite: consent of school.
   Evaluation of mining sites; surface and underground mining methods and related equipment. Coal, ores and industrial minerals and rocks: safety and environmental aspects of mining.
Met. 4115. Mineral Engineering: Economics of the Mineral Industries
3-0-3. Prerequisite: consent of school.
   Mineral property titles and concessions, valuation, acquisition and operating costs, marketing, taxation, environmental considerations and the role of minerals in industrialized nations.
Met. 4116. Mineral Engineering: Separation Technology
3-0-3. Prerequisite: junior standing.
   A study of the processes for separating mineral products and other materials and solid fuels; crushing, grinding, volumetric sizing, classifying and concentration.
Met. 4403. Introductory Nuclear Metallurgy
3-3-4. Prerequisite: Chem. 1102, Phys. 2123.
   Fundamentals of physical metallurgy, metal crystals, phase diagrams, properties, fabrication and testing with emphasis on refractory metals and fuel materials. Primarily for N.E. students. Not open to Ch.E. students.
Met. 4411. Basic Extractive Metallurgy
3-0-3. Prerequisite: Chem. 3413 or equivalent.
   Theory and practice of extraction and refining of ferrous and nonferrous metals. Calculations and reactions related to pyrometallurgical and hydrometallurgical extraction processes will be emphasized.
Text: At the level of Gilchrist, Extraction Metallurgy.
Met. 4421. Nonferrous Metallurgy
2-3-3. Prerequisite: Met. 3301 or equivalent.
   The influence of processing variables on the structure and properties of nonferrous al-
  loys. Pyrometallurgical instrumentation applied to heat treating and thermal analysis.
Met. 4422. Ferrous Metallurgy
3-3-3. Prerequisite: Met. 3301, 4241 or equivalent.
   The influence of processing variables on the microstructure and properties of steels and alloys. Heat treating and thermal of ferrous materials.
Met. 4423. Metallurgical Fabrication
3-0-3. Prerequisite: Met. 3301 or equivalent.
   Primary forming techniques and secondary fabrication and joining processes. Some of the processes to be discussed are casting, forging, extrusion, drawing, machining and welding.
Met. 4441. Theoretical Physical Metallurgy
3-0-3. Prerequisite: Met. 3301 and Chem. 3413 or equivalent. A study of the physical and mechanical properties of metals and alloys in the light of metal engineering. Text: At the level of Cottrell, An Introduction to Metallurgy.
Met. 4445. Electron Microscopy
2-3-3. Prerequisite: Math. 2308 and Met. 3301.
   Theory and principles of electron optics and electron microscopy. Preparation and observation of materials by electron microscopy.
Text: At the level of Thomas, Transmission Electron Microscopy of Metals.
Met. 4446. X-ray Metallurgy
3-3-3. Prerequisite: Met. 3301.
   Theory and application of X-ray diffraction to metallurgy. Crystal studies, texture studies, phase diagram determination and chemical analysis.
Text: At the level of Cullity Elements of X-ray Diffraction and Azaroff and Donahue, Laboratory Experiments in X-ray Crystallography.
Met. 4463. Metallurgical Testing
2-3-3. Prerequisite: Met. 3301.
   A study and nondestructive test methods are outlined. The emphasis will be on the significance of results and the choice of materials based on test data.
Met. 4464. Nondestructive Testing
2-3-3. Principles and theory of industrial nondestructive testing methods. Emphasis on testing the soundness and reliability of primary and fabricated metal structures.
Met. 4491. Corrosion and Protective Measures
3-0-3. Prerequisite: Chem. 3413 and Met. 3325 or 3301.
   The electrochemical theory of corrosion, recommended materials and protective measures for chemical, processing equipment and for atmospheric, underground, underwater and elevated temperature exposures.
Met. 6005. Dental-Medical Materials
2-0-2. Prerequisite: Met. 3301 and Met. 4491.
   Theoretical requirements and compatibility of metals as medical and dental applications in a review of up-to-date research. Special lectures will be given by visiting researchers.
Met. 6011. Pyrometallurgy
3-0-3. Prerequisite: Met. 4411 or equivalent.
   Pyrometallurgical processes for the production or recycling of ferrous and nonferrous metals.
Met. 6012. Hydrometallurgy
3-0-3. Prerequisite: Met. 4411 or equivalent.
   Hydrometallurgical processes used in the production of copper, aluminum, zinc, uranium and other metals.
Met. 6014. Electrometallurgy
2-3-3. Prerequisite: Chem. 3413 or equivalent.
   Electrolytic dissolution and deposition of metals, electroplating, anodizing and electropolishing.
Met. 6021. Metallurgical Design Problems
1-6-3. Prerequisite: full graduate standing.
   Selection of process equipment design of special equipment, plant layouts and preparation of equipment, utilities. Production costs. Design methods are discussed, evaluated and utilized.
Met. 6025. Powder Metallurgy
1-3-2. Prerequisite: Met. 4423.
   Physical and chemical production of metallic powders. Pressing, sintering, forming and the theoretical aspects of these processes. Hot pressing and coining, industrial applications and materials.
Text: At the level of ASM Powder Metallurgy, selected literature by Steinburg, Kuczynski and Schwarzkopf.
Met. 6033. High Temperature Metallurgy
2-0-2. Prerequisite: Met. 3301, 4491.
   Property changes with temperature. Creep phenomena. Elevated temperature corrosion. Inclusions and the properties of ceramics and structure on high temperature properties. Superalloys and cermet products. High temperature testing.
Text: At the level of G. V. Smith, Properties of Metal at Elevated Temperatures.
Met. 6035. Advanced Nuclear Materials 3-0-3. Prerequisite: Met. 4403 or equivalent. Phase diagrams, properties and fabrication of nuclear materials, ceramics, graphite and alloys used for construction, fuel elements, screening and control rods. Welding, corrosion and survey in nuclear engineering.


Met. 6787. Heterogeneous Catalysis 3-0-3. Physical chemistry of surfaces; thermodynamics, kinetics and mechanisms of chemisorption and surface reactions; industrial catalysis. Also taught as Ch. 6797. Text: At the level of Gates, Katzer and Schult, *Chemistry of Catalytic Processes*.


Met. 7052. Advanced Dislocations and Strengthening Mechanisms I 3-0-3. Prerequisite: Met. 7051. The emphasis in this course will be on dislocation networks and their effect on the mechanical behavior of materials. Text: At the level of Friedel, *Dislocations*.

Met. 7053. Advanced Dislocations and Strengthening Mechanisms II 3-0-3. Prerequisite: Met. 7052. The emphasis in this course will be on the interaction of dislocations with other defects and the correlation of these interactions with the mechanical properties of materials. Text: At the level of Friedel, *Dislocations*.


Met. 8001-2-3. Seminar 2-0-1 each. Prerequisite: Met. 7081. The latest advances in metallurgical research and development will be presented by the enrolled students from articles in recent issues of recognized periodicals.
Chem. 4181. Synthetic Inorganic Chemistry 0-6-2. Concurrently with or following Chem. 3111.

Preparation and characterization of inorganic compounds, with special emphasis on the apparatus and techniques employed in modern synthetic inorganic chemistry. Text: at the level of Jolly, Synthetic Inorganic Chemistry.


Provides a background to modern analytical chemistry and to instrumental methods of analysis with applications to engineering and other areas. Not open to chemistry majors. Text: at the level of Flaschka, Barnard and Sturrock, Quantitative Analytical Chemistry, volume one.

Chem. 4211. Instrumental Analysis I 3-6-5. Concurrent with or following Chem. 3411.

Introduction to both theory and practice of modern instrumental methods: polarography, spectrophotometry, colorimetry, microscopy, polarography, polarimetry, electroanalytical methods. Text: at the level of Leinhenger, Biochemistry.

Chem. 4511-2. Biochemistry 3-0-3 each. Prerequisite: Chem. 3511 or consent of school.

The chemistry and biochemistry of proteins, lipids, carbohydrates, nucleic acids and other biomolecules. Text: at the level of Leinhenger, Biochemistry.

Chem. 4701. Chemistry of Nuclear Technology 3-4. For students in nuclear engineering.

Principles of nuclear irradiation and radiochemistry, separation methods for actinide elements and fission products and topics related to production and utilization of nuclear energy.

Chem. 4901-2. Special Problems Credit to be arranged. Prerequisite: consent of school.

Individualized instruction which will include library, conference and laboratory work.

Chem. 5201. Analysis of Atmospheric Contaminants 3-0-3. Prerequisite: Chem. 1102 or 1112, Math. 1309 and Phys. 2123. May not be used by a student for credit towards any graduate degree in chemistry.

Acquaints the student with modern analytical techniques and instrumental methods of analysis involving station in the measurement of air contaminants. Text: at the level of Willard, Merrit and Dean, Instrumental Methods of Analysis and Jacobs, The Chemical Analysis of Air Pollutants.


Chem. 6141. Chemical Applications of Group Theory 3-0-3. Prerequisite: Chem. 4112 or consent of school.

Introduction to basic definitions and theorems of group theory and their application to molecular symmetry and quantum mechanics and use in valence bond, molecular orbital and ligand field treatments. Text: at the level of Cotton, Chemical Applications of Group Theory.

Chem. 6151. Chemical Crystallography 3-0-3. Prerequisite: consent of school.

Application of X-ray diffraction to the determination of crystal structures including crystal symmetry, reciprocal lattice, intensity of diffraction, the phase problem and refinement of structure parameters.

Chem. 6211-2. Analytical Chemistry 3-0-3 each. Prerequisite: consent of school.

Theoretical and practical applications of modern instrumental methods: spectrophotometry, microscopy, colorimetry, polarography, polarimetry and electroanalytical methods. Text: at the level of Jolly, Barnard and Sturrock, Quantitative Analytical Chemistry, volume one and Willard, et al., Instrumental Methods of Analysis.


Chelating agents used in the detection and determination of inorganic ions, spot testing methods and extraction procedures employing organic reagents.

Chem. 6230. Electrochemistry 3-0-3. Prerequisite: consent of school.

A study of electrochemical instrumentation, the thermodynamics, structure, absorption, chemistry of the electrical double layer and the kinetics of simple and complex electrode processes.

Chem. 6251. Electron analytical Chemistry 3-0-3. Prerequisite: Chem. 4212 or consent of school.

Coulometry, electrolytic separations, polarography, chronopotentiometry, coulometric titrations and voltametric methods of equivalence point detection. Text: at the level of Lingane, Electroanalytical Chemistry.

Chem. 6241. Advanced Analytical Chemistry 3-0-3. Prerequisite: consent of school.

Competing equilibria, including polybasic acids, differential precipitation, complex ion formation in competitive systems. Com-plexometric titrations and homogenous precipitation. Adsorption, partition, ion exchange and gas chromatography.

Chem. 6311-2. Organic Chemistry 3-0-3 each. Prerequisite: Chem. 3313 and consent of school.


Chem. 6321-2. Reactivity, Mechanism and Structure in Organic Chemistry 3-0-3 each. Prerequisite: consent of school.

Theoretical interpretations of reactivity, reaction mechanisms and molecular structures of organic compounds.

Chem. 6342. Instrumental Methods of Organic Analysis 3-0-3. Prerequisite: Chem. 3313 or consent of school.

Interpretation of spectroscopic and other common methods of organic analysis and structure determination. Text: at the level of Jolly, Barnard and Sturrock, Quantitative Analytical Chemistry, volume one.

Chem. 6351. Organometallic Chemistry 3-0-3. Prerequisite: consent of school.

Survey of organometallic chemistry of main group elements, particularly lithium, sodium, potassium, magnesium, zinc, cadmium, mercury, boron and aluminum, emphasizing structure, bonding, reaction mechanisms and applications.


A study of molecular structure based upon quantum mechanical principles.

Chem. 6421-2. Chemical Thermodynamics 3-0-3 each. Prerequisite: Chem. 3411-2-3.

Laws of thermodynamics and their chemical applications. Introduction to chemical kinetics and statistical mechanics.

Chem. 6451. Surface Equilibria 3-0-3. Prerequisite: consent of school.

Classical and statistical thermodynamics of surface systems, interfacial phenomena at the gas-solid interface, adsorption phenomena and capillarity.

Chem. 6541. Advanced Biophysical Chemistry 3-0-3. Prerequisite: Chem. 3411 and 3412 or consent of instructor.
Applications of the principles and techniques of physical chemistry in biochemistry with emphasis on the equilibria and dynamic behavior of macromolecules in solution.

Properties and structure of the atomic nucleus, radioactive and decay schemes, interaction of radiation with matter, detection and experimental methods, nuclear reactors, radiocarbon techniques.

Text: at the level of Evans, The Atomic Nucleus.


Chem. 621. Fast-neutron Interactions 3-0-3. Prerequisite: Chem. 6612 or consent of school.

Chem. 622. Nuclear Fission 3-0-3. Prerequisite: Chem. 612 or consent of school.
Theory, probability, mass and charge distributions, fragments, low, intermediate and high energy processes and photofission processes occurring in nuclear fissions.

Chem. 6531. Radiochemistry 3-0-3. Prerequisite: consent of school.
Properties of atomic nuclei, types of radioactive decay, interaction of radiation with matter, measuring devices for detection and measurement of radiation.

Text: at the level of Friedlander and Kennedy, Nuclear and Radiochemistry.

Chem. 6632. Experimental Radiochemistry 1-3-2. Prerequisite: Chem. 5631.
Radiochemical practice, applications of radioisotopes to methods of analysis, physical chemical studies and reaction mechanisms.

Text: at the level of Overman and Clark, Radioisotope Technique.

A highly specialized laboratory course using modern analytical and research instrumentation to characterize and study the surface properties of materials.

Introduction to theory of electronic structure of transition metal compounds and its application to the interpretation of physical and chemical properties of these compounds—especially spectral and magnetic properties.

Text: at the level of Royer, Ligand Field Theory, An Introduction.

Chem. 7131. Inorganic Stereochemistry 3-0-3. Prerequisite: Chem. 3112 or consent of school.
A discussion of the structure of inorganic compounds and relationships between structures, bonding and properties of these compounds.

Chem. 7141. Mechanisms of Inorganic Reactions 3-0-3. Prerequisite: Chem. 3112 or consent of school.
Discussion of mechanisms of inorganic reactions based on kinetic and stereochemical studies—the substitution and redox reactions of coordination complexes in solution.

Text: at the level of Basolo and Pearson, Mechanisms of Inorganic Reactions.

Chem. 7421. Statistical Thermodynamics 3-0-3. Prerequisite: Chem. 6422 or consent of school.
A study of statistical mechanical ensembles, partition functions and their relationship to thermodynamic properties, statistical mechanics distribution and correlation functions, thermodynamics of liquids and solutions, phase transitions and cluster theory.

Important concepts of quantum chemistry at the intermediate level including: angular momentum, perturbation theory, electronic structure of molecules and radiation matter interaction. Applications will vary from year to year.

Mechanisms of chemical reactions, cross sections and rate constants. Elastic, inelastic and rearrangement channels are discussed using quantum and semiclassical techniques.

Chem. 7611. Nuclear Spectroscopy 2-0-2. Prerequisite: Chem. 6612 or consent of school.
A study of nuclear levels and of energy absorption and emission by nuclei both by radioactive decay and by nuclear reaction and scattering experiments.

Text: at the level of Siegbahn, Alpha-, Beta- and Gamma-Spectroscopy, volumes one and two.

Discussion group composed of staff and graduate students.

Chem. 8111-2. Special Topics in Inorganic Chemistry 3-0-3 each. Prerequisite: Chem. 3112.
Topics vary from year to year. Will include mechanisms of inorganic reactions, ligand field theory and bonding in inorganic compounds.

Chem. 8211. Special Topics in Analytical Chemistry 3-0-3. Prerequisites: consent of school.
Discussions of specialized areas of analysis—spectroscopy, polargraphy, coulometry, chromatography and others. Content of course varies from year to year.

Chem. 8311. Special Topics in Organic Chemistry 3-0-3. Prerequisite: consent of school.
Topics vary from year to year. Will include such subjects as synthetic methods and their application to research in organic chemistry.

Chem. 8351-2. Special Topics in Biochemistry 3-0-3. Prerequisite: Chem. 4512 or consent of school.
Topics vary from year to year. Will include such subjects as proteins, enzyme mechanisms, metabolism and membranes.

Chem. 8411-2. Special Topics in Physical Chemistry 3-0-3. Prerequisite: Chem. 3413 or consent of school.
Topics vary from year to year. Will include such subjects as photochemistry, solid state, surface chemistry and radiation chemistry.

Chem. 8461. Special Topics in Nuclear Chemistry 3-0-3. Prerequisite: Chem. 6612 or consent of school.
Topics vary from year to year. Will include nuclear fission, radiochemical techniques, nuclear reactions, in-beam nuclear spectroscopy and on-line investigations of nuclei far from stability.

Chem. 9000. Doctoral Thesis

City Planning
See Architecture.

Civil Engineering

Civil Engineering

C.E. 1503. Introduction to Civil Engineering 2-3-3.

What engineering is, what civil engineering is and what civil engineers do. The civil engineering approach to the solution of mankind's problems.

C.E. 2254. Plane Surveying 3-3-4. Prerequisite: E.G. 1170.
Use of modern instruments and office procedures in obtaining and analyzing field data for use in engineering planning, design and construction and in land surveying.

C.E. 2502. Civil Engineering Applications of Digital Computers 1-3-2. Prerequisite: Math. 1308.
A study of the application of digital computers to the solution of civil engineering problems. This course is a prerequisite to all junior and senior C.E. courses.

Elementary mechanics of fluids with emphasis on analysis, fluid kinematics, equations of motion, momentum and energy principles, surface and form resistance.

C.E. 3054. Fluid Mechanics II 3-3-4. Prerequisite: C.E. 3053.
Elementary mechanics of fluids with emphasis on engineering applications. Enclosed conduit flow, open-channel flow, hydraulic machinery, fluid measurements, dynamic similitude.

C.E. 3061. Fluid Mechanics Laboratory 0-3-1. Prerequisite: C.E. 3054.
Experiment, demonstration and analysis of basic fluid phenomena and exercises in laboratory techniques.

C.E. 3216. Structural Analysis I 3-3-4. Prerequisites and E.S.M. 3901.
Determination of internal forces in statically determinate and indeterminate structures including influence lines with applications to beams, frames and trusses.

C.E. 3254. Advanced Surveying I 3-3-4. Prerequisite: C.E. 2254.
Field astronomy. Precise taping, leveling, triangulation, sub-base bar, adjustments of level nets and triangulation figures, special problems in land division, introduction to photogrammetry.

C.E. 3309. Materials of Construction 3-3-4. Prerequisite: E.S.M. 3301, Geol. 2100, 2102.
Basic principles of the properties of materials. Physical, chemical and mechanical properties of metals, concrete, timber, masonry and asphalt. The laboratory period is for tests, demonstrations and writing reports.
C.E. 3780. Introduction to Urban Engineering
3-0-3. Prerequisite: junior standing.
Survey of the current status of scientific and technical contributions to urban socio-economical problems.

C.E. 4003. Construction Operations
2-3-3. Prerequisite: I.Sy.E. 4725.
The construction industry, contracts and forms of construction company organization. Financing, equipment, manpower and materials. Time and cost control methods are introduced.

C.E. 4013. Design of Construction Operations
3-0-3. Prerequisite: junior standing.
Modeling and analysis of construction operations at the job site level. Productivity calculations and allocation of construction resources.

C.E. 4053. Applied Hydraulics
3-0-3. Prerequisite: C.E. 3054, 4353.
Analysis and design of hydraulic works and structures. Typical exercises: stability of dams, spillway design, stilling basins, culverts, pipe systems, sediment transport, erosion and erosion control.

C.E. 4103. Sanitary Engineering I
3-0-3. Prerequisite: Math. 2308, Chem. 1102 or consent of school.
Introduction to physical, chemical and biological properties of the aquatic environment with reference to environmental quality. Quality of water for domestic use. Basic principles of aquatic microbiology and chemistry.

C.E. 4113. Sanitary Engineering II
3-0-3. Prerequisite: C.E. 4103, Corequisite: C.E. 3054.

C.E. 4123. Sanitary Engineering III
2-3-3. Prerequisite: C.E. 4113.
The layout, hydraulic process and operational design of water and waste water systems. Supervised design problems and independent studies.

C.E. 4123. Engineering Aspects of Environmental Health
3-0-3. Prerequisite: C.E. 4113.
Sanitary engineering in public health administration and control of environmental health problems.

C.E. 4143. Man in His Environment
3-0-3.
Open to students from all fields. On population, resources, wastes and health as related to development of science and technology.

C.E. 4154. Physical Behavior of Soil and Rock
3-3-4. Prerequisite: C.E. 3309, Geol. 2100, 2102.
Introduction to the engineering properties of soil and rock. The origin, composition and structure of soils. The effect of water and control.

C.E. 4163. Soil and Rock Engineering
2-3-3. Prerequisite: C.E. 4154.
Mechanics of soil and rock masses as applied to civil engineering design and construction. Trench fill, pile foundations, retaining walls, bulkheads, fills, embankments, control of landslides.

C.E. 4204. Metal Structural Components
3-3-4. Prerequisite: C.E. 3309, 3216.
Principles of behavior of tension and compression members, beams and connections with application to the design of structural systems.

C.E. 4213. Structural Analysis II
2-3-3. Prerequisite: C.E. 2502, 3216.
Flexibility and stiffness matrix methods of static structural analysis. Computer programs.

C.E. 4214. Concrete Structural Components
3-3-4. Prerequisite: C.E. 3309, 3216.
Principles of behavior of reinforced concrete beams, columns and slabs with application to the design of elementary structures.

C.E. 4223. Structural Design
2-3-3. Prerequisite: C.E. 4204, 4214, 4154.
Design of structures in metal and concrete with emphasis on buildings and bridges.

C.E. 4233. Design in Timber and Prestressed Concrete
2-3-3. Corequisite: C.E. 4214.
Principles of behavior of timber and of prestressed concrete structural members, application to the design of elementary structures.

C.E. 4253. Elementary Aerial Photogrammetry
2-3-3. Prerequisite: C.E. 3254.
Principles of stereophotography and stereoscopic instruments. Analytical solutions of attitude, base line, line of flight and parallax. Radar line plotting for planimetric and topographic maps.

C.E. 4273. Advanced Surveying II
2-3-3. Prerequisite: C.E. 3254. Winter quarter.
Errors and adjustments of surveying and photogrammetric instruments, analysis of measurement errors. Mercator and Lambert projections, plane table traversing, special control problems, hydrographic surveying.

C.E. 4283. Advanced Route Surveying
2-3-3. Prerequisite: C.E. 2254.
Horizontal and vertical curves in transportation systems, application of transition curves, earthwork computations, problems involving fixed points and relocations.

C.E. 4304. Transportation Engineering I
3-3-4. Prerequisite: C.E. 3309.
Planning, design and construction of streets and highways. Computer-oriented laboratory problem acquaints student with modern highway design techniques and criteria.

C.E. 4313. Transportation Engineering II
3-3-3. Prerequisite: senior standing.
History and economics of transportation systems, traffic and planning problems and techniques, planning and design of air, rail, highway and water transportation facilities as a system.

C.E. 4353. Hydrology
3-0-3. Prerequisite: C.E. 3054.
Occurrence and movement of water on the earth, hydrologic measurements, elementary meteorology, precipitation, evapotranspiration and runoff, ground water, frequency analysis.

C.E. 4363. Applied Hydrology
3-0-3. Prerequisite: C.E. 3054, 4353. Winter quarter.
Applications of hydrology in the design of hydraulic structures for water supply, irrigation, power, drainage and flood control facilities.

C.E. 4373. Water Resources Development
3-0-3. Prerequisite: C.E. 4363. Spring quarter.
Comprehensive planning for water resource management, identification of needs, problems and issues, alternative creative solutions, economic and fiscal evaluation, institutional setting and public participation.

C.E. 4383. Groundwater Hydrology
3-3-3. Prerequisite: C.E. 4333, Geol. 2100. Spring quarter.
Occurrence, distribution and movement of water beneath the earth, groundwater resources and dependable supply rates from wells, artificial recharge and waste disposal.

C.E. 4774. Application of Microbiology to Sanitary Engineering
3-3-4. Prerequisite: senior standing. Fall quarter.
Microbiology in environmental engineering. Relationship of protozoa, algae, bacteria and viruses to waterborne disease, treatment of wastes and deterioration of aquatic habitats.

C.E. 4801-2-3-4-5-6. Special Topics
Credit hours equal last digit of course number.

C.E. 4811-2-3-23. Special Topics
Credit hours equal last digit of course number.

C.E. 4900. Special Problems
Credit hours to be arranged.

C.E. 6003. Construction Administration
2-3-3. Fall quarter.
Management tools used to carry out administrative aspects of construction project management. Estimating and bid control. Quantity take-off procedures, cost accounting, insurance, bonding, finance and safety.

C.E. 6013. Civil Engineering Management I
Scientific methods in the management of construction projects. Techniques such as C.P.M. and P.E.R.T. for planning, scheduling and control of construction projects.

C.E. 6023. Civil Engineering Management II
Continuation of C.E. 6013. Additional topics include linear and dynamic programming, queuing models and simulation as applied to construction project management.

C.E. 6053. Steady Flow in Open Channels I
3-0-3. Prerequisite: C.E. 3054, 3061. Fall quarter.
Flow of liquids with free surfaces in natural and artificial channels, general and specific solutions of backwater curve problem, routing of floods through rivers and reservoirs.

C.E. 6058. Intermediate Fluid Mechanics
3-0-3. Prerequisite: C.E. 3054. Fall quarter.
Fundamental treatment in which basic principles of hydromechanics are adapted systematically to limitations imposed by properties of real fluids.

C.E. 6063. Steady Flow in Open Channels II
3-0-3. Prerequisite: C.E. 3054, 3061. Winter quarter.
Flow of liquids in channel transitions, bends and obstruction, contractions and expansions, hydraulic jump, stilling basins, hydraulic analysis and design of low weirs, free overfalls, control gates.

C.E. 6068. Advanced Topics in Hydromechanics
3-3-3. Prerequisite: C.E. 6058. Winter quarter.
Potential-flow analysis. Navier-Stokes equations. Turbulent flow. Laminar and turbulent boundary layers, boundary-layer controls. Diff-
C.E. 6073. Transient Flow in Enclosed Conduits
3-0-3. Prerequisite: C.E. 3054. Spring quarter.
Undeflected flow of compressible and incompressible fluids in conduits, pressure wave propagation, frequency-dependent friction, one-dimensional wave equations, method of characteristics, pressure wave, water hammer.

C.E. 6078. Engineering Hydrodynamics
Irrotational flow, principles of continuity, energy and momentum, stream and potential functions, introductory conformal transformations, analogies and numerical methods, design applications.

C.E. 6083. Sedimentation and Sediment Transport
3-0-3. Prerequisite: C.E. 3054. Spring quarter.
Sediment entrainment, transportation by suspension, bed load movement. Sediment properties, measurement, sampling techniques, analysis, scour and siltation, evaluation of engineering structures, reservoir siting, desilting devices.

C.E. 6088. Gravity-wave Phenomena
Hydrodynamic equations of water waves, reflections, transmission and refraction, tides and wind-generated waves, wave forces of structures, unstable flow in canals and rivers.

3-0-3. Winter quarter.
Darcy’s law, continuity and Laplace equations, steady and unsteady flow in isotropic and anisotropic media. Problems of flow of water, drains and ditches.

C.E. 6103. Aquatic Chemistry
3-0-3. Prerequisite: C.E. 6139. Spring quarter.
Chemical behavior of natural aquatic systems: lakes, oceans, rivers, estuaries, ground water, wastewater, treatment systems. Analysis of natural waters using physical chemistry principles.

C.E. 6104. Sanitary Engineering Design I
3-3-4. Prerequisite: C.E. 4103. Spring quarter.
Theory and design of structures for collection, purification, conditioning and distribution of public water supplies.

C.E. 6108. Application of Instrumental Analysis in Sanitary Engineering
2-3-3. Prerequisite: C.E. 6139. Winter quarter.
Theory, design, sensitivity and limitations of environmental sampling instruments. Emphasis on spectrophotometric, electromechanical and gas chromatograph analysis of solid waste, water and wastewater.

C.E. 6113. Industrial Wastes Treatment and Disposal
2-3-3. Prerequisite: C.E. 6144 and C.E. 6149 or consent of school. Spring quarter.
Evaluation of industrial waste characteristics, treatment and disposal of municipal sewage and industrial wastes, industrial processes which produce liquid wastes.

C.E. 6118. Solid Waste Technology I
2-3-3. Prerequisite: consent of school. Winter quarter.
An introduction of the fundamentals of solid waste characterization, handling and disposal systems, physical and chemical methods of solid waste analysis.

C.E. 6123. Stream Analysis
3-0-3. Prerequisite: C.E. 3054, 4113. Winter quarter.
Factors affecting deoxygenation and retention in streams, evaluation of stream self-purification capacity, design, stream surveys, prediction of the effects of organic loading.

C.E. 6124. Air Pollution Measurements and Control
3-3-4. Prerequisite: consent of school. Fall quarter.
Analysis of air pollution problems of cities and industries, methods of evaluating the problems. Description, design and use of air sampling equipment.

C.E. 6128. Solid Waste Technology II
2-3-3. Prerequisite: C.E. 6118. Spring quarter.
Evaluation of typical solid waste problems, application of fundamental principles to design and management, case studies of operational solid waste systems, new methods, advanced topics.

C.E. 6133. Basic Radiological Health
3-0-3. Prerequisite: consent of school. Winter quarter.
Introduction to radiological health and its influence on the general environment and occupational activities, personnel survey and laboratory instrumentation.

C.E. 6138. Applied Limnology
2-3-3. Spring quarter.
Consideration and application of limnological principles as they pertain to evaluating impact wastewater disposal will have on the biological productivity of inland waters.

C.E. 6139. Applications of Chemistry in Sanitary Engineering
3-3-4. Prerequisite: Chem. 1102, C.E. 4113. Fall quarter.
Review of general and organic chemistry, concepts of biochemistry and physical chemistry, chemistry of water and wastewater processes, corrosion, coagulation, softening and disinfection.

C.E. 6144. Sanitary Engineering Processes I
3-3-4. Prerequisite: C.E. 3054, 4113. Winter quarter.
Study of selected physical and chemical processes common to water and wastewater treatment systems, i.e. coagulation, flocculation, sedimentation and filtration.

C.E. 6145. Field Methods In Sanitary Engineering
3-1-5. Prerequisite: C.E. 6123, 6138. Spring quarter.
Provides experience in the organization and conduct of sanitary surveys and field studies in stream analysis and applied limnology.

C.E. 6149. Advanced Microbiology of Water and Wastewater Systems
2-3-3. Prerequisite: C.E. 4774. Winter quarter.
Microbial growth in water and waste treatment systems, enrichment cultures and their application, processes, design, Respiratory mechanisms and fermentation in wastewater treatment and stream pollution.

C.E. 6149. Sanitary Engineering Processes II
3-3-4. Prerequisite: C.E. 6144. Winter quarter.
Study of biological and chemical processes employed in water and waste treatment systems. Biological growth kinetics, activated sludge, trickling filters, lagoons and oxidation ponds.

C.E. 6153. Dock, Harbor and Shore Structures
3-0-3. Prerequisite: C.E. 4214. Spring quarter.
Fundamentals of marine structures such as docks, bulkheads, dry docks, breakwaters, channels and shore protection works.

C.E. 6154. Advanced Soil Mechanics
3-3-4. Prerequisite: C.E. 4163. Winter quarter.
Flow of water through soil and rock, design of drainage systems, earth dams and dam foundations. Elastic and plastic equilibrium applied to problems of slope stability.

C.E. 6159. Rock Mechanics
3-3-4. Prerequisite: C.E. 4163. Spring quarter.
Mechanics of rock masses and influence of geologic features on their engineering properties. Discussion of relevant tests for determination of both in situ and laboratory properties of rocks.

C.E. 6163. Physical and Physiochemical Properties of Soils
3-0-3. Prerequisite: C.E. 4154. Fall quarter.
Formation of soils, physical and chemical properties of soil minerals and soil water, consolidation, swell-shrinkage, shear strength and related phenomena, geology of soil deposits.

C.E. 6164. Advanced Foundation Engineering
3-3-4. Prerequisite: C.E. 4163. Spring and summer quarters.
Analysis and design of foundations, bearing capacity and settlement theory. Analysis of pile and continuous foundation, theories of earth pressure, design of earth-retaining structures.

C.E. 6172. Soil Testing
1-3-2. Prerequisite: C.E. 6194. Winter quarter.
Theory of physical testing of soils for engineering design and research, laboratory exercises in consolidation, soil testing, illustrations of test procedure effects on character of data.

C.E. 6173. Terrain Evaluation and Applications
2-3-3. Prerequisite: C.E. 6163. Fall quarter.
Structure of soil and rock formations and their reflection in the terrain. Analysis of terrain features by aerial photographs and other forms of remote sensing.

C.E. 6183. Soil Contamination
2-3-3. Corequisite: C.E. 4154. Fall quarter.
The migration of soil moisture, frost action, compaction, soil stabilization, evaluation of subgrades and bases for pavements.

C.E. 6193. Dynamics of Massive Media
2-3-3. Prerequisite: C.E. 6174. Spring quarter.
Introduction to dynamics of massive media with applications to analysis of complex engineering dynamics problems. Dynamic properties of soil and rock.

C.E. 6194. Theoretical and Applied Soil Mechanics I
4-0-4. Corequisite: C.E. 6163. Fall quarter.
Theories of elastic equilibrium of soil masses, application to analysis of complex soil engineering problems such as stresses and settlements of soil and pavement.

C.E. 6199. Theoretical and Applied Soil Mechanics II
4-0-4. Prerequisite: C.E. 6194. Winter quarter.
Theories of plastic equilibrium of soil masses, application to analysis of complex soil

Introduction to planning aspects of structural design, economic proportions, erection procedures, comparison of determinant and indeterminate structures, stress control, normal and hybrid behavior.

C.E. 6204. Reinforced Concrete Structures I 4-0-4. Prerequisite: C.E. 4214. Fall quarter.

Review of working stress methods, analysis and design procedures based on ultimate load capacity, effects of creep, shrinkage and temperature, torsional stresses and reinforcing deflections.

C.E. 6209. Reinforced Concrete Structures II 4-0-4. Prerequisite: C.E. 6204. Winter quarter.

Principles and practices of prestressed concrete, systems and techniques for applying prestress, analysis and design of determinate and indeterminate prestressed concrete structures, stress-strain behavior.


Data acquisition from models. Stress analysis through strain measurements. Transduction of their circuitry and related indicating and recording equipment. Motion measurement, equivalent circuits.

C.E. 6214. Indeterminate Structural Theory I 4-0-4. Prerequisite: C.E. 3216. Fall quarter.

Study of principles and fundamental theorems of structural analysis with applications to indeterminate structures: beams, frames and trusses.


C.E. 6299. Principles of Matrix Structural Analysis 4-0-4. Prerequisite: C.E. 3216. Fall quarter.

Matrix formulation of the governing equations of framed structures, linear elastic behavior, physical and geometrical nonlinearities, force and displacement methods, nonlinear analysis.


Study of advanced topics from mechanics of materials with application to civil engineering structures. Typical topics: generalized stress and strain, failure theories, torsion, shear flow, buckling, fatigue.


Introduction to finite element method, matrix formulation of stress, strain and bending. Three-dimensional solid and shells. Static and dynamic, linear and nonlinear analysis.

C.E. 6244. Plastic Design In Steel Structures 4-0-4. Prerequisite: C.E. 4204. Spring quarter.

Analysis and design procedures based on ultimate load capacity are applied to steel beams, frames and their connections.

C.E. 6248. Structural Dynamics 3-0-3. Prerequisite: consent of school. Fall quarter.

Vibration and dynamic response of simple linear and nonlinear structures to periodic and general disturbing forces. Response analysis of multi-degree of freedom systems. Wind and earthquake effects.


Analysis and design of slab and thin-shell structures, additional applications of prestressing, yield-line theory, shells of revolution, cylindrical shells, folded plates, hyperbolic paraboloids, prestressed tanks.

C.E. 6273. Legal Principles of Land Surveying 2-3-3. Prerequisite: C.E. 3254. Winter quarter, alternate years.

History and development of legal principles controlling boundary location of real property. Writing, interpreting and locating of deeds. Descriptions.


Theory of flexible and rigid pavement behavior, stress distribution and deflection, climate, pavement design methods and evaluation of pavement performance.

C.E. 6308. Concrete Technology 2-3-3. Prerequisite: C.E. 3309, 4214. Winter quarter.

Design theories for concrete mixtures, mixes for specific conditions of workability, density strength, admixtures and air entrainment. Preparation and testing of concrete mixtures. Minor research in concrete.

C.E. 6313. Airport Planning and Design 2-3-3. Prerequisite: C.E. 4304. Fall quarter.

Airport site selection, runway length and orientation, traffic control, drainage and lighting, long-range planning, government responsibility for air transportation.


Theories of asphalt mix design. Preparation of asphaltic mixes for stability, durability, economy. Use of various materials and grades of asphalt in bituminous concrete pavements.

C.E. 6323. Transportation Administration 2-3-3. Fall quarter.

Analysis of national transportation policies, financial problems, administrative procedures relating to development of transportation facilities.


Characteristics and costs of present and innovative mass transit systems. Roles of engineers, planners, developers in estimating transit usage and choosing optimal plan.

C.E. 6333. Traffic Engineering 2-3-3. Prerequisite: C.E. 4304. Fall quarter.

Characteristics of drivers and vehicles, traffic studies, capacity, signal systems, engineering solution of traffic movement problems. Supervised traffic engineering studies.


Application of traffic control devices to improve capacity, safety of urban street systems. Emphasis on computer control of signal systems, application of computer simulation models.


Geometric configurations of streets, expressways, busways, railways and their terminals to meet characteristics of vehicle performance and operator limitations.

C.E. 6344. Urban Transportation Planning 3-3-4. Prerequisite: C.E. 6333. Winter quarter.

Planning of urban transportation facilities, mathematical models for prediction of traffic flow assignment, interrelationship of land use and land use, parking and the transportation problem.


Traffic flow phenomena, description of traffic arrival, merging movements, shock waves by mathematical models, simulation of traffic flow processes and applications.


Discounting techniques for public works planning. Microeconomics in project formulation. Applications from welfare economics, capital formation theory, input-output analysis.


Principles of resource allocation, benefit-cost analysis, water-resources project formulation, justification, allocation of joint costs in multipurpose developments.

C.E. 6373. Flood Management 3-0-3.

Hydrology and hydraulics of flood management measures. Analysis of flood control and flood damage abatement: levees, floodways, channel improvements, reservoirs.

C.E. 6378. Watershed Analysis 3-0-3. Prerequisite: C.E. 4353. Fall quarter.

Physical hydrology, watersheds as research tools, variable source area concepts, geomorphology and hydraulic geometry, field trips to research and experimental watersheds.


Techniques for the statistical analysis of hydrologic data, construction of statistical models of hydrologic processes. Methods of frequency analysis, linear and nonlinear least squares.


Digital computer simulation of the land phase of the hydrologic cycle, processes and their interaction, optimization and sensitivity, calibration of a model to measured data, use of the model in a simulation experiment.


Effects of urbanization on storm runoff, sedimentation, and water supply. Modeling of urban runoff. Urban watershed in planning and design.


Systems analysis of water resources operations, design and planning. Characteristics of water resources systems as they relate to operations research methodologies.
C.E. 6703. Urban Sanitary Facilities
2-3-3. Fall quarter. No credit for civil or sanitary engineering students.
Basic information for city planner on engineering aspects of water supply, sewage, storm drainage, waste collection and disposal systems, public health administration and environmental sanitation.

C.E. 6704. Urban Transportation Facilities and Policies
3-3-4. Fall quarter. No credit for civil engineering students.
Interrelated planning of urban transportation facilities. The engineering of vehicular thoroughfares including standards, highway capacity estimates, traffic regulation surveys and parking studies.

C.E. 6751-2. Complex Systems Design
2-4-3 each. Prerequisite: graduate standing.
Permits students from all schools to meet, form an interdisciplinary team and carry out a preliminary design of a significant, complex system.

C.E. 6772. Advanced Computer Interfacing and Design
2-3-3. Prerequisite: N.E. 6770. Spring quarter.
A study of system design using MSI and LSI chips and programmable digital devices as system modules. Subjects include Boolean optimization and register transfer design techniques.

C.E. 6773. Computer Control of Real-Time Systems
3-3-4. Prerequisites: N.E. 6770, E.E. 4077 or equivalent. Summer quarter.
A study of concepts common to all computer-controlled real-time systems. Subjects include evolution of time sets, vectorized interrupts and statistical alarm conditions.

C.E. 6775. Advanced Engineering Programming Methods
3-3-4. Prerequisite: C.E. 2502 or equivalent. Summer quarter.
Advanced engineering programming concepts and their implementation on large scale digital computers. Dynamic data, dynamic programs, engineering data management, engineering problem oriented language development and ICES.

C.E. 6781-2. Projects in Urban Systems Design
0-9-3 each. Prerequisite: consent of instructor.
Analysis of an unstructured urban problem situation by a multidisciplinary group. Groups identify, structure and analyze a specific local off-campus urban problem and propose a solution to that problem.

C.E. 7000. Master's Thesis
Credit hours to be arranged.

C.E. 7999. Doctoral Examinations Preparation
Credit hours to be arranged.
For students preparing for doctoral qualifying or language examinations or both.

C.E. 8001. Seminar in Sanitary Engineering
0-2-1. Prerequisite: consent of school.
Developments in sanitary engineering science and technology. Current research and special topics related to environmental quality assessment and control.

C.E. 8011-21. Seminar in Environmental Resources Problems I and II
0-2-1 each. Fall and winter quarters.
Seminar discussions of current environmental management issues. Guest participants will include advocates of different interest groups.

C.E. 8031. Seminar in Soil and Rock Mechanics
Case histories of design and construction problems involving soil and rock mechanics, including excavations, drainage, dams, retaining structures and slope stability.

C.E. 8041. Seminar in Foundation Engineering
Case histories of design, construction and performance of foundations. Special topics such as machine foundations, foundations in seismic regions, and reentrant programs. Microprogram computing.

C.E. 8051. Seminar in Transportation Engineering
1-0-1. Prerequisite: consent of school. Winter quarter.
Developments in the design and planning of traffic engineering and transportation systems, impact of current literature and technology on the field.

C.E. 8061. Construction Seminar
0-2-1. Corequisite: C.E. 6002.
Course work on actual construction. Whenever possible, guest speakers from the construction industry. Graduate students will present results of required special research projects and thesis research.

C.E. 8101-2-3-4-5. Special Topics
Credit hours equal last digit of course number.

C.E. 8113-4-23. Special Topics
Credit hours equal last digit of course number.

C.E. 8500-1-2. Special Problems
Credit hours to be arranged.

C.E. 8755. Master's Special Research Problem
Credit hours to be arranged.
Six to 12 hours of master's research problem to be scheduled by master's student under direction of school during two or more successive quarters.

C.E. 8999. Doctoral Thesis Preparation
Credit hours to be arranged.
For student in preliminary stages of formulating doctoral research program but who has not obtained formal approval of thesis topic.

C.E. 9000. Doctoral Thesis
Prepared by student.

Engineering Graphics
E.E. 1170. Introduction to Visual Communication and Engineering Design I
2-3-3.
Theory and application of the design process, assigned design project and report. Elements of projection theory that enhance ability to communicate graphically.

E.E. 1171. Introduction to Visual Communication and Engineering Design II
2-3-3. Prerequisite: E.E. 1170.
Consider environmental, human, material and socioeconomic factors. Team project reports. Graphical analysis of empirical equations, calculus, nomography.

Economics
See Industrial Management.

Electrical Engineering
E.E. 1001. Introduction to Electrical Engineering
1-0-1. Enrollment limited to freshmen.
An introduction to electrical engineering, both at Georgia Tech and in industry. Lectures, discussion and outside work provide insight to the exciting directions of the profession it takes.

E.E. 1010. Computer Programming and Graphics
2-3-3.

Computer programming and graphics using a problem solving approach. Programs are written in FORTRAN IV for the main campus computer (CDC CYBER 74) and a CALCOM PLOTTER.

Text: Cress, Dirksen and Graham, FORTRAN IV with WATFOR and WATFIV.

E.E. 1011. Electrical Engineering Fundamentals
2-3-3.
Survey of the diverse areas within electrical engineering. Basic engineering concepts developed and applied quantitatively to representative engineering problems.

E.E. 1750. Introduction to Bioengineering
3-0-3.
An introduction to the perspectives of science and technology pertinent to bioengineering, with emphasis on ongoing activity at Georgia Tech.

E.E. 1900-1-2-3. Special Problems
Credit to be arranged. Normally taken by freshmen.
Special engineering problems are assigned according to each student's needs, interests and capabilities.

E.E. 2900-1-2-3. Special Problems
Credit to be arranged. Normally taken by sophomores.
Special engineering problems are assigned according to each student's needs, interests and capabilities.

E.E. 3015. Mechanical Plant of Buildings
3-0-3. Prerequisite: either E.E. 3200, 3700 or 3725.
Electrical power distribution systems for buildings and plants. Study of National Electrical Code. Lighting design considering sources, luminaires and reflectances.


E.E. 3032. Computer Engineering I
3-0-3. Prerequisite: E.E. 1010 or equivalent.
Machine language, machine organization and design concepts of digital computers. Loaders, assemblers, subroutines, recursion and reentrant programs. Microprogram control, interrupt, output and storage devices.

E.E. 3033. Computer Engineering II
3-3-4. Prerequisite: E.E. 3032 or 3560.
Register transfer level logic design using microoperations. Design computer structures including sequences for instruction fetch, addition, multiplication, division, shifting, logical operations, timing and control. Discussion of bus structures, interrupts and input/output. Design projects based on CDL.
E.E. 3034. Computer Engineering III
3-0-3. Prerequisite: E.E. 3032 or 3033.
A study of topics in computer architecture. The topics include addressing techniques and their interaction on stacks, position independent code and reentrant code. Fixed point instructions are studied and timing diagrams developed for performance evaluation. Floating point processors including typical instruction sets, data types, timing and data conversion techniques are investigated. Various memory configurations are introduced to show the effects of interleveling, instruction overlays, cache buffering and associative addressing on machine performance. Typical bus structures which are introduced are the PDP Unibus, Intel Multi Bus and the hobby market S-100 bus. Error detection and correction techniques are also introduced.

E.E. 3036. Computational Methods for Simulation
3-0-3. Prerequisite: Math. 2309 or 3308.
A study of numerical algorithms for solving complex electrical engineering problems using digital computers. Theoretical approaches and practical algorithms are discussed. Text: Jackson and Conte, Elementary Numerical Analysis.

E.E. 3042. Electrical Measurements
3-0-3. Prerequisite: E.E. 3270, 3360, 3421.
A study of measurements of electrical quantities using electromechanical and electronic, analog and digital methods, consideration of recording, indication and processing of measurement data.
Text: Cooper, Electronic Instrumentation and Measurement Techniques.

E.E. 3200. Elements of Engineering
3-0-3. Prerequisite: E.E. 3210, Math. 3210, 3360, 3421.

E.E. 3210. Circuits and Systems
3-0-3. Prerequisite: E.E. 3250, Math. 3308.
System analysis in the time and frequency domains. Convolution, Fourier series and Fourier transform with applications.

E.E. 3215. Signals and Systems
3-0-3. Prerequisite: E.E. 3210.
An introduction to the fundamentals of signal representation, system characterization and signal processing with applications to communication, control and instrumentation.

E.E. 3220. Circuits and Systems
Energy state functions, force energy functions, basic transducers, introduction and D.C. machines.

E.E. 3250. Elements of Electrical Engineering
3-0-3. Prerequisite: E.E. 3200.
Introduction to instrumentation equipment and techniques. Basic laboratory techniques and design of oscilloscopes and meters. Measurement of parameters of electrical engineering components and devices.

E.E. 3260. Engineering Electronics
3-0-3. Prerequisite: E.E. 3250.
Development of techniques necessary for the analysis of active linear electronic circuits.
Text: Millman and Halkias, Integrated Electronics.

E.E. 3511. Junior Electrical Engineering Laboratory I
Introduction to instrumentation equipment and techniques. Basic laboratory techniques and design of oscilloscopes and meters. Measurement of parameters of electrical engineering components and devices.

E.E. 3725. Electric Circuits and Fields
2-3-3. Prerequisite: Phys. 2122 and Math 2308.
An introduction to the steady state and transient response of circuits to periodic and step inputs.

E.E. 3726. Elementary Electronics
2-3-3. Prerequisite: E.E. 3725.
An introduction to electronic and semiconductor devices and a study of circuits containing such elements. Both linear and digital systems are considered. Laboratory experiments.

E.E. 3727. Electric Power Conversion
2-3-3. Prerequisite: E.E. 3725.
A study of energy conversion principles and devices such as motors, generators, transformers and rectifiers. Lecture, computation and laboratory periods.

E.E. 3740. Electrical Instrumentation Laboratory
Problems are assigned to some electrical instruments. Coordinated descriptive lectures and laboratory exercises.

E.E. 3741. Electronic Systems Laboratory
0-3-1. Prerequisite: E.E. 3740. Corequisite: E.E. 3710.
An introduction to linear and digital electronic systems with the aid of integrated circuit modules.

E.E. 3900-1-2-3. Special Problems
Credit to be arranged. Normally taken by seniors.
Special engineering problems are assigned according to each student's needs, interests and capabilities.
A study of automatic control systems. Basic control principles, system modeling and analysis techniques. Coordinated laboratory exercises.

Text: Ogata, *Modern Control Engineering*.

E.E. 4017. Pulse Circuits
3-0-3. Prerequisite: E.E. 3270
Systems analysis/design for processing analog and digital data, generation and synchronization of sweeps, switching considerations of MOSFET multivibrators, active-element memories, D-A and A-D converters.


E.E. 4019. Power System Analysis
3-0-3. Prerequisite: E.E. 3200 or consent of school.
A study of power systems, power system components and techniques of analysis.


E.E. 4020. Solid-state Electronics
3-3-4. Prerequisite: E.E. 4350
A study of underlying physics and resultant terminal properties of solid-state devices such as transistors, charge coupled devices and microwaves to optical devices.

E.E. 4021. Electromagnetic Properties of Solids
3-3-4. Prerequisite: E.E. 4350
Properties of dielectric and magnetic materials including piezoelectricity, superconductivity, magnetic domain dynamics and ferromagnetic resonance. Applications as transducers, memories, logic elements and microwave devices.

E.E. 4022. Industrial Electronics
3-3-4. Prerequisite: E.E. 3210, 3270, 3360.
A study of analog and analysis of continuous and two-position industrial control systems, including polyphase and controlled rectifiers, transducers, photosensitive devices and timing circuits.

E.E. 4023. Integrated Circuits and Systems
3-0-3. Prerequisite: E.E. 3270.
A study of integrated circuit technology available today. The merits and drawbacks to electronic applications offered by circuit configurations available in digital and linear ICs.

Text: Grinich and Jackson, *Introduction to Integrated Circuits*.

E.E. 4024. Speech Analysis, Synthesis and Compression
3-0-3. Prerequisite: E.E. 3210 or consent of school.
Modern speech analysis and synthesis techniques as applied to the communication problem of speech synthesis. Classical phonology, vocoder, vocal track models, spectral analysis of speech.


E.E. 4025. Information Theory
3-0-3. Prerequisite: E.E. 3340 or equivalent.
Definitions and applications of the measure of information, redundancy, channel capacity and mutual information and Shannon's coding theorems are presented with emphasis on communication problems.


E.E. 4026. Audio Engineering
3-0-3. Prerequisite: E.E. 3270, 3310.
An introduction to the application of the tools of electrical engineering to the detection, measurement, processing, recording and reproduction of audio frequency signals.

E.E. 4027. Computer Graphic Design
3-0-3. Prerequisite: E.E. 1010 or equivalent and junior standing.
Study of computer-aided design (CAD), with emphasis on interactive graphics. Engineering applications and introduction to hardware and programming for interactive computing.

E.E. 4028. Communication Engineering
3-3-4. Prerequisite: E.E. 3210, 3270.
Circuit design for communication system devices operating below one gigahertz. Oscillators, amplifiers, mixers, discriminators, modulators, detectors, primarily for analog system applications.

E.E. 4030. Communication Engineering
3-3-4. Prerequisite: E.E. 3210, 3270.
Theory and practice in the design of radio and television. Also a study of signal propagation, radio frequency interference, frequency allocation and fundamental antennas.

E.E. 4032. Communication Circuits
3-3-4. Prerequisite: E.E. 3210.
A study of two-port communication circuits by means of methods of modern network synthesis.


E.E. 4044. High-frequency Measurements
3-0-3. Prerequisite: E.E. 3320.
High-frequency measurements emphasizing characteristics of standard laboratory equipment together with the techniques of high-frequency measurements. Includes system design and state-of-the-art measurements.


E.E. 4055. High Frequency Amplifier Design
3-0-3. Prerequisite: E.E. 3320, 3330.
An introduction to the techniques used in the analysis and design of high frequency amplifiers with emphasis placed on design.

Text: Carson, *High Frequency Amplifiers*.

E.E. 4056. Ultra-high-frequency Techniques
3-3-4. Prerequisite: E.E. 3320.
Introduction to waveguides, cavities, klystrons, magnetrons, traveling wave tubes, im­mittance, ferrite gyrotors and circulators. Associated laboratory emphasizes microwave measurements.

Text: Collin, *Foundations for Microwave Engineering*.

E.E. 4057. Antennas
3-3-4. Prerequisite: E.E. 3320.
An introduction to linear antennas, linear arrays and aperture antennas. Far field pattern calculation and measurement are presented. Students design and construct antennas in associated laboratory.

Text: Kraus, *Antennas*.

E.E. 4058. Electrical Sensors and Transducers
3-0-3. Prerequisite: senior standing or consent of school.
A study of how electrical sensors function and their system applications. Classical, state-of-the-art and advanced sensors and systems are examined for design purposes.

E.E. 4041. Illumination Engineering
3-0-3. Prerequisite: E.E. 3310.
An introduction to interior and exterior lighting design. Basic topics considered are light, sight, color, photometry, illumination, luminaires and sources.

E.E. 4062. Electrical Design
3-3-4. Prerequisite: E.E. 3200 or consent of school.
Team-oriented electrical and electronic system design problems of various types. Topics often specified in advance and often related to national student engineering competitions.

E.E. 4043. Linear Graph Theory
3-0-3. Prerequisite: E.E. 3210.
Comprehensive and unified study of oriented and nonoriented graphs for use in network topology, analysis and synthesis, signal flow theory and communication networks.

E.E. 4045. Power System Protection
3-0-3. Prerequisite: E.E. 4019.
An introduction to fundamental concepts in the protection of electric power system apparatus.


E.E. 4046. Power System Engineering
3-0-3. Prerequisite: E.E. 4019.
Modeling of power semiconductor elements and components, elements of steady state operation and power system protection.

E.E. 4047. Power Electronics
3-0-3 Prerequisite: E.E. 3270.
An introduction to power semiconductor devices and to the electronic circuits incorporating these devices that can be used in the amplification, generation and control of electrical energy.

E.E. 4050. Optical Engineering
3-3-4. Prerequisite: E.E. 3320 or consent of school.
Introduction to optics and optical systems as applied to modern engineering problems. Image formation, holography, optical data processing, optical memories, specification of optical systems, fiber optics.

Text: Meyer-Arendt, *Classical and Modern Optics*.

E.E. 4051. Fiber Optics
3-0-3. Prerequisite: E.E. 3310 or consent of school.
Exploration of state-of-the-art material related to the fabrication, measurement and use of optical fibers. Development of the theory of dielectric waveguides.

Text: Gioge, *Fiber Optic Technology and class notes*.

E.E. 4061. Communication Systems
3-0-3. Prerequisite: E.E. 3340 or equivalent, E.E. 3215.
Definitions, basic concepts and applications of analog and digital modulation techniques are considered. Modulators for generating various signals and demodulators for information recovery are studied.

E.E. 4062. Communication Systems Laboratory
0-3-1. Prerequisites: E.E. 3340 or equivalent, E.E. 4060. Corequisite: E.E. 4061.
Experiments in signal processing and communication systems.
E.E. 4075. Microcomputer-Based Design 3-3-4. Prerequisite: E.E. 3032 and E.E. 3360 or equivalent.
Design and implementation of computer systems. A study of the ability to define and design "smart" microcomputer-based systems will be emphasized.
Text: Peatman, Microcomputer-Based Design.
Design using commonly encountered systems structures. Complex performance with hardware simplicity via read-only memories. Design problems implemented on digital synthesizer in digital systems laboratory.
Text: Texas Instruments, TTL Data Book.
E.E. 4077. Interfacing Small Computers 3-3-4. Prerequisite: E.E. 3360.
The input-output structure and programming of small computers is studied together with the characteristics of a variety of peripheral devices. Emphasis is placed on design problem work.
Text: Data General and Georgia Tech, Interfacing Small Computers.
Introduction to the theory and application of processing discrete data. Special attention will be paid to the design and implementation of both FIR and IIR digital filters.
A study of the properties of linear sequential systems in relation to their applications in various digital and analog systems.
E.E. 4080. Introduction to Sequential Systems 3-0-3. Prerequisite: E.E. 3350 or equivalent.
A study of procedures for synthesis of synchronous and asynchronous sequential systems.
Text: Torng, Switching Circuits Theory and Logic Design.
E.E. 4081. Introduction to Bioelectronics 3-0-3. Prerequisite: E.E. 3270 or consent of school.
An introduction to the study of the electrical phenomena of biological systems. The measurement and control of biological systems.
Linear system theory with emphasis on transform and state-variable methods. Applications to both continuous and discrete systems.
Text: Padulo and Arbib, System Theory.
Analysis and design of linear electronic circuits. Single stage amplifiers, multistage amplifiers, tuned amplifiers with emphasis on design techniques.
Practical design problems which emphasize creativity and imagination are posed and their solutions are individually implemented in the laboratory.
Theory and applications of operational amplifiers as they are currently utilized in today's electronic systems to produce both linear and nonlinear functional operations.
E.E. 4087. Biomedical Instrumentation 3-3-4. Prerequisite: E.E. 3220 or 3700 or Phys. 2122.
Instrumentation used in the hospital and clinic from a systems viewpoint. Includes a review of pertinent physiological and electrophysiological concepts.
Text: Bogart, Biomedical Instrumentation Application and Design.
E.E. 4088. Microcomputer-Based Design II 3-0-3. Prerequisite: E.E. 4075.
A variety of hardware and software topics of importance for the design of "smart" microcomputers will be explored.
Text: Peatman, Microcomputer-Based Design.
E.E. 4090. E.E. Senior Seminar 1-0-1. Prerequisite: junior standing.
A capstone seminar between undergraduate electrical engineering education and a postgraduate career. Talk followed by a question and answer period with various authorities.
Analysis of transient conditions in power systems. System parameters. Types of transients. Protective devices and techniques.
A study of the physical, electrical and optical properties of metals, semiconductors, dielectrics and magnetic materials with emphasis on microscopic as well as macroscopic behavior.
Text: Wert, Physics of Solids.
The use, operation and limitations of standard electromagnetic field measurement and signal generating equipment.
E.E. 4412. Senior Electrical Engineering Laboratory II 0-3-1. Prerequisite: E.E. 3330, 3400.
Experimental studies of electromagnetic and electromechanical systems.
E.E. 4430. Project Laboratory 0-3-1. Prerequisite: E.E. 3400. Normally taken by seniors.
Individual experimental investigations and projects tailored to student interests. Projects are selected in consultation with student's faculty adviser.
Principles of advanced energy conversion for electric power. Operation and engineering considerations. Also taught as M.E. 4780 and N.E. 4780.
Text: Angrist, Direct Energy Conversion.
E.E. 4801-2-3-4-5. Special Topics 3-0-3 each. Normally taken by seniors.
New developments in electrical engineering are presented as demand or interest warrants.
Special engineering problems are assigned according to each student's needs, interests and capabilities.
E.E. 6050. Random Processes 3-0-3. Prerequisite: graduate standing.
An introduction to the concepts of probability theory and random variables with applications to electrical engineering problems.
E.E. 6051. Random Processes 3-0-3. Prerequisite: E.E. 6050 or equivalent.
E.E. 6061 and E.E. 6062 constitute a study of the design principles of modern communication systems. Typical topics in E.E. 6061 include: carrier transmission, carrier reception and demodulation of noise, baseband waveforms and multiplexing.
A continuation of E.E. 6061. Typical topics include: binary and multilevel digital signaling, optimum receivers, synchronization and comparisons of digital transmission techniques.
Introduction to pattern recognition. Several approaches to pattern classification will be presented, including the linear discriminant function approach, perceptrons, Bayesian learning and nearest neighbor rule.
E.E. 6071. Communication Circuits and Signals 3-0-3. Prerequisite: graduate standing or consent of school.
Discussion of Fourier transforms and related topics from an intermediate viewpoint, with emphasis on operational skills. Application to electrical networks, sampling, antennas, statistics, optics. Transform-domain reasoning and insight stressed.
E.E. 6072. Fourier Optics and Holography 3-0-3. Prerequisite: E.E. 6071 or consent of school.
Principles of diffraction, lenses, coherent and incoherent imaging, optical information processing and holography presented in a linear systems framework.
Introduction to information theory. The con-
cepts of information, information rate and channel capacity are developed and applied to communication theory problems. Rate-distortion theory is introduced.

E.E. 6082. Coding
3-0-3. Prerequisite: E.E. 6050. Coding techniques for efficient, reliable communication are introduced. Techniques studied include parity-check, maximal-length, Hamming, BCH and convolutional codes, Viterbi decoding and coding for burst-noise channels.

3-0-3. Prerequisite: graduate standing. Provides introduction necessary for the design or analysis of computer-to-computer data transmission systems.

E.E. 6100. Linear Networks and Systems
3-0-3. Prerequisite: E.E. 6100. Introduction to a rigorous treatment of linear systems theory. Topics include theory of vector spaces, linear transformations, state variables, linear dynamical systems, controllability and observability.

E.E. 6101. Time Varying and Nonlinear Systems
3-0-3. Prerequisite: E.E. 6100. Analysis and design of engineering systems with time varying and/or nonlinear characteristic. Topics include theory of vector spaces, linear transformations and properties of the presentation. Linearization techniques. Stability analysis using Liapunov and Popov's theories.

E.E. 6111. Feedback Control Systems
3-0-3. Prerequisite: E.E. 6100. Optimal control approach to control system design. Formulation of optimal control problems using state-space programming, calculus of variations and maximum principles.

E.E. 6112. Feedback Control Systems
3-0-3. Prerequisite: E.E. 6050, 6111 or consent of school. Design techniques for stochastic dynamical systems. Analysis of stochastic systems, state estimation, stochastic control and adaptive control.

E.E. 6113. Feedback Control Systems
3-0-3. Prerequisite: E.E. 6050. Application of discrete time control to continuous systems. Time and frequency domain analysis of sampled data systems.

E.E. 6131. Optimum Linear Filters
3-0-3. Prerequisite: E.E. 6050, 6100 or consent of school. Estimation theory, both classical and modern approaches. Applications in communication and control. System identification techniques.

E.E. 6152. Computer Simulation
3-0-3. Prerequisite: graduate standing or consent of school and elementary Programming ability. A study of computational methods for use in the digital simulation of deterministic systems. Several simulation projects are a part of the course.

E.E. 6153. Computer Simulation
3-0-3. Prerequisite: E.E. 6050 or consent of school and elementary Programming ability. Non-deterministic systems—a study of problems associated with generating and analyzing random data sets using digital computers. Spectral estimation and statistical inference are among topics covered.

E.E. 6161. Digital Systems Engineering I
3-0-3. Prerequisite: graduate standing. Functional organization and operation of digital computers. Register level design of computing structures using microoperations and the CDL language. Design of microsequences for arithmetic, logical, timing, control and floating point functions. Comparisons and evaluations of several micro and minicomputers. The design and simulation of a computer structure is required for each student.

E.E. 6162. Digital Systems Engineering II
3-0-3. Prerequisite: E.E. 6152. Concepts, technology related to microprogramming. Comparison of hardwired control and microprogrammed control. Design of a hypothetical microprogrammed computer. Design of a computer structure using the INTEL 3000 and AMD 2900 bit slice systems. The use of FPLA's, ROM's, PROM's, EPROM's and sequencers. Several design projects are assigned each quarter.

E.E. 6163. Digital Systems Engineering III
3-0-3. Prerequisite: graduate standing. A study of information structures using the MIX assembly language. Structures include stacks, queues, and circular lists. Memory allocation using sequential allocation, linked lists and doubly linked lists are considered. Arrays and orthogonal lists are considered as special examples. Dynamic storage allocation and the problem of garbage collection is also treated. Several problems are assigned for special credit.

E.E. 6201. Automata Theory
3-0-3. Prerequisite: graduate standing. An introduction to automata and the theory of automata. Study of general classes of digital systems including computer components as special cases. A detailed study is made of steps leading to optimal design.

E.E. 6202. Automata Theory
3-0-3. Prerequisite: E.E. 6201. A continuation of the digital system study including fault detection and decomposition of systems. Reliability, memory span and quadratic logic are also examined.

E.E. 6203. Automata Theory
3-0-3. Prerequisite: E.E. 602 or consent of school. An introduction to finite automata through of sequential circuits. Concepts in modern algebra are developed for direct application to sequential circuits.

E.E. 6251. Applied Electromagnetics
3-0-3. Prerequisite: graduate standing or consent of school. Advanced electromagnetic theory. Particularly and complementary solutions of the wave equation for both discrete and continuous cases. Analysis, synthesis and boundary value problems.

E.E. 6252. Microwaves

E.E. 6253. Antennas

E.E. 6301. Electromagnetics
3-0-3. Prerequisite: graduate standing. Introduction to electromagnetics with emphasis on lasers and modern optics. Parametric interactions and resonances. Radiation and scattering, transmission and reflection, electromagnetic waves. Applications include communication, data processing, antennas and propagation.

E.E. 6315. Advanced Electrical Measurements
3-0-3. Prerequisite: graduate standing. A selection of advanced topics in digital signal processing. Topics include multidimensional signal processing, homomorphic systems and auto-regressive modelling.

E.E. 6415. Digital Processing of Speech Signals
3-0-3. Prerequisite: E.E. 4076 or E.E. 6413. A detailed treatment of the theory and application of digital speech processing. Provides fundamental knowledge of digital signal processing methods and about how digital techniques are applied in...
speech transmission, speech synthesis, speech recognition and speaker verification.

E.E. 6421. Advanced Network Theory II
3-0-3. Prerequisite: graduate standing or consent of school.
An introduction to applied combinatorics including combinations, permutations, recursion, partition, generating functions, inclusion and exclusion, root polynomials and Polya's theorem.

E.E. 6422. Advanced Network Theory II
3-0-3. Prerequisite: graduate standing.

E.E. 6451. Electrical Properties of Materials
3-0-3. Prerequisite: graduate standing or consent of school.
A study of the physical and electrical properties of materials. The basis of quantum mechanical formalism and modeling to serve as an introduction to the modern study of electrical properties of materials.

E.E. 6452. Magnetic and Dielectric Properties of Materials
3-0-3. Prerequisite: E.E. 6451 or consent of school.

E.E. 6500. Introduction to Management and Control of Energy Systems
3-0-3. Prerequisite: E.E. 6100, 6502, or consent of school.
Fundamentals of static as well as dynamic system theory as applied to typical energy engineering problems. Optimization theory, decision analysis techniques for large-scale systems.

E.E. 6501. Planning of Power Systems
3-0-3. Prerequisite: E.E. 4019, 6500, 6503 or consent of school.
The study of the physical considerations involved in the use of heavy-current semiconductor devices, the study of magnetic circuits, transformers and their applications.

E.E. 6502. Control and Operation of Interconnected Power Systems
3-0-3. Prerequisite: E.E. 4019, 6100 or consent of school.
Power flow analysis techniques. Modern control of power systems with emphasis on security, economic and environmental issues.

E.E. 6503. Evaluation of Power System Reliability
3-0-3. Prerequisite: E.E. 4019, 6502 or consent of school.
The study of problems in applying the digital computer to real-time control. The digital computer and its supporting control equipment are treated as devices in several control applications. Problems which are considered include sampling, input buffering, control algorithms, error checking, real-time monitoring and data conversion. Applications in the power area are protective relaying and turbine control. Several problems are assigned which require a knowledge of INTEL 6800 assembly language programming.

E.E. 6504. Computer Applications in Power Systems
3-0-3. Prerequisite: E.E. 4075.
A study of the techniques by which atomic collisions phenomena are studied, including scattering of ions and electrons in gaseous and scattering from solid surfaces. Also taught in the School of Physics.

E.E. 6760. Atomic Collisions
3-0-3. Prerequisite: graduate standing in science or engineering.
A discussion of the techniques by which atomic collisions phenomena are studied, including scattering of ions and electrons in gaseous and scattering from solid surfaces. Also taught in the School of Physics.

E.E. 6761. Engineering Computer Software Systems
2-3-3. Prerequisite: E.E. 6760 or consent of school.
Computer programming for real-time process control systems in complex multiprocessor environments. Subjects include assembler programming, operating systems and real-time systems on minicomputers. Also taught as N.E. 6771.

E.E. 6772. Advanced Computer Interfacing and Digital Design
2-3-3. Prerequisite: graduate consent of school. For non-electrical engineering students, and for electrical engineering students whose major program area is not computers or digital systems. A study of system design using MSI and LSI chips, and programmable digital devices as system modules. Subjects include Boolean optimization and register transfer design techniques. Also taught as C.E. 6772, M.E. 6772 and N.E. 6772.

E.E. 6773. Computer Control of Real-time Systems
3-3-4. Prerequisite: consent of school. For non-electrical engineering students, and for electrical engineering students whose major program area is not computers or digital systems. A study of system design for all computer controlled real-time systems. Subjects include evolution of control algorithms, interrupt and error checking, and statistical system reliability. Also taught as C.E. 6773, M.E. 6773 and N.E. 6773.

E.E. 6965. Power System Relaying
3-3-4. Prerequisite: E.E. 4019, consent of school. Principles and techniques of electric power system protection. Application of relaying techniques for system stabilization, protection of high voltage transmission system and substations. Coordinated field trip and demonstrations.

E.E. 6976. Advanced Electrical Transients
3-3-3. Prerequisite: graduate standing or consent of instructor.
Development and application of those aspects of complex variable and transform theory which are helpful in the study of transients and which are particularly useful to electrical engineers in general.

E.E. 7000. Master's Thesis
E.E. 7051-2-3. Advanced Communication Theory
3-0-3 each. Prerequisite: E.E. 6501, 6502, 6503. Latest developments in communications are treated in lecture and seminar. Emphasis on current literature and open research areas.

E.E. 7101. Advanced Feedback Control Theory
3-0-3. Prerequisite: consent of school. Advanced techniques for analysis and design of automatic control systems.

3-3-4 each. Prerequisite: E.E. 6251 or consent of school. Topics of fundamental importance in electromagnetics. Advanced developments in the fields of antennas, propagation, and microwave theory and practice.

E.E. 7899. Preparation for Doctoral Qualifying Exams
3-0-3. Prerequisite: graduate standing.
Preparatory reading for the doctoral qualifying examination.

1-0-1 each.
1-0-0 each.
E.E. 8140 through 8149. Special Topics
1-0-1 each.
Special topics of unusual current interest: introductory treatments of new developments in electrical engineering.
E.E. 8240 through 8249. Special Topics
2-0-2 each.
E.E. 8340 through 8249. Special Topics
3-0-3 each.
E.E. 8430 through 8439. Special Topics
4-0-4 each.
E.E. 8440 through 8449. Special Topics
5-0-5 each.
E.E. 8500-1-2-3. Special Problems
Credit to be arranged. Prerequisite: junior standing.
Problems meeting the special interests of the student. Approval to schedule must be obtained in advance of registration.
E.E. 9000. Doctoral Thesis

Engineering Graphics
See Civil Engineering.

Engineering Science and Mechanics

E.S.M. 1101. Introduction to Engineering
2-0-3.
The engineer and design, relation between the student's curriculum and his or her career in engineering. Emphasis placed on student participation in creative design process.
Text: at the level of Beakley and Leach, Engineering: An Introduction to a Creative Profession.

E.S.M. 1750. Introduction to Bioengineering
3-0-3.
Biomechanics of human body including its mechanics, nervous system control, material properties and biological fluid flows. Diagnostic techniques and assisting and therapeutic devices. Also listed as A.E. 1750, E.E. 1750, M.E. 1750.

E.S.M. 1901 through 1909. Special Problems in Engineering Science
3-0-3, maximum. Prerequisite: freshman standing.
Individual study and analysis of problems of current and future interest in engineering and science, approved by faculty adviser.

E.S.M. 2101. Engineering Design I
0-3-1. Prerequisite: E.S.M. 1101 or consent of school.
Study of a problem that arises from a need of society. Proposals for a creative solution studied to select best design.

E.S.M. 2102. Engineering Design II
0-0-2. Prerequisite: E.S.M. 2101. Solution of design problem to be completed, a model to be submitted as part of final report.

E.S.M. 2201. Statics
3-0-3. Prerequisite: Phys. 2121 or corequise: Math. 2307.
Elements of statics in two- and three-dimensional problems, centroids, analysis of structures and machines, friction.
Text: at the level of Beer and Johnston, Vector Mechanics for Engineers; Statics.

E.S.M. 2901 through 2909. Special Problems in Engineering Science
3-0-3, maximum. Prerequisite: sophomore standing.
Individual study and analysis of problems of current and future interest in engineering and science, approved by faculty adviser.

E.S.M. 3111. Experimental Methods in Engineering Science
Methods used to observe behavior of physical parameters in engineering problems, photo-optics, signal analysis, transducers and signal processing, methods of data analysis and computer solutions.
Text: at the level of Tuve and Domholdt, Engineering Instrumentation.

E.S.M. 3201. Dynamics I
3-0-3. Prerequisite: E.S.M. 2201, Math. 2307.
Kinematics and mechanics of rigid bodies in plane motion.
Text: at the level of Higidon, Stiles, Davis and Evces, Dynamics.

E.S.M. 3202. Dynamics II
3-0-3. Prerequisite: E.S.M. 3201.
Kinematics and mechanics of three-dimensional motion of rigid bodies.
Text: at the level of Higidon, Stiles, Davis and Evces, Dynamics.

E.S.M. 3301. Mechanics of Deformable Bodies
5-0-5. Prerequisite: E.S.M. 2201. Prerequisite or corequisite: Math. 2308.
Definition and analysis of strain and stress, applications to axially loaded elements, torsion of circular shafts and bending of beams, introduction to simple plasticity and to column stability.

E.S.M. 3302. Mechanics of Materials
3-0-3. Prerequisite: E.S.M. 3301.
Analysis and design of beams (using singularity functions), various structural elements (using energy methods), thick-walled cylinders, rotating discs, curved beams. Theories of failure.

E.S.M. 3451. Computer Applications in Engineering Science and Mechanics
3-3. Prerequisite or corequisite: E.S.M. 3302, 3501, 4210 or consent of school.
Introduction to the use of the digital computer. FORTRAN language and computer solutions of problems in statics, dynamics, mechanics of deformable solids, vibrations and fluid mechanics.

E.S.M. 3501. Fluid Mechanics
3-0-5. Prerequisite: E.S.M. 3202. Prerequisite or corequisite: Math. 2308.
Kinematics of fluid motion, material and spatial coordinates, acceleration, continuity, vorticity, stresses and strains, introduction to the motion of a viscous fluid.
Text: at the level of Owczarek, Introduction to Fluid Mechanics.

E.S.M. 3701. Statics
3-0-3. Prerequisite: Arch. 2301, Math. 1309, Phys. 2111.
Elements of coplanar statics, particle and rigid body equilibrium, centroids, centers of gravity, distributed loads, analysis of structures and beams, shear and bending moment.
Text: at the level of Beer and Johnston, Mechanics for Engineers: Statics.

E.S.M. 3702. Mechanics of Materials
3-0-3. Prerequisite: E.S.M. 3701.
Simple stress and strains, mechanical properties of materials, Hooke's law, moments of inertia of areas, analysis and design of beams and columns, deflection of beams.
Text: at the level of Popov, Mechanics of Materials.

E.S.M. 3711. Dynamics
5-0-5. Prerequisite: E.S.M. 2201.
Kinematics of particles and rigid bodies, kinematics of translation, rotation and plane motion, work and energy relations.
Text: at the level of Work, A Programmed Instruction in Dynamics.

E.S.M. 3750. Introduction to Biofluid Dynamics
3-0-3. Prerequisite: Math. 2309, Phys. 2123 or consent of instructor.
Introduces students to the study of blood flow in the cardiovascular system, with emphasis on the modeling of such flows and the potential of flow studies for clinical research application.

E.S.M. 3901 through 3909. Special Problems in Engineering Science
Credit to be arranged. Prerequisite: junior standing.
Individual study and analysis of problems of current and future interest in engineering and science, approved by faculty adviser.

E.S.M. 4111. Introduction to Experimental Stress Analysis
1-6-3. Prerequisite: E.S.M. 3301 or equivalent, senior standing.
Plane stress analysis using transmitted light photoelasticity and photoelastic models, study of surface strain using resistance strain gauges, transducer design and application.
Text: at the level of Holister, Experimental Stress Analysis.

E.S.M. 4121. Projects in Engineering Science
3-0-3. Prerequisite: consent of school.
Experimental and/or theoretical investigation of an engineering problem, individual student effort with faculty project adviser, written report.

E.S.M. 4201. Intermediate Dynamics I
3-0-3. Prerequisite: E.S.M. 3202 or consent of school.
Kinematics and kinetics of particles and particle systems, applications include motion in resisting medium, redistribution of mass, central forces motion, effects of earth rotation.
Text: at the level of Marris and Stoneking, Advanced Dynamics.

E.S.M. 4202. Intermediate Dynamics II
3-0-3. Prerequisite: E.S.M. 4201 or consent of school.
Two- and three-dimensional motion of a rigid body, Euler's equations, introduction to energy methods and Lagrange's equations.

E.S.M. 4210. Mechanical Vibrations I
3-0-3. Prerequisite: E.S.M. 3201, 3301 and Math. 2308 or their equivalent.
Single degree-of-freedom system, two degrees-of-freedom system, and finally many degrees-of-freedom system, complex representation, applications.
Text: at the level of Timoshenko, Young, Weber, Vibration Problems in Engineering.

E.S.M. 4211. Mechanical Vibrations II
3-0-3. Prerequisite: E.S.M. 4210 and E.S.M. 3302 or equivalent, Fall quarter.
Complex representation, step and impulse loads, many degrees of freedom, influence coefficients, matrix methods, stability of solu-
tion, vibrations of strings, beams and membranes, approximate methods.

Text: at the level of Timoshenko, Young, Weaver, Vibration Problems in Engineering.

E.S.M. 4301. Mechanics of Deformable Bodies
3-0-3. Prerequisite: E.S.M. 3301.
Small strain linear elasticity in two- and three-dimensions, applications in generalized plane stress and plane strain, torsion and bending of noncircular prisms.

E.S.M. 4302. Stress Analysis
3-3-4. Prerequisite: E.S.M. 4301.
Continuation of E.S.M. 4301, further treatment of torsion and bending, strain energy, introduction to thin plates and simple shells, approximation methods.

E.S.M. 4351. Continuum Mechanics
3-0-3. Prerequisite: Math. 2309, E.S.M. 3301.
Geometrical foundations, analysis of stress and deformation, balance laws, constitutive equations, finite and infinitesimal elasticity.

E.S.M. 4401. Materials Science
3-0-3. Prerequisite: senior standing.
Introduction to fatigue, creep, effect of shape, size, temperature and microstructure of specimen, more common stress-strain equations, hysteresis, after effect, etc., theories of failure.


E.S.M. 4451. Biomechanics
3-0-3. Prerequisite: Math. 2309 or equivalent, E.S.M. 3301 or equivalent.
Elastic and inelastic behavior of biomaterials, muscle mechanics, mechanical modeling of biological structures. Hemodynamics, properties of blood, flow in the circulatory system.

E.S.M. 4760. Engineering Acoustics and Noise Control I
3-0-3. Prerequisite: senior standing.
Acoustics related to noise and its control, acoustic terminology, wave propagation, solutions to the wave equation, instrumentation, sound field in large and small rooms, noise legislation. Also taught as A.E. 4760, M.E. 4760.

E.S.M. 4761. Engineering Acoustics and Noise Control II
3-0-3. Prerequisite: E.S.M. 4760 or equivalent.
Continuation of E.S.M. 4760 emphasizing techniques for the solution of noise problems. Vibration isolation, energy absorption, dissipative and reactive mufflers, enclosures, barriers, properties of materials, panel damping. Also taught as A.E. 4761, M.E. 4761.

E.S.M. 4801 through 4809. Special Topics in Engineering Science
1-0-1 through 3-0-9, respectively. Prerequisite: senior standing.
Special courses not included in regular course offerings.

E.S.M. 4901 through 4909. Special Problems in Engineering Science
3-0-3. Prerequisite: E.S.M. 6222 or consent of school.
Free and forced longitudinal, torsional and lateral vibration of bars; vibration of membranes, plates, shells and extended elastic bodies; approximate methods.

E.S.M. 6223. Wave Propagation in Solids
3-0-3. Prerequisite: E.S.M. 6222 or consent of school.
Wave propagation in elastic solids: dilation, shear, normal and surface waves, reflection and refraction; waves in structural elements: analysis of impact problems.

E.S.M. 6241. Gyroscopic Motion and Devices
3-0-3. Prerequisite: E.S.M. 2601 or equivalent.
Spring quarter.
Motion of a rigid body about a fixed point, the top, precession and nutation of the earth, the gyrocompass, rate and integrating gyros, the monorail, ship stabilizers.

E.S.M. 6261. Space Mechanics I
3-0-3. Prerequisite: graduate standing. Fall quarter.
The two-body problem, Kepler's equation, transfer orbits, Hohmann transfer, dynamics of rocket motion, rocket staging.

E.S.M. 6262. Space Mechanics II
3-0-3. Prerequisite: E.S.M. 6261 or consent of school.
Winter quarter.
Celestial sphere, aberration, parallax, Laplace's and Routh's methods, three- and n-body problems, Lagrangian points, Lagrange brackets, perturbations of an oblate planet and atmospheric drag.

E.S.M. 6281. Random Vibrations
3-0-3. Prerequisite: Math. 4215 and E.S.M. 4161, or consent of school. Winter quarter.
Statistical analysis of mechanical systems, correlation function, power spectral density, response to random inputs, method of normal modes, fatigue failures, nonstationary inputs, vibration of beams.

E.S.M. 6282. Random Vibrations II
3-0-3. Prerequisite: E.S.M. 6281. Spring quarter.
Continuation of E.S.M. 6281. Advanced engineering problems in random theory, nonstationary random inputs and response, measurement of power spectra, Fokker-Planck techniques, nonlinear systems.

E.S.M. 6222. Vibrations I
3-0-3. Prerequisite: Math. 4582 or consent of school. Fall quarter.
Lagrangè's equations, small oscillations of conservative and nonconservative systems.

E.S.M. 6223. Wave Propagation in Solids
3-0-3. Prerequisite: E.S.M. 6222 or consent of school. Spring quarter.
Free and forced longitudinal, torsional and lateral vibration of bars; vibration of membranes, plates, shells and extended elastic bodies; approximate methods.

E.S.M. 6301. Advanced Strength of Materials
3-0-3. Prerequisite: Math. 2309, E.S.M. 3301. Summer quarter.
Shear centers for beams, analyses of stresses and deflections in unsymmetrical bending, stresses and deflections in curved flexural members, beams on elastic supports.

E.S.M. 6321. Applied Elasticity I
3-0-3. Prerequisite: E.S.M. 3301 or equivalent. Fall quarter.
Analysis of stress and strain, stress-strain relations, equilibrium, compatibility and boundary conditions, simple three-dimensional applications, plane elasticity problems in Cartesian and polar coordinates.

E.S.M. 6322. Applied Elasticity II
3-0-3. Prerequisite: E.S.M. 6321. Winter quarter.
Continuation of Applied Elasticity I, torsion and flexure of bars, introduction to thermoelasticity, finite-element, finite-difference approximations and relaxation method as applied to elasticity problems.

E.S.M. 6341. Theory of Elasticity I
3-0-3. Prerequisite: E.S.M. 3301 and Math. 2309 or consent of school. Fall quarter.
Introduction to generalized tensors, analysis of deformation, equilibrium, linearly elastic materials, formulation of the first, second and mixed boundary value problems.

E.S.M. 6342. Theory of Elasticity II
3-0-3. Prerequisite: E.S.M. 6341 or consent of school. Winter quarter.
Continuation of E.S.M. 6341, linear elastocity, Saint-Venant's theory of torsion, bending of beams, Love's strain function, Galerkin vector, Papkovitch-Neuber representation, stress potentials, Amy's stress function.

E.S.M. 6343. Theory of Elasticity III
3-0-3. Prerequisite: E.S.M. 6342 or consent of school. Spring quarter.
Continuation of E.S.M. 6342, variational formulation of elasticity, energy theorems, introduction to thermoelasticity, representation of biharmonic functions by analytic functions of a complex variable.

E.S.M. 6381. Theory of Elastic Stability I
3-0-3. Prerequisite: E.S.M. 3301, Math. 4582 or consent of school. Winter quarter.
Various stability methods and their applicability, the elasctica problem, snap and bifurcation buckling, stability of conservative systems, buckling of beams on elastic foundation, lateral buckling.
E.S.M. 6362. Theory of Elastic Stability II
3-0-3. Prerequisite: E.S.M. 6361 or consent of school. Spring quarter.
Stability of various systems—velocity dependent, conservative, dissipative, circular and nonstationary, with examples of each, recent developments in elastic stability theory.

E.S.M. 6371. Theory of Plates
3-0-3. Prerequisite: graduate standing and Math. 4321 or equivalent. Spring quarter.
Van Konrath theory of plates, pure bending of laterally loaded rectangular and circular plates, approximate methods, nonlinear considerations, stiffened and layered anisotropic plates.

E.S.M. 6372. Theory of Shells
3-0-3. Prerequisite: E.S.M. 6371 or consent of school. Summer quarter.
Stresses and deformation of shells with and without bending under various loading conditions, shells forming surfaces of revolution, hyperbolic paraboloidal and elliptic paraboloidal shells.

E.S.M. 6381. Plasticity
3-0-3. Prerequisite: E.S.M. 6341 or consent of school. Spring quarter.
Stress-strain relations in three dimensions, three-dimensional yield conditions and flow laws; extruded bar, rolled tube and sphere, torsion of bars, slip line fields, technological processes, plates.

E.S.M. 6391. Finite Elasticity
3-0-3. Prerequisite: E.S.M. 4351 or consent of school. Winter quarter.
Kinematics of finite deformation, stress, deformation and strain tensors, classical theory of finite elasticity for isotropic materials, introduction to simple materials.

E.S.M. 6401-2. Optimization Techniques I and II
3-0-3 each. Prerequisite: graduate standing. Winter and spring quarters.¹
Applications of calculus to variations to optimization of engineering systems and processes, end and corner conditions, discontinuous optimal processes, control and state variable inequality constraints, direct methods, etc.

E.S.M. 6411. Energy Methods in Mechanics
3-0-3. Prerequisite: E.S.M. 2301, Math. 4362 or consent of school. Summer quarter.
Virtual work, minimum total potential energy, minimum complementary energy, Castiglione’s theorems, applications of calculus of variations, Rayleigh-Ritz method.
¹ Even years (80-81, 82-83, etc.)
hemodynamics, pulsatile flows, microcirculation, joint lubrication, pulmonary physiology, etc., with emphasis on quantitative approach. Also listed as A.E. 7750.

E.S.M. 7999. Preparation for Doctoral Qualifying Examination
Credit to be arranged. Prerequisite: consent of adviser.

E.S.M. 8000-1-2-3. Graduate Seminar 1-0-0 each.

Special ad hoc courses not included in regular E.S.M. graduate course offerings.

E.S.M. 8104-14-24-34-44-54. Special Topics 4-0-4 each. Prerequisite: consent of adviser. Special ad hoc courses not included in regular E.S.M. graduate course offerings.

E.S.M. 8105-15-25-35-45-55. Special Topics 5-0-5 each. Prerequisite: consent of adviser.

E.S.M. 8501-2-3. Special Problems
Credit to be arranged. Prerequisite: consent of adviser. Individual study and analysis of problems of current and future interest in engineering and science.

E.S.M. 8999. Doctoral Thesis Preparation
Credit to be arranged. For student in preliminary stages of formulating doctoral research program but who has not obtained formal approval of thesis topic.

E.S.M. 9000. Doctoral Thesis

English

Special attention given to developing the vocabulary and basic skills in reading and writing for students who need additional preparation for college-level English. Offered on pass/fail basis only. Lectures, exercises, laboratory. Cannot be counted for credit toward graduation.

Engl. 0020. Writing the Impromptu Essay 3-0-0.
Special attention given to developing basic skills in writing for students who need additional preparation for college-level English. Offered on pass/fail basis only. Lectures, exercises. Cannot be counted for credit toward graduation.

Engl. 0050. Efficient Reading 2-0-0.
Mechanics of reading: intensive, rapid learning and performing reading processes based on reading objectives and language levels of difficulty.


Study of principles of logic and semantics and their use in increasing effectiveness of oral and written communication. Analysis of fallacies in the mass media.

 Normally taken by juniors and seniors. Instruction in the basic principles of effective public speaking, with emphasis on practice and criticism. The course is conducted as a laboratory.

Engl. 3018. Persuasive Speaking 3-0-3. Prerequisite: consent of the department. Principles of argumentation and persuasion. Practice in their application, with the emphasis on issues of current public interest.

Study of informative oral communication in science, business and industry. Practice in committee, panel and technical briefing settings. Emphasis on use of audio-visual aids.

 Normally taken by juniors and seniors. Practice in application of principles of effective written communication to important types of professional writing—reports, letters, memoranda. Case method of instruction and individual projects.

 Intensive practice in composition at an advanced level in informative, argumentative and persuasive forms. Discussion of principles and theory of composing. Analysis of appropriate models.

Engl. 3037. Acting and Producing the Play 0-3-1 each. Prerequisite: consent of the department.
See Engl. 3037-8-9.

Study of works of three of the following: Dorne, Bacon, Jonson, Milton, Defoe. Emphasis on their reflection of social, scientific, philosophical attitudes of the age.

Study of the works of three of the following: Swift, Fielding, Thoreau, Wordsworth, Keats. Emphasis on their reflection of social, scientific, philosophical attitudes of the age.

Study of works of three of the following: Carlyle, Melville, Arnold, Tennyson, Twain. Emphasis on their reflection of social, scientific, philosophical attitudes of the age.

Study of works of three of the following: James, Yeats, Shaw, Lawrence, Eliot. Emphasis on their reflection of social, scientific, philosophical attitudes of the age.

Introduction to the poetry of Chaucer in Middle English. Major emphasis on the study of The Canterbury Tales.

A brief statement of the life and times of Shakespeare and a careful study of certain of his principal works. Lectures, reports, papers, quizzes.

A study of the works of James Joyce, with particular emphasis on Joycean techniques of fiction as developed in Ulysses and other selected works.

An analytic survey of prominent playwrights and trends in contemporary drama. Lectures, reports, collateral reading, quizzes.

An analytic study of prominent writers and trends in contemporary fiction. Lectures, reports, collateral reading, quizzes.

Study of selected Old Testament writings.
with emphasis on literary quality and intellectual content. Discussion of both in the cultural heritage of the Western world.

Study of selected New Testament writings, with emphasis on literary quality and intellectual content. Discussion of both in the cultural heritage of the Western world.

Engl. 3076. Faulkner
A study of selected works of William Faulkner with particular emphasis on major themes and the nature of his narrative art.

Engl. 3081-2-3-4-5-6. Seminars in Literature
3-0-3 each. Prerequisite: consent of the department.
Intensive study of individual writers, movements, periods or themes in literature, with the purpose of developing knowledge in depth, critical independence and expository skill.

Engl. 3161. Science Fiction
Study of selected works of science fiction, with emphasis on the relationship of their ideas to those of mainstream fiction, science, politics and history. Seminars, reports, papers.

Engl. 3760. Myth in German Literature
Major literary works of the classical, romantic and modern periods and their use of myths and archetypes. All readings in English translation.

Engl. 3761. Dostoevsky and Tolstoy in Translation
The short works of Dostoevsky and Tolstoy. Major themes and the nature of their narrative art. Readings in English.

Engl. 3786. The Immigrant Experience
The history and literature of the immigrant, stressing life in the Old World and reasons for emigrating, the passage to America, impressions of the New World and problems of assimilation. Lectures, reports, papers.

Engl. 4041. Studies in the Novel
Intensive analysis of selected novels, with emphasis on the artistic excellence and significance of the works in the development of modern scientific and philosophical attitudes.

Engl. 4042. Studies in Drama
Intensive analysis of selected plays, with emphasis on the artistic excellence and significance of the works in the development of modern scientific and philosophical attitudes.

Engl. 4043. Studies in Poetry
Intensive analysis of selected poems, with emphasis on the artistic excellence and significance of the works in the development of modern scientific and philosophical attitudes.

Intensive analysis of selected essays, with emphasis on the artistic excellence and significance of the works in the development of modern scientific and philosophical attitudes.

Engl. 4051. Chaucer II
3-0-3. Prerequisite: Engl. 3051.
Continuation of Engl. 3051. Major emphasis on the study of Troilus and Criseyde.

Intensive study of works of modern literature which treat the themes of man and society, and selected issues of concern.

Engl. 4755. Sex Roles: Their Development and Cultural Influence
3-0-3. Prerequisite: consent of the department.
Psychological principles, legal facts and literary expositions are integrated in an examination of the roles of men and women from three time perspectives: historical, current and future. Readings, lectures, discussions and invited panelists will be utilized. Jointly taught by English, philosophy and social sciences.

Engl. 4801-11.21. Special Topics
1-0-1. Prerequisite: consent of the department.
Study of special topics of current interest in the humanities.

Engl. 4803-12-22. Special Topics
3-0-3. Prerequisite: consent of the department.
Study of special topics of current interest as reflected in selected literary works.

Engl. 4901-2-3-4. Special Problems
Credit to be arranged. Prerequisite: consent of the department.
Studies in specialized aspects of literature and language selected on basis of current interest.

French
See Modern Languages.

Geophysical Sciences

Geo.S. 1000. Introduction to Earth Science
3-0-3.
A survey of planetary science, atmospheric science and oceanography giving general insight into the nature of man's environment.

Geo.S. 2100. General Geology
3-0-3. Corequisite: Chem. 1102 or 1112, Phys. 2124.
Introduction to minerals, rocks and soils. Structure and evolution of the earth's surface features, crust and interior.

Geo.S. 2120. General Geology Laboratory
4-0-0. Corequisite: Geo.S. 2100.
Exercises on minerals, rocks, topographic maps and geologic maps.

Geo.S. 2300. Survey of Oceanography
3-0-3.
Selected topics from geological, physical, chemical and biological oceanography, marine technology, marine environment, resources from the sea. Relationships between man and the sea.

Geo.S. 3000. Earth Resources
3-0-3. Prerequisite: Geo.S. 2100.
A study of Earth's physical resources—fresh water, land (soils), minerals and fuels—emphasizing the geologic origin, geographic distribution and future availability of the resources.

Geo.S. 3100. History of the Earth
3-0-3. Prerequisite: Geo.S. 2100 or consent of department.

Geo.S. 3400. Mineralogy
3-0-3. Prerequisite: Geo.S. 2100 or consent of department.
Crystal bonding and symmetry, crystal structure and crystal chemistry, application to geologically important minerals. Laboratory devoted to crystallography, hand specimen identification, X-ray diffraction.

Geo.S. 3410. Optical Mineralogy
1-3-2. Prerequisite: Geo.S. 3400.
A brief introduction to the use of the polarizing microscope for the identification and study of rocks and minerals.

Geo.S. 3500. The Earth-Moon System
3-0-3. Prerequisite: Phys. 2123.

Geo.S. 4100. The Influence of Man's Activities on the Global Environment
3-0-3. Prerequisite: Geo.S. 2100.
The interacting equilibrium of atmosphere, hydrosphere, biosphere and lithosphere. The interfering effects of man's activities on the cyclic equilibria on the earth.

3-0-3. Prerequisite: Geo.S. 3410.
Texture, composition and structure of sediments and sedimentary rocks, sedimentary processes (hydraulics and aqueous geochemistry), analysis of sedimentary environments.

Geo.S. 4200. Structural Geology
3-0-3. Prerequisite: Geo.S. 2102.
Structures produced by rock deformation during tectonic and metamorphic activity. Primary structural features. The laboratory will include several field trips.

Geo.S. 4250. Engineering Geology
3-0-3. Prerequisite: Geo.S. 2100.
Applications of geological science to problems of civil engineering.

Geo.S. 4300. Introduction to Physical and Chemical Oceanography
3-0-3. Prerequisite: Geo.S. 2100 or consent of department.
Ocean geometry, physical properties of sea water, water movements and energy fluxes, sediments, marine geochemistry, marine geophysics and tectonics, ocean history.

Geo.S. 4301. Applied Oceanography
6-4-5 (six weeks). Prerequisites: Geo.S. 2100 or consent of department.
The aspects of physical, chemical and biological sciences which are marine-oriented as applied to specific problems in the ocean and its environs. Collection and interpretation of field data stressed, utilizing facilities and equipment of the Skidaway Institute of Oceanography.

Geo.S. 4400. Petrology of Igneous and Metamorphic Rocks
3-0-3. Prerequisite: Geo.S. 3410.
Composition, texture and structure of igneous and metamorphic rocks. Physical, chemical, and geologic conditions controlling metamorphism and igneous activity. Laboratory involves microscopy.

Geo.S. 4500. Introduction to Geophysics
3-0-3. Prerequisite: Geo.S. 2100.
General survey of terrestrial geophysics. Topics included are the earth's seismicity, internal structure, shape, gravity, magnetic
field, paleomagnetism, heat flow and global tectonics.

Geo.S. 4550. Applied Geophysics
3-3-4. Prerequisite: Geo.S. 2100, Phys. 2143.
Theory of electrical, magnetic, gravity, seismological, infrasound and reflection exploration methods. The laboratory provides exercises in instrumentation and data interpretation.

Geo.S. 4600. Introduction to Geochemistry
3-3-4. Prerequisite: Chem. 2113.
Distribution and behavior of the chemical elements and natural compounds in the earth, its waters, and its atmosphere. Application of chemical principles to geologic processes.

Geo.S. 4650. Introduction to Atmospheric Sciences
3-0-3. Prerequisite: Chem. 1102, Math. 2309, Phys. 2123, thermodynamics.
Introduction to atmospheric physics, chemistry and dynamics, with emphasis on the interdisciplinary nature of atmospheric science, and man's interaction with the environment.

Geo.S. 4900. Special Topics
0-6-2.

Geo.S. 4900. Special Problems.

Geo.S. 6050. Geophysics I — Seismology and Heat Flow
3-3-4. Prerequisite: consent of department.
An intense theoretical survey of terrestrial geophysics. Topics include seismology, wave motion, structure of earth's interior and heat flow. Laboratory stresses directed projects.

Geo.S. 6051. Geophysics II — Gravity
3-3-4. Prerequisite: consent of department.
An intense theoretical survey of terrestrial geophysics. Topics include potential theory, shape of the earth and physical geodesy.

Geo.S. 6052. Geophysics III — Geomagnetism and Paleomagnetism
3-0-3. Prerequisite: Geo.S. 6051 or consent of department.
Topics include magnetohydrodynamics, origin and description of Earth's magnetic field, rock magnetism, remnant magnetism, geophysical evidence for global tectonics and tectonic mechanisms.

Geo.S. 6100. Clay Mineralogy
3-0-3. Prerequisite: consent of department.
The composition and structure of clay minerals, physical and chemical properties, X-ray identification and classification, geologic distribution and significance, origin.

Geo.S. 6110. Advanced Clay Mineralogy
2-3-3. Prerequisite: Geo.S. 6100.
Clay-water relations; cation exchange; effects of crystal structure and composition on physical and chemical properties, X-ray, electron microscope and other techniques.

Geo.S. 6150. Sedimentary Geology
3-3-4. Prerequisite: Geo.S. 3410.
Composition, texture and structure of sediments and sedimentary rocks, sedimentary processes, diagenesis, environments of deposition, stratigraphy of sedimentary rocks.

Geo.S. 6160. Stratigraphy and Sedimentation
3-0-3. Prerequisite: Geo.S. 6150.
Continuation of Geo.S. 6150 with emphasis on sedimentary environments, recent and ancient. Principles of correlation, stratigraphic mapping and stratigraphic analysis.

Geo.S. 6180. Geology of Ground Water
3-0-3. Prerequisite: Geo.S. 2100.
Relates ground water quality and availability to the geology of specific areas.

Geo.S. 6210. Global Tectonics
3-0-3. Prerequisite: Geo.S. 4200.
A study of the nature of earthquake motion and the damage it causes. The laboratory provides exercises in the interpretation of Geologic aspects of the new global tectonics.

Geo.S. 6220. Advanced Structural Geology
3-0-3. Prerequisite: Geo.S. 4200.

Geo.S. 6300. Principles of Physical Oceanography
3-0-3. Prerequisite: consent of department.
Temperature, atmospheric and oceanic, density of the oceans. Dynamics of ocean currents. Theory of ocean waves. Selected topics with application to coastal and estuarine circulation.

Geo.S. 6310. Principles of Chemical Oceanography
3-0-3. Prerequisite: Chem. 3412, Geo.S. 4300 or consent of department.
Text: the level of Neumann and Pierson, Principles of Physical Oceanography.

Geo.S. 6400. Igneous Petrology
3-4-4. Prerequisite: Chem. 2113, Geo.S. 4400 or consent of department.
Brief overview of the chemistry of sea water and marine sediments. Detailed discussion of selected topics.

Geo.S. 6405. Analytical Methods in Geochemistry I
3-0-3. Prerequisite: Geo.S. 6050, 6051.
Theory and practice in the application of numerical analysis methods to geophysical data. Topics include information theory in seismology and harmonic analysis of potential data.

Geo.S. 6520. Analytical Methods in Geochemistry II
3-0-3. Prerequisite: Geo.S. 6050, 6051.
Theory of magnetotelluric and electromagnetic methods, conductivity of earth materials, theory of direct current resistivity, spontaneous potential and induced potential.

Geo.S. 6550. Observational Seismology
3-0-3. Prerequisite: Geo.S. 4500.
Converse and interpretation of seismic waves.

Geo.S. 6560. Theoretical Seismology
3-0-3. Prerequisites: Math. 4320, 4581, 4582, Geo.S. 6050, 6550.
Theory of elastic wave propagation in the earth. Topics include reflection of waves, surface waves and Cauchy's theory of body waves.

Geo.S. 6600. Aqueous Geochemistry
3-0-3. Prerequisite: Chem. 3412, Geo.S. 2100 or consent of department.
Reactions of minerals in waters on or near the surface of the Earth.

Geo.S. 6610. Organic Geochemistry
3-0-3. Prerequisite: Chem. 3313 or consent of department.

Geo.S. 6620. Nuclear Geochemistry
3-0-3. Prerequisites: Phys. 2123, Geo.S. 3400.
Nuclear reactions and radioactive decay in nature. Geochemistry of radionuclides. Age measurements based on radioactive decay. Abundance variations of radiogenic and cosmogenic stable nuclides.

Geo.S. 6625. Stable Isotope Geochemistry
2-0-2. Prerequisite: Chem. 2113, Geo.S. 3400.
Variations in isotopic composition of the elements owing to isotope effects in natural physical and chemical processes. Application of stable isotopes in paleoclimatology, hydrology, oceanography and paleontology.

Geo.S. 6750. Introductory Diffraction Studies
2-6-4. Prerequisite: consent of department.
Introduction theory and practice of the most widely applicable X-ray diffraction techniques. Identification, lattice parameters, textures, line breadth and crystal orientation. Cross-listed with Phys. 4266.

Geo.S. 6764. Ocean Acoustics
Propagation of sound waves in the ocean. Topics selected from stress-strain relationships, asymptotic ray theory. Propagation in shallow and deep water. Irregularities of the sea, the media and boundaries, sonar arrays. Cross-listed with A.E. 6764, M.E. 6754, E.S.M. 6764.

Geo.S. 6791. Atmospheric Turbulence
3-0-3. Prerequisite: Geo.S. 4650, fluid dynamics.
Introduction to turbulence, turbulent transport of momentum and heat, sources of turbulence in the atmosphere, the dynamics of turbulence in the atmosphere, the dynamics of turbulence, statistical description, correlation functions and the spectral dynamics of turbulence.

Geo.S. 6792. Air Pollution Meteorology
3-0-3. Prerequisite: Geo.S. 4650 or concurrently.
Vertical temperature and wind structure, topographic effects, natural removal processes, atmospheric dispersion of stack effluents, air pollution climatology, meteorological management of air pollution.

Geo.S. 6793. Atmospheric Boundary Layer
3-0-3. Prerequisite: Geo.S. 6910 or Geo.S. 6912.
Structure and aerodynamics of atmospheric boundary layer, turbulence and contaminants in the environment, stratified and disturbed atmospheric boundary layer, free convection layer, current problems.

Geo.S. 6910. Dynamic Meteorology
3-0-3. Prerequisite: Geo.S. 4650, fluid dynamics.
Scale analysis, equations of motion, equilibrium motion in the atmosphere, circulation, vorticity and divergence, thermodynamics of the spherical waves; hydrodynamic and baroclinic instability; frontal systems; global circulation.

Geo.S. 6911. Dynamic Meteorology II
1-3-2. Prerequisite: Geo.S. 4650, fluid dynamics.
Meteorological instrumentation and measurement techniques. Thermodynamics and stability, air flow charts, weather map and chart analysis. Cross-section and trajectory analysis. Advection of pressure and temperature patterns.
Geo.S. 6920. Atmospheric Chemistry I
3-0-3. Prerequisite: Chem. 3413 or concurrently.
This course will primarily address the chemistry of the natural troposphere. Major topics will include: physical characteristics, chemical composition, physical and chemical transformations and global budgets.

Geo.S. 6921. Atmospheric Chemistry II
3-0-3. Prerequisite: Geo.S. 6920 or concurrently.
This course is designed to introduce the student to modern instrumental techniques used in obtaining basic information about the chemical properties of the atmosphere.

Geo.S. 6930. Physical Meteorology
3-0-3. Prerequisite: Math. 2309, thermodynamics.
Physical processes in the atmosphere. Effects of atmospheric composition and structure on solar and terrestrial radiation; physics of clouds, precipitation and thunderstorms.

Geo.S. 6931. Physical Meteorology II
1-3-2. Prerequisite: Geo.S. 6930.
Laboratory course in atmospheric physics. Experiments with state-of-the-art instrumentation for observing and measuring physical properties of atmospheric radiation, aerosols, condensation and precipitation.

Geo.S. 6932. Meteorology for Solar and Wind Energy
2-3-3. Prerequisite: Geo.S. 4650 or concurrently.

Geo.S. 7000. Master's Thesis

Geo.S. 8000. Geophysical Sciences Seminar
1-0-0

Geo.S. 8011-23. Seminar
1-0-1 each.
A forum for graduate students in geophysical sciences to present and discuss topics related to their research interests.

Geo.S. 8101-23. Special Topics
2-0-2, 2-0-2, 3-0-3.

Geo.S. 8500-12. Special Problems
Credit to be arranged.

Geo.S. 9000. Doctoral Thesis

German
See Modern Languages.

Health Systems

H.S. 1000. Overview of Health Systems
1-0-1. Prerequisite: freshmen and sophomores only.
A career-oriented description of the interdisciplinary area known as health systems and an orientation to current issues and alternatives. Insights into the analysis and planning of health care delivery.

H.S. 2111. The Health Field
3-0-3. Prerequisite: none.
History of hospitals and medicine, the nature, problems and costs of modern health care institutions, proposed improvements and the role of health systems specialists.

H.S. 3011. Hospital Functions
3-0-3. Prerequisite: none.
Internal structures, functions and management problems of hospitals, including departmental interactions, hospital and medical terminology, process flows of materials, supplies, personnel, patients, paperwork and information.

H.S. 3021. Nonhospital Components
3-0-3. Prerequisite: none.
Delivery of medical care including solo, group, prepaid group and emergency services. Health resource planning, private and public finance, health care policy and the role of government.

H.S. 3115. Management Engineering I
3-3-4. Corequisite: H.S. 3011 and statistics.
Work simplification, flowcharting, job analysis and evaluation, merit rating and suggestion plans in hospitals. Work measurement principles and practice, predetermination motion-timing, work sampling, standard data and incentive plans.

H.S. 3116. Management Engineering II
3-0-3. Prerequisite: H.S. 3115.
Hospital applications of work measurement to output prediction, crew sizing and work distribution. Manpower and work scheduling, staffing methodologies and cyclical planning. Labor performance control and productivity measurements.

H.S. 3171. Management Engineering III
3-0-3. Prerequisite: H.S. 3115.
Process planning and control in hospitals. Forecasting, materials management, inventory control and quality control, queuing analysis and simulation.

H.S. 3181. Management Engineering IV
2-3-3. Prerequisite: H.S. 3115.
Functional programming, space utilization and facility planning within the hospital. Proximity analysis, layout techniques, material handling, automation and equipment selection. Critical path methods and interfaces with architecture and construction.

H.S. 3211. Data Processing
3-0-3. Prerequisite: H.S. 3011, Mgt. 3700, computer programming.
Hospital and medical information systems, data collection, storage, processing and reporting, file design, record structure, processing requirements, controls, report formats, medical records and statistical audits.

H.S. 3322. Health Care Cost Analysis
3-0-3. Prerequisite: Econ. 2000, H.S. 3011, Mgt. 3700.
Microeconomic analysis of health care delivery, hospital cost finding and cost analysis, evaluating financial alternatives, budget development, pricing policy, rate setting, reimbursement formulas and cost containment.

H.S. 3341. Health Systems Planning
3-0-3. Prerequisite: H.S. 3111 or 3021.
The systems approach to health planning, policy and program decisions, functional systems specifications, recycling for compromise, systems integration, facility planning and manpower requirements.

H.S. 3351. Projects and Reports
3-0-3. Prerequisite: Eng. 3023, H.S. 3111, 3116, 3211.
Methods and techniques of proposing, planning, conducting and reporting field studies, experiments and projects in health systems. Methodological preparations for externships or special problems.

H.S. 3710. Methods Improvement
3-0-3. Prerequisite: None. Not open to H.S. students.
Hospital applications of work simplification, process charting, forms design, work measurement, job analysis and evaluation, merit rating, incentives and suggestion plans.

H.S. 3780. Introduction to Urban Engineering
3-0-3. Normally taken by juniors.
A survey of the current status of scientific and technical contributions to urban socioeconomic problems. Opportunities for increased participation by engineering and related disciplines. Cross-listed with other participating schools.

H.S. 3971-23. Special Problems
Credit to be arranged. Prerequisite: prior arrangements with school.
Individual student projects that apply systems techniques to health care management problems with emphasis upon student initiative, methodology, problem solution and written report.

H.S. 4021. Community Health Problems
3-0-3. Normally taken by seniors.
Problems of urban and rural communities and planning for health care needs, community structure and decision making, accessibility and acceptability, planner-community interactions within a systems context.

H.S. 4351. Case Studies
3-0-3. Normally taken by seniors.
Applications of health systems planning techniques using examples drawn from previous student projects and from professional practice reported in the literature.

H.S. 4570. Field Training Proposal
0-3-1. Prerequisite: H.S. 3351. Open to H.S. students only.
Preparations for field training. Project adviser selection and site assignment, arrangements with site organization, detailed project planning, formal project proposal. Offered on a pass-fail basis only.

H.S. 4571-23. Senior Externship
0-12-4 each. Prerequisite: H.S. 3116-7-8, 3211, 4570. Open to H.S. students only.
Field training for students in actual health care institutions, health service organizations or health planning agencies. Major project, formal written report and oral presentation. Normally full time for one quarter.

H.S. 4692-3. Seminars
1-0-1 each. Normally taken by seniors.
Guest speakers, discussions of health issues, problems and solutions, field training experiences and external opportunities. Offered on a pass-fail basis only.

H.S. 4755. Hospital Management Systems
3-0-3. Normally taken by seniors.
Case studies of hospital management engineering using examples drawn from previous student projects and from professional practice reported in the literature. Cross-listed as I.S.E. 4755.

H.S. 4861-2-3. Health Systems Topics
3-0-3 each. Prerequisite: prior arrangements with school.
Provides formal coursework on special topics not included in regular health systems courses.

H.S. 6001. Introduction to Health Systems
3-0-3. Normally taken by graduate students.
Description of the health care system and its interactive resource components, with emphasis upon accessibility, availability, distribution and cost. Health systems inputs, processes and outputs.

H.S. 6231. Project Management
3-0-3. Prerequisite: H.S. 6001, psychology.

H.S. 7000. Doctoral Thesis

H.S. 8000. Geophysical Sciences Seminar
1-0-0

H.S. 8011-23. Seminar
1-0-1 each.
A forum for graduate students in geophysical sciences to present and discuss topics related to their research interests.

H.S. 8101-23. Special Topics
2-0-2, 2-0-2, 3-0-3.

H.S. 8500-12. Special Problems
Credit to be arranged.

H.S. 9000. Doctoral Thesis

German
See Modern Languages.
Principles and techniques of managing a health care systems service program; project planning, direction, and control; dealing with environmental subtleties; management reporting and project implementation.

H.S. 6331. Health Systems Analysis I
3-0-3. Prerequisite: H.S. 3115, 6001.
Applications of management engineering methods and techniques to institutional health care programs; use of forecasting methods, scheduling and staffing techniques, inventory and quality control.

H.S. 6332. Health Systems Analysis II
3-0-3. Prerequisite: Econ. 6000, H.S. 6001.
Applications of economic analysis to resource allocation in health care delivery. Health care financial and factors involved in cost containment programs.

H.S. 6333. Health Systems Analysis III
3-0-3. Prerequisite: H.S. 6001, I.Sy.E. 6734, 6739.
Advanced health systems analysis. Applications of statistics, computer technology, operations research and other quantitative methods to health care delivery problems.

H.S. 6340. Health Planning Techniques
3-0-3. Prerequisite: H.S. 6001, I.Sy.E. 6739. Methods of group-consensus formation, goal setting and health needs assessment. Coverage includes Delphi and nominal group process, patient-origin studies, accessibility analysis and decision procedures.

H.S. 6341. Health Systems Planning
3-0-3. Prerequisite: Econ. 6000, H.S. 6340, I.Sy.E. 6734.
Community health planning, facility master planning, health care requirements analysis, systems integration, financial planning and life-cycle costs.

H.S. 6351. Research and Evaluation Methods
3-0-3. Prerequisite: I.Sy.E. 6739.
Methods and techniques of planning, proposing, conducting, evaluating and reporting research projects. Elements of the scientific method. Critical reviews of theses, research reports and publications.

H.S. 6570. Field Training Proposal
3-0-3. Prerequisite: H.S. 6001, 6351. Open to H.S. students only.
Preparations for field training. Project advisor selection and site assignment, arrangement for data sources, detailed project planning, formal project proposal. Offered on a pass-fail basis only.

H.S. 6571-2, Graduate Field Training
3-0-1, 0-6-2, 0-9-3, respectively. Prerequisite: H.S. 6331 or 6340, 6570. Open to H.S. students only.
Field training for individual graduate students in relation to health care institutions. Health service organizations or health planning agencies. Graduate project, formal written report and presentation. Normally part time over two or three quarters.

H.S. 6765. Case Studies
3-0-3. Prerequisite: H.S. 6001, I.Sy.E. 6734 or equivalents.
Applications of hospital management engineering and health systems planning techniques using examples drawn from professional practice and research reported in the literature. Cross-listed as I.Sy.E. 6765.

H.S. 7000. Master's Thesis
Prerequisite: prior arrangements with school.
H.S. 7750. Projects.
1-8-3. Prerequisite: prior arrangements with school.
Research projects addressing real life problems confronting operational health care institutions and employing modern principles and approaches of health systems analysis. Project report. Cross-listed as I.Sy.E. 7750.

H.S. 8092-3. Graduate Seminars
1-0-3 each. Normally taken by graduate students.
Guest speakers, discussions of health issues, problems and solutions, field training experiences and employment opportunities. Offered on a pass-fail basis only.

H.S. 8161-3. Topics in Health Systems
3-0-3 each. Prerequisite: prior arrangements with school.
Provides formal coursework on special topics not included in regular health systems graduate coursework.

H.S. 8971-2, Special Problems
Credit to be arranged. Prerequisite: prior arrangements with school.
Individual student projects that apply systems techniques to health care management and planning problems with emphasis upon planning, project initiation, methodology, project solution and written report.

History
See Social Sciences.

Industrial Design
See Architecture.

Industrial Management

Economics

Econ. 3400. Principles of Economics I
3-0-3. Prerequisite: sophomore standing. The behavior of economic units in pricing and output decisions.

Econ. 2001. Principles of Economics II
3-0-3. Prerequisite: sophomore standing surveys of economic systems, employment, income, money and banking and international trade. Relates consumer, business, government and international sectors to the aggregate economy.

Econ. 3000. Economic Theory of the Firm
3-0-3. Prerequisite: Econ. 2000-1. Intermediate price theory with applications to management problems.

Econ. 3001. National Income Analysis
3-0-3. Prerequisite: Econ. 2000-1. An intermediate macroeconomic theory course to enable the student to analyze the national economic environment relative to the firm and stabilization of the national economy.

Econ. 3002. Money and Banking
3-0-3. Prerequisite: Econ. 2000-1. An analysis of how money fits into the economic system and the problems of administering monetary policy both domestically and internationally.

Econ. 3095. Seminar in Economic Policy
3-0-3. Prerequisite: Econ. 3000-1. Topics for discussion will be chosen to encourage the student to focus understanding of economic theory on a substantive problem. Designed for economics majors.

Econ. 3100. Econometrics I
3-0-3. Prerequisite: Econ. 3905 or M.Sci. 3111. An introduction to the statistical methods for estimating the quantitative relationships among economic variables. Topics include model specification, parameter estimation, prediction and verification.

Econ. 3400. The Process of American Industrial Development
3-0-3. Prerequisite: Econ. 2000-1. The forces, unique characteristics and problems associated with American industrialization.

Econ. 3401. European Economic History
3-0-3. Prerequisite: Econ. 2000-1. An economic survey of the major institutions, inventions and innovations of the commercial revolution, the agricultural revolution and the industrial revolution in Europe.

Econ. 3410. Economic Development
3-0-3. Prerequisite: Econ. 2000-1. General theories of economic development. Each student will be required to analyze the economic of a developing country.

Econ. 3500. Scope and Method of Political Economy
3-0-3. Prerequisite: Econ. 2000-1. The logical structure of scientific theory as it applies to knowledge of economic situations and events.

Econ. 3501. Political Economy: Public Policy Analysis I
3-0-3. Prerequisite: Econ. 2000-1. A theoretical perspective to explain and predict the effects of actual and proposed public policy and to generate some standards of evaluation.

Econ. 4000. Topics in Advanced Microeconomics
3-0-3. Prerequisite: Econ. 3000-1. Selected topics in advanced microeconomics. Designed for economics majors.

Econ. 4050. Monetary Theory and Policy
3-0-3. Prerequisite: Econ. 3001. Determinants of supply and demand for money and the effect of changes in these determinants on interest rates, prices and the level of national income.

Econ. 4100. Econometrics II
3-0-3. Prerequisite: Econ. 3100. A detailed discussion of the problems encountered in empirical econometric studies. Emphasis is placed on data problems and errors in estimation and prediction.

Econ. 4110. Mathematical Economics
3-0-3. Prerequisite: Econ. 2000-1. Emphasizes the application of mathematical tools to economic analysis. Topics include static analysis, comparative-static analysis, optimization and dynamic analysis.

Econ. 4120. Economic Forecasting
3-0-3. Prerequisite: Econ. 2000-1. Cyclical fluctuations in the total economy are examined empirically. Methods of making forecasts of national and industry performance are presented.

Econ. 4230. Economics of the Labor Market
3-0-3. The application of microeconomic theory to wages, employment and productivity.

Econ. 4231. Labor History
3-0-3. A survey of the times and conditions facing the working class in attempting to establish a body of industrial jurisprudence.
Econ. 4235. Protective Labor Legislation 3-0-3.
Federal and state regulation of worker safety against occupational injury, unemployment, old-age, disability and discrimination, plus wage and hour legislation.

Econ. 4265. U.S. Labor Relations Law 3-0-3. Prerequisite: Mgt. 4200.
An examination of labor legislation, court decisions and NLRC rulings on labor-management relations.

Econ. 4300. International Economics 3-0-3. Prerequisite: two of Econ. 3000-1-2.
Foreign trade and commercial policy, international finance and current problems of international economic relations.

Econ. 4330. Regional Economics 3-0-3. Prerequisite: Econ. 3000.
Theories of regional income determination and regional growth, spatial economic structure, central-place theory and regional effects of government spending and revenue raising activities.

Econ. 4332. Economics of Location 3-0-3. Prerequisite: Econ. 3000.
A survey of economic factors influencing industrial location. Consideration will be given locational patterns, the impact of transfer processing costs and land use competition.

Econ. 4340. Economics of Industrial Competition 3-0-3. Prerequisite: Econ. 3000-1.
The competitive structure of the American economy in terms of economic models, alternative public policy goals and the development of anti-trust laws.

Econ. 4341. Economics of Regulated Industries 3-0-3. Prerequisite: Econ. 4000-1.
The problems and policy options associated with government regulation of particular industries.

Econ. 4400. History of Economic Thought 3-0-3. Prerequisite: Econ. 2000-1.
A historical survey of schools of economic thought. The main body of the course is concerned with classical, neoclassical, Marxist, Keynesian and modern economic thought.

Econ. 4410. Industrial Development in Latin America 3-0-3. Prerequisite: Econ. 2000-1.
The principles of industrial development in emerging nations. The student prepares an analysis of the problems in a specific Latin American country.

A critical study is made of the methods by which various economic systems meet common fundamental problems in production, exchange, distribution and capital formation.

Collective choice through an economic-rational choice perspective, seeking to explain and predict the relationships among campaigns, voting and public policy toward private enterprise.

The economics and politics of change, technological progress, price effects on innovation and trade-offs between economic efficiency and political expediency in national policies for energy, research, etc.

Econ. 4801-2-3. Special Topics in Economics 3-0-3 each.
A course designed to permit students to pursue a specialized interest in an area of economics not extensively treated in the offerings of the college.

Econ. 4811-2-3-4-5. Special Topics in Economics 1-0-1 through 5-0-5 respectively.
Courses designed to permit students and a professor to pursue a specialized interest in an area of economics not extensively treated in the offerings of the college.

Econ. 4900. Georgia Internship Program Credit to be arranged. Prerequisite: consent of college.
Broadens the scope of the college curriculum by offering students a community-based learning experience which stresses the completion of a specific task.

Econ. 4990. Georgia Internship Program Credit to be arranged. Prerequisite: consent of college.

Econ. 6000. Microeconomic Analysis and Policy Analysis 3-0-3. Prerequisite: consent of college.
Theoretical analysis of the determination of prices and output. The objective is to develop the basic economic concepts.

Econ. 6001. Macroeconomic Analysis and Policy Analysis 3-0-3. Prerequisite: consent of college.
National income accounting methods and the theory of national income determination.

Econ. 6005. Cost Benefit Analysis 3-0-3. Prerequisite: Econ. 6000.
Methods for public project evaluation, including decision criteria, identifying and quantifying costs and benefits, sensitivity analysis and procedures for performing a cost-benefit analysis.

Econ. 6120. Economic Forecasting 3-0-3. Prerequisite: Econ. 6001.
Methods for economic forecasting. A historical survey of research techniques and development of macroeconomic theory and the analysis of overall economic conditions with their application to management problems of the industrial firm.

Econ. 6230. Labor and the Economy 3-0-3. Prerequisite: previous course in labor relations.
A course involving contract negotiations, grievance handling and arbitration.

Econ. 6266. Wage and Employment Theory 3-0-3. Prerequisite: Econ. 6000, 6001.
An analysis of the economic theories and institutional developments explaining the terms, conditions and levels of employment.

Econ. 6300. International Trade and Finance 3-0-3. Prerequisite: Econ. 6001.
Foreign exchange market, foreign trade and commercial policy, international finance and current problems of international economics.

Econ. 6320. Managerial Economics 3-0-3. Prerequisite: Econ. 6000.
Relationships between economic concepts and managerial decisions. Topics covered include nonprofit goals of the firm, unstructured managerial problems and the determinants of good managerial decisions.

Econ. 6330. Regional Economics 3-0-3.
Survey of the economics of regions, emphasizing region delineation, systems of cities, measurement of regional activity, theories of income, employment and economic growth.

Econ. 6331. Economics of Industrialization 3-0-3.
An examination of long-run growth processes seeking causes of underdevelopment, exploring theories of economic growth and applying these explanations to developed and underdeveloped economies.

Econ. 6335. The Economics of Environmental Quality 3-0-3. Prerequisite: consent of college.
Topics included are the causes of market failure to provide a high quality environment, amenity resources and extra-market values.

Econ. 6340. Industry and Government 3-0-3. Prerequisite: Econ. 6000.
Organization and the structure of American industry, beginning with price theory under various forms of market structure.

Major public issues from the viewpoint of American economic history.

Econ. 6410. Development of Economic Thought 3-0-3. Prerequisite: Econ. 6000-1, consent of college.
Development of the various schools of economic thought and their contributions to the present body of economic theories. Credit not given for both Econ. 4400 and 6410.

Econ. 6430. Research Methods in Development 3-0-3.
General review of research techniques and to acquaint the student with the literature and reference sources in industrial development.

Econ. 6435. Development Seminar I 1-0-1. Prerequisite: Econ. 6410.
Planning and researching a project in an industrial development.

Econ. 6436. Development Seminar II 3-0-3. Prerequisite: Econ. 6435.
Writing and presenting a research paper on industrial development. The paper may be either applied or theoretical in nature and should be of publishable quality.
Econ. 6500. Nonmarket Processes and Economic Decisions
3-0-3. Prerequisite: Consent of college.
Development of political economy and relation of political-economic processes to managerial decision-making.

Econ. 6501. Private and Public Spheres of Influence 3-0-3.
Processes of private and public decisions in a modern economy.

Econ. 6750. The Changing Economy 3-0-3.
This course examines the long run forces within the economy that support economic growth and rising standards of living. Studies the changes in these sources of growth due to the recent performance of the economy.

Interdisciplinary relationship of the nuclear fuel cycle and reactor system to the electrical power industry treated as a system, effect of management decisions on the overall economy. Also listed as N.E. 6760.

Econ. 7010. Advanced Microeconomic Analysis 3-0-3. Prerequisite: Econ. 6000 and consent of college.
Analysis of resource allocation and income distribution.

Econ. 7011. Advanced Macroeconomic Analysis 3-0-3. Prerequisite: Econ. 6001 and consent of college.
Interrelationships among the major aggregated sectors of a national economy taking special cognizance of institutions which exist in U.S.

Econ. 7020. Seminar in Microeconomics 3-0-3. Prerequisite: Econ. 7000 and consent of college.
Students have an opportunity to pursue in depth some topic or problem in the area of microeconomics.

Econ. 7021. Seminar in Macroeconomics 3-0-3. Prerequisite: Econ. 7001 and consent of college.
Students have an opportunity to pursue in depth some topic in the area of macroeconomics.

Econ. 7100. Econometrics 3-0-3. Prerequisite: consent of college.
An analysis of the problems of heteroscedasticity, multicollinearity, underidentification and autocorrelation as whole.

Econ. 7101. Seminar in Econometrics 3-0-3. Prerequisite: Econ. 7100 and consent of college.
Empirical economic research.

Econ. 8401. 2-3-4-5-6. Special Topics 1-0-1 through 6-0-6. Prerequisite: consent of college.
Topics of current interest in the field of economics.

Econ. 8501. 2-3-4. Special Problems 1-0-1 to be arranged. Prerequisite: consent of college.
Provides project work experience in the field of economics.

Econ. 9000. Doctoral Thesis

Management

Provides a general understanding of financial accounting systems and an interpretation of financial reports.

Provides a general understanding of cost accounting systems with emphasis on the manufacturing situation.

Provides a general understanding of management applications of accounting output in a decision context.

Mgt. 3010. Taxation 3-0-3. Prerequisite: Mgt. 2000
Business income tax requirements and the management planning necessitated by various tax alternatives. Some attention to personal income taxes.

Accounting techniques and principles for measuring assets, equities and earnings of manufacturing and financial corporations. Includes revenue recognition, inventory valuation, accounting theory, etc.

Mgt. 3021. Topics in Managerial Accounting and Control 3-0-3. Prerequisite: Mgt. 2002 and consent of the instructor.
Advanced topics in managerial reporting and analysis, such as divisional performance measurement, capital budgeting under uncertainty, budgeting, control and other issues in internal resource allocation.

An introduction to concepts used in the design of management systems relying on computers and information technology.

Introduces the institutions and instruments for acquisition of funds and stresses their utilization in an economic environment for financing financial decisions.

Mgt. 3061. Finance II 3-0-3. Prerequisite: Mgt. 3060.
Application of capital budgeting techniques to the firm, including selection from alternative investment opportunities, determining cost of capital and treatment of uncertainty.

A study of the analytical techniques in finance including capital budgeting, portfolio theory and capital market theory.

Mgt. 3080. Investments 3-0-3. Prerequisite: Mgt. 3060 or 3701.
An introduction from a theoretical point of view to the selection and acquisition of proper securities for managing portfolios with different goals.

Mgt. 3100. Organizational Development 3-0-3. Prerequisite: Mgt. 3150 or consent of college.
Analysis of the structural development of the organization. Particular emphasis is given to organization-environment interfaces, effectiveness and efficiency. Managing technology and change.

Mgt. 3150. Management Theory 3-0-3
Provides students with a fundamental management theory matrix essential to the understanding of management, process and role.

Role of the manager in today's era of pervasive change, viewing the firm as a socioeconomic unit of the society.

Mgt. 3161. Management as a creative Force 3-0-3. Prerequisite: Mgt. 3160.
Describe the manager's role in accomplishing the entrepreneurial mission of the enterprise. Each student analyzes and reports on an existing organization.

Development and function of the law, court organization, procedure and substantive law in contracts, business organizations, and agencies.

Legal problems encountered in an urban environment within a socioeconomic and political atmosphere, specifically in the areas of consumer problems, bankruptcy and constitutional law.

Marketing's role in productive process, basic buyer behavior, market segmentation concepts, the management of marketing activities, environmental influences on marketing management.

Mgt. 3301. Marketing Management 3-0-3. Prerequisite: Mgt. 3300.
Emphasis on marketing management problems through the process of analysis, planning and control, case analysis and readings.

Mgt. 3310. Marketing Research 3-0-3. Prerequisite: Mgt. 3300, M.Sc. 3100.
Research orientation, planning an investigation, questionnaires, sampling, interpretation of results, report presentation.

The use of management science models to solve marketing management problems, application rather than theory is stressed.

Mgt. 3330. Contemporary Issues in Marketing 3-0-3. Prerequisite: Mgt. 3300.
A survey of general and cost systems. Emphasis on the use of accounting data. Credit not given for Mgt. 3700 and any other undergraduate accounting course.

Emphasizes both the design of accounting
Mgt 4022. Special Problems in Financial Reporting
4-0-4. Prerequisite: Mgt. 3020. Consolidations, funds statements, earnings per share, results of operations, mergers and poolings, general price level adjustments, foreign exchange transactions and not-for-profit organizations.

Mgt 4024. Seminar in Financial Reporting and Control
4-0-4. Prerequisite: Mgt. 2002 and consent of the instructor. In-depth study of one or two major current issues in accounting, involving controversy and a significant possibility of substantial impact on theory and practice.

Mgt 4040. Auditing Concepts
4-0-4. Prerequisite: Mgt. 4022 or consent of the instructor. Problems in certifying financial statements, including audit objectives, statistical approaches to audit scope and auditing complex computerized data systems.

Mgt 4100. Organizational Analysis
3-0-3. Prerequisite: Mgt. 3150 or consent of college. Analysis of internal outcomes of the organizing process. The individual-organization interface is studied to understand perception, motivation, group formation and leadership within the firm.

Mgt 4110. The Management of Organized Effort
3-0-3. Open only to seniors. Management as a process of developing and controlling situations toward which people act and respond, both individually and as members of groups.

Mgt 4115. Contemporary Management Thought
3-0-3. Prerequisite: Mgt. 3150 or consent of college. This course emphasizes the impact of changing social values on management thought and practices. Guest speakers make important contributions to the course.

Mgt 4120. Contemporary Research in Management
3-0-3. Prerequisite: either Mgt. 3100, 4100 or consent of college. Investigations, analysis, critiques and proposals for future research orientations in management. Students learn how management research is done.

Mgt 4140. Personnel Management Problems
3-0-3. Prerequisite: Mgt. 3150 or consent of college. Analysis of the personnel management process with emphasis placed upon the role and contribution of the firm to the staff function of personnel administration.

Mgt 4151. Management of Industrial Research and Development Programs
3-0-3. Normally taken by seniors. Analysis of managerial considerations involved in conducting industrial basic and applied research programs and their integration with marketing, manufacturing and finance activities of the firm.

Mgt 4160. Management Concepts and Issues in World Business

Mgt 4165. Seminar
1-0-1. Junior standing. Lectures and discussions with prominent business, government, labor and educational leaders. Offered winter quarter only.

Mgt 4170. Career Analysis
3-0-3. A course designed to enable students to analyze classified jobs in a company to determine education, training provided and counseling for workers.

Mgt 4180. Industrial Management Honors Seminar
3-0-3. Last or next to last quarter seniors by faculty invitation. Gives outstanding seniors an opportunity to research, analyze and discuss current management and economic problems.

Mgt 4195. Integrated Management Problems
3-0-3. Prerequisite: senior standing and Mgt. 3150, 3300, a marketing elective, Mgt. 3601 and 3700 and 4350. Comprehensive cases are used to integrate knowledge at the policy level of management and to relate managerial decisions to the economic and competitive forces affecting business.

Mgt 4200. Industrial Relations
3-0-3. Theories of the labor movement, union-management relationship, including the legal setting, contract negotiations, contract administration and the roles and nature of third parties.

Mgt 4201. Contemporary Unionism and Collective Bargaining
3-0-3. Prerequisite: Mgt. 4200. A study of union structure, collective bargaining procedures and the analysis of union-management contracts.

Mgt 4202. Cases in Labor-Management Relations
3-0-3. Prerequisite: Mgt. 4200. A case study of problem areas in union-management relations. The cases used will be actual NLRB and labor arbitration decisions.

Mgt 4250. Nonmarket Environment of the Firm
3-0-3. Open only to seniors. An examination of the sociocultural factors which must be taken into account in the management decision process and the forces which lead to their change through time.

Mgt 4290. Public Administration
3-0-3. An examination of the managerial function of federal, state and local governments with emphasis on the role of their interaction with the private sector.

Mgt 4331. Consumer Behavior
3-0-3. Prerequisite: Mgt. 3300. Stresses the impact of buyer decisions on the firm's marketing functions. Discusses economic, psychological, sociological, anthropological and organization impacts on buyer decisions.

Mgt 4335. International Marketing
3-0-3. Prerequisite: Mgt. 3300. Emphasis on international comparative analysis, the role of marketing in economic development and marketing strategies and policies of multinational firms.

Mgt 4450. Production Management I
3-0-3. Prerequisite: Mgt. 3150, M.Sci. 3400. Developing understanding of the organizational, economic and physical framework within which the manufacturing division functions.

Mgt 4801-2-3. Special Topics in Industrial Management
3-0-3-4-3 each. Permits groups of students and a professor to pursue areas of management not extensively treated in other courses.

Mgt 4811-2-3-4-5. Special Topics In Management
3-0-3. Prerequisites: Mgt. 4811-2-3-4-5 respectively. Permits a group of students and a professor to pursue areas of management not extensively treated in other courses of the college.

Mgt 4901-2-3. Individual Research in Industrial Management
Credit to be arranged. Prerequisite: consent of college. Designed to permit independent study with a faculty member. To register, the student must obtain the written approval of the associate dean and of the sponsoring professor.

Mgt 4950. Georgia Internship Program
Credit to be arranged. Prerequisite: consent of college. Broadens the scope of the college curriculum by offering students a community-based learning experience which stresses the completion of a specific task.

Mgt 6000. Management Accounting and Control
3-0-3. Prerequisite: consent of college. Covers the use of accounting systems to provide information for performance evaluation.

Mgt 6001. The Budget Process
3-0-3. Prerequisite: Mgt. 6000 and consent of college. Develops the concepts of planning, budgeting and control as they relate to large resource allocation decisions.

Mgt 6020. Accounting Theory and the Analysis and Interpretation of Financial Statements
4-0-4. Prerequisite: Mgt. 6000. Accounting techniques and principles for measuring assets, equities and earnings of manufacturing and non-manufacturing corporations. Includes revenue recognition, inventory valuation, accounting theory, etc.

Mgt 6021. Topics In Managerial Accounting and Control
3-0-3. Prerequisite: Mgt. 6001 and consent of college. Advanced topics in managerial and accounting and analysis, such as divisional performance measurement, capital budgeting under uncertainty, budgeting and control and other issues in internal resource allocation.

Mgt 6022. Special Problems in Financial Reporting
4-0-4. Prerequisite: Mgt. 6020. Consolidations, funds statements, earnings per share, results of operations, mergers and poolings, general price level adjustments, foreign exchange transactions and not-for-profit organizations.

Mgt 6023. Behavioral Aspects of Control
3-0-3. Prerequisite: Mgt. 6001, 6100. The relationship between planning, budgeting and control processes in complex organizations and their interaction with organization
structure, managerial behavior, information systems and financial performance.

Mgt. 6024. Seminar in Financial Reporting and Control
3-0-3. Prerequisite: Mgt. 6000 and consent of college.

In-depth study of one or two major current issues in accounting, involving controversy and a significant possibility of substantial impact on theory and practice.

Mgt. 6025. Socioeconomic Accounting
4-0-4. Prerequisite: Mgt. 6001

Use and limitations of accounting analysis in defining and measuring the economic costs, benefits and effectiveness of public projects and not-for-profit organizations.

Mgt. 6030. Financial Control I
4-0-4.

The general and cost accounting system of the firm will be studied as a managerial information system.

Mgt. 6031. Financial Control II
3-0-3. Prerequisite: Mgt. 6030.

Principles, problems and methods of accumulating, analyzing and interpreting accounting data.

Mgt. 6032. Financial Control III
3-0-3. Prerequisite: Mgt. 6031.

Applies decision principles developed in Mgt. 6031.

Mgt. 6040. Auditing Concepts
4-0-4. Prerequisite: Mgt. 6022 or consent of college.

Problems in certifying financial statements, including audit objectives, statistical approaches to audit scope, and auditing complex computerized data systems.

Mgt. 6041. Taxation and Decisions
4-0-4. Prerequisite: Econ. 6000, 6001 and Mgt. 6000 or consent of college.

A comprehensive examination of the major provisions of the Internal Revenue Code. Emphasis is placed upon the impact of taxes on business decisions.

Mgt. 6060. Financial Management I
3-0-3. Prerequisite: graduate standing and Mgt. 6000.

Instruments and instirutions of finance, the creation and modification of the financial structure of the firm.

Mgt. 6061. Financial Management II
3-0-3. Prerequisite: Mgt. 6060

Theory and the application of funds within the firm in a manner consistent with predetermined objectives.

Mgt. 6062. Theory of Financial Management
3-0-3. Prerequisite: Mgt. 6060.

The theory of the firm from a financial viewpoint—including capital budgeting with special emphasis on uncertainty and capital rationing.

Mgt. 6063. Corporate Cash Management and Banking Relations
3-0-3.

Daily cash management, short-term securities, cash planning, cash forecasting, credit lines, short-term financing, banking relations, collection systems, credit policy and other aspects of the corporate treasurer’s job.

Mgt. 6064. Financial Planning Systems
3-0-3.

Computer-based financial statement generators and budgeting systems, short- and long-term financial models, computer-based capital budgeting systems and a variety of other financial planning models.

Mgt. 6065. Seminar in Financial Management
3-0-3. Prerequisite: Mgt. 6060.

Topics of current interest in the field of financial management.

Mgt. 6080. Investments
3-0-3. Prerequisite: Mgt. 6060.

Analysis of the valuation of securities and examination of the implications of the efficiency of capital markets.

Mgt. 6100. Organization Processes
3-0-3. Prerequisite: consent of college.

Introduction to and analysis of individual behavior and to individual and group performance in organizations.

Mgt. 6101. Organizational Problems, Theory and Application
3-0-3. Prerequisite: consent of college.

Introduction to, and analysis of various theories of organization in terms of goals, form and social setting. Organizational design-performance relationships are key issues considered.

Mgt. 6105. Individuals in Organizations
3-0-3. Prerequisite: graduate standing, consent of college.

Combines the theory of management with a workable knowledge of the behavioral sciences in achieving the objective of management.

Mgt. 6106. Group Processes in Organizations
3-0-3. Prerequisite: Mgt. 6105.

Administrative problems that arise in the relationships among people in organizations.

Mgt. 6107. Organization Theory
3-0-3.

Background for student to build sound organizational structure within the objectives of the enterprise.

Mgt. 6140. Management Systems Analysis
3-0-3.

Analysis of the environmental factors and forces that interact to form systems and their resultant impact upon the practice of management.

Mgt. 6155. Development of Management Thought
3-0-3.

A survey of the development of management thought based upon a critical examination of classic works in management literature.

Mgt. 6160. Management Theory
3-0-3. Prerequisite: consent of college.

Provides resources essential to the development of a matrix of management theory at the professional level.

Mgt. 6170. The Entrepreneur, Innovation and Change
3-0-3.

The role of the entrepreneur and innovation in economic development.

Mgt. 6180. Multinational Business
3-0-3. Prerequisite: consent of college.

Critical examination of business concepts, organizational structures and control processes of the multinational corporation in different political and economic environments.

Mgt. 6195. Managerial Policy
3-0-3. Prerequisite: Mgt. 6000, 6100, Econ. 6000 and two of Mgt. 6001, 6002, 3650.

Economic, competitive and governmental forces affecting the formulation of corporate strategy and managerial policies and decision-making.

Mgt. 6196. Managerial Policy II
3-0-3.

An examination of selected strategic issues, problems and competitive strategies in particular industries and types of organizations, combined with field projects and guest lecturers.

Mgt. 6200. Labor Problems
3-0-3.

An examination of the union-management relationship. Includes analysis of labor agreement, grievance procedures and arbitration and the legal environment of labor relations.

Mgt. 6260. The Legal Environment
3-0-3.

The role of law in society, legal philosophy and basic legal concepts.

Mgt. 6300. Marketing Management I
3-0-3.

Critical analysis of the marketing functions of an industrial enterprise, organizing and control of marketing programs emphasized.

Mgt. 6301. Marketing Management II
3-0-3. Prerequisite: Mgt. 6300.

Advanced course in marketing analysis and strategy formulation. Particular emphasis will be given to application of materials from Mgt. 6300.

Mgt. 6310. Marketing Research and Analysis
3-0-3. Prerequisite: Mgt. 6300.

Theory and techniques of marketing analysis and its use in the formulation of policy and strategy.

Mgt. 6320. Marketing Models
3-0-3. Prerequisite: Mgt. 6300 and a knowledge of probability and statistics.

Marketing models utilizing probability and statistics as well as behavioral techniques.

Mgt. 6330. Consumerism and Public Policy Issues in Marketing
3-0-3. Corequisite: Mgt. 6300.

Recent issues in consumerism, the performance of marketing activity within our society.

Mgt. 6350. Manufacturing Management I
3-0-3.

Provides the student an opportunity to combine the theories of economics and management in the production of manufactured products.

Mgt. 6351. Manufacturing Management II
3-0-3. Prerequisite: Mgt. 6350.

Further development and application of managerial and economic concepts in the solution of problems in the manufacturing firm.

Mgt. 6750. The Changing Economy
3-0-3.

This course examines the long run forces within the economy that support economic growth and rising standards of living. Studies the changes in these sources of growth due to the recent performance of the economy.

Mgt. 7000. Master’s Thesis
3-0-3. Prerequisite: consent of college.

Seminars in research techniques being employed in the current literature of management and economics.
Management Science

M.Sc. 2000. Management Applications of Data Processing
2-0-3
Provides a technical foundation for the development of computer-based management systems.

M.Sc. 3100. Survey of Statistics
3-0-3
Prerequisite: Math 1711.
A survey of discrete probability and statistics with emphasis on economic and business applications. Serves as core requirement for I.M. degree. Credit cannot be obtained for M.Sc. 3100 and either or both M.Sc. 3110 and M.Sc. 3111.

M.Sc. 3110. Statistics I
3-0-3
Prerequisite: Math. 1713, 1711.
Emphasis on continuous probability models and discrete models. Required of economics majors and recommended to those wanting a two course sequence in statistics. Credit cannot be obtained for M.Sc. 3110 and M.Sc. 3100.

M.Sc. 3111. Statistics II
3-0-3
Prerequisite: Math. 1713, 1711.
Classical inference and estimation drawing heavily on calculus for such topics as maximum likelihood estimation, evaluation of decision rules, etc. Credit cannot be obtained for M.Sc. 3111 and M.Sc. 3100.

M.Sc. 3200. Management Science I
3-0-3
Prerequisite: Matrix algebra.
Applications of linear programming to the analysis of managerial problems. Topics include duality, transportation problems and postoptimality analysis.

M.Sc. 3201. Management Science II
3-0-3
Prerequisite: Math. 3215.
This second course in the methodology and application of management science is concerned with the use of stochastic models in the analysis of managerial and economic decision-making.

M.Sc. 3300. Decision Analysis in Management
3-0-3
Prerequisite: Math. 1711.
An introduction to decision models for management situations under risk and uncertainty including fundamental economic concepts of a theory of rational choice.

M.Sc. 3400. Analytical Methods in Management I
3-0-3
Prerequisite: Math. 1711.
Introduction to management science. Analytical models of management decision situations. Topics include classical optimization and linear programming.

M.Sc. 3401. Analytical Methods in Management II
3-0-3
Prerequisite: M.Sc. 3400 or 3200.
Additional applications of linear programming to analysis of management decision problems. Topics include alternatives to the simplex algorithm and special applications.

M.Sc. 3402. Analytical Methods in Management III
3-0-3
Prerequisite: M.Sc. 3400 or 3200.
Introduction to the theory and applications of efficient, dynamic and nonlinear programming in the analysis of management decision problems.

M.Sc. 3403. Analytical Methods in Management IV
3-0-3
Prerequisite: M.Sc. 3100 or 3110.
Analytical and simulation approaches to the analysis of queueing and inventory systems.

M.Sc. 4100. Management Statistics
5-0-3
Prerequisite: consent of college.
Statistical fundamentals and techniques for graduate students with diverse backgrounds.

M.Sc. 4110. Introduction to Sampling
3-0-3
Prerequisite: statistical inference.
Theory and applications of sampling techniques with applications to substantive management and economic research problems.

M.Sc. 4801-2-3. Special Topics in Management Science
1-0-1
Each. Normally taken by seniors.
Required of econo­mics and management science not extensively treated in the offerings of the college.

M.Sc. 4900. Georgia Internship Program
1-0-1
Credit to be arranged.
Prerequisite: consent of college.
Broadens the scope of the college curriculum by offering students a community-based learning experience which stresses the completion of a specific task.

M.Sc. 4991-2-3. Special Problems
Credit to be arranged.
The special project is designed to provide the student an opportunity to apply his or her full training to the analysis of an applied or theoretical problem. To register, the student must obtain the written approval of the assistant dean and of the sponsoring professor.

M.Sc. 6000. Quantitative Decision Procedures I
3-0-3
Prerequisite: consent of college.
Introduction to formal analysis of managerial and economic decision problems. Management science models are applied to management problems.

M.Sc. 6070. Management Systems and Information Technology
3-0-3
Prerequisite: consent of college.
Management use of information technology to capture, process and distribute information for support of managerial decision-making.

M.Sc. 6051. Computer Simulation of Management Problems
3-0-3
Prerequisite: M.Sc. 6050 or equivalent. Techniques of simulating general management decisions utilizing information from the areas of marketing, production, finance and industrial relations.

M.Sc. 6055. Management Information Systems
2-2-3
Prerequisite: M.Sc. 6050.
Applies the concepts of general systems theory and systems analysis to organizations and to the design and implementation of management information systems.

M.Sc. 6101. Applications of Statistical Methods to Management Decision-Making
3-0-3
Prerequisite: M.Sc. 4100 and consent of college.
Theory and applications of elementary multiple regression analysis in a management framework.
Industrial and Systems Engineering

I.Sy.E. 1010. Basic Concepts in Industrial and Systems Engineering
- Available to freshmen only. Introduction to types of problems concerning industrial and systems engineers. Students develop solutions which are compared to typical analytical solution techniques encountered in I.Sy.E. practice.

I.Sy.E. 1010. Man-Machine Systems
- Introduction to methods for analysis and design of man-machine systems. Stresses quantitative techniques in analysis of work center design and work systems design.

I.Sy.E. 1014. Systems and Productivity
- Human contributions to productivity and interaction of technical advances with human performance. Examination of impact of individual employee needs, leadership styles and organizational design on productivity.

I.Sy.E. 3025. Engineering Economy
- Methods of economic analysis in engineering including decision problems, value measurement, interest relationships, criteria for decisions under uncertainty, risk and uncertainty.

I.Sy.E. 3027. Applications of Probability
- Scheduling computations. Resource allocation.

- Topics include probability concepts, random variables, discrete and continuous distributions.

I.Sy.E. 3029. Engineering Statistics II
- Topics include estimation, hypothesis testing and process control.

I.Sy.E. 3030. Engineering Statistics III
- Introduction to analysis of planned and unplanned experiments. Topics include regression and analysis of variance with applications to problems in engineering and science.

I.Sy.E. 3100. The Professional Practice of Industrial and Systems Engineering
- Provides project work experience in the field of management science.

I.Sy.E. 3105. Organizational Structures
- The organizational elements, activities and structures within which an industrial engineer works.

I.Sy.E. 3113. Physiological and Biomechanical Analysis of Work
- Techniques of data collection and analysis for effective man-power oriented tool and work place design.

I.Sy.E. 3115. Industrial and Systems Engineering Measurements
- Corequisite: I.Sy.E. 3028, 3105, or consent of instructor.

I.Sy.E. 3131. Operations Research I
- Models and methods of operations research in solving engineering and management problems. Includes linear models, linear programming, duality, post optimality and network analysis.

I.Sy.E. 3132. Operations Research II

I.Sy.E. 4000. Introduction to Systems Theory
- Corequisite: I.Sy.E. 3010 or equivalent.

I.Sy.E. 4006. Integer and Dynamic Programming
- Optimization by dynamic and integer programming. Decision trees, optimality principle and recursive relationships. Optimization in integer by cutting planes, branch and bound and implicit enumeration.

I.Sy.E. 4022. Job Evaluation and Wage Incentives
- Study of principles used to establish wage rates and salaries. Emphasizes methods and objectives of wage incentive plans and design and analysis of incentive formulas.

I.Sy.E. 4024. Fundamentals of Materials Handling
- Development of principles and techniques for analysis and solution of materials handling problems. Plant trips and laboratories utilized to illustrate modern materials handling methods.

I.Sy.E. 4028. Introduction to Feedback Dynamics
- Examination of feedback processes as causes of dynamic behavior in socioeconomic and managerial systems. Emphasizes feedback loop performance characteristics and computer simulation of multivariate non-linear systems.

I.Sy.E. 4030. Project Management Systems Design
- Prerequisite: senior standing or consent of school.

M.Sci. 6102. Application of Regression Analysis
- 3-0-3. Prerequisite: M.Sci. 6101.

M.Sci. 6105. General Decision Theory: Utility and Games
- Models of nondeterministic decision situations. General finite games in extensive and normal forms, utility indicators, matrix games, mixed extensions, the fundamental theorem and computational techniques.

M.Sci. 6106. Applications of General Decision Theory in Management and Economics
- 3-0-3. Risk games, statistical games, Bayes and minmax strategies, principle of choice problem, no data and data variants. Applications in management and economics.

M.Sci. 6270. Stochastic Models in Management Science
- 3-0-3. Prerequisite: M.Sci. 6101 and consent of instructor.

M.Sci. 6410. Mathematical Programming
- 3-0-3. Prerequisite: M.Sci. 6101 and consent of instructor.

M.Sci. 6411. Seminar in Mathematical Programming
- 3-0-3. Prerequisite: M.Sci. 6410.

M.Sci. 6401-2-3-4-5. Special Topics
- 1-0-1 through 6-0-6 respectively. Prerequisite: consent of department.

M.Sci. 6501-2-3-4. Special Problems
- 3-0-3. Credit to be arranged. Prerequisite: consent of instructor.

M.ScI. 6410. Spectral problems in regression analysis and other multivariate methods as found in business, management and economics.

M.ScI. 6105. General Decision Theory: Utility and Games
- 3-0-3. Models of nondeterministic decision situations. General finite games in extensive and normal forms, utility indicators, matrix games, mixed extensions, the fundamental theorem and computational techniques.

M.ScI. 6106. Applications of General Decision Theory in Management and Economics
- 3-0-3. Risk games, statistical games, Bayes and minmax strategies, principle of choice problem, no data and data variants. Applications in management and economics.

M.ScI. 6270. Stochastic Models in Management Science
- 3-0-3. Prerequisite: M.ScI. 6101 and consent of instructor.

M.ScI. 6410. Mathematical Programming
- 3-0-3. Prerequisite: M.ScI. 6101 and consent of instructor.

M.ScI. 6411. Seminar in Mathematical Programming
- 3-0-3. Prerequisite: M.ScI. 6410.

M.ScI. 6401-2-3-4-5. Special Topics
- 1-0-1 through 6-0-6 respectively. Prerequisite: consent of department.

M.ScI. 6501-2-3-4. Special Problems
- Credit to be arranged. Prerequisite: consent of instructor.

M.ScI. 6501-2-3-4. Special Problems
- Credit to be arranged. Prerequisite: consent of instructor.

M.ScI. 6410. Application of Regression Analysis
- 3-0-3. Prerequisite: M.ScI. 6101.

M.ScI. 6105. General Decision Theory: Utility and Games
- 3-0-3. Models of nondeterministic decision situations. General finite games in extensive and normal forms, utility indicators, matrix games, mixed extensions, the fundamental theorem and computational techniques.

M.ScI. 6106. Applications of General Decision Theory in Management and Economics
- 3-0-3. Risk games, statistical games, Bayes and minmax strategies, principle of choice problem, no data and data variants. Applications in management and economics.
I.Sy.E. 4039. Quality Control
3-0-3. Prerequisite: I.Sy.E. 3028 or equivalent.
Not available to students with credit for I.Sy.E. 3749.
Design of quality control systems. Quantitative techniques for establishing product specifications, process controls, acceptance inspection and other techniques of quality assurance.

I.Sy.E. 4040. Case Problems in Industrial Engineering
3-0-3. Prerequisite: senior standing or consent of school.
Unstructured diverse problems requiring industrial engineering and systems methodology for pragmatic solutions. Problems simulate challenges most likely to be experienced by functioning professional engineers.

I.Sy.E. 4044. Simulation
Discrete simulation methodology emphasizing statistical basis for simulation modeling and experimentation. Overview of computer languages and continuous flow models. Laboratory exercises illustrating model architecture, inference and optimization.

I.Sy.E. 4053. Introduction to Socioeconomic Systems Analysis
3-0-3. Prerequisite: senior standing or consent of school.
Applications of operations research/systems analysis technology and methodology to current social problems. Topics include human resource development, transportation systems, environmental quality and management of municipalities.

I.Sy.E. 4056. Technological Forecasting
3-0-3. Prerequisite: senior standing or consent of school.

I.Sy.E. 4073. Storage and Distribution Systems Design
3-0-3. Prerequisite: I.Sy.E. 4102.
Fundamentals of designing efficient materials and product distribution systems emphasizing warehouse planning, materials and information flow, equipment selection, building design and location, automated warehousing and transportation.

I.Sy.E. 4074. Facilities Management
3-0-3. Prerequisite: I.Sy.E. 4102.
Study of functions, activities, procedures and organizational interrelationships involved in managing physical facilities, emphasizing maintenance, construction and modification, security and safety, waste disposal and planning.

I.Sy.E. 4080. Legal and Ethical Phases of Engineering
3-0-3. Prerequisite: senior standing or consent of school.
Introduces the engineer to the ethical, legal and professional attitudes to be encountered in the future working environment. Includes business, patent and copyright law considerations.

I.Sy.E. 4101. Operations Planning and Scheduling
3-3-4. Prerequisite: I.Sy.E. 3131.
Analytical methods for production and inventory control emphasizing forecasting techniques, inventory models, application of mathematical programming and network models, sequencing and scheduling techniques and line balancing.

I.Sy.E. 4102. Operations and Facilities Design
3-0-3. Prerequisite: I.Sy.E. 3115.
Principles and practices in the design of operations and facilities for a productive system.

I.Sy.E. 4103. Management Information and Control Systems
3-0-3. Prerequisite: I.Sy.E. 4101.
Principles of the analysis and design of management information and control systems—especially those involving electronic data processing.

I.Sy.E. 4104. I.Sy.E. Design I
0-9-3. Prerequisite: I.Sy.E. 4101, 4044, 4102 or 4053. Must be followed by I.Sy.E. 4105 in consecutive quarters.
Senior I.Sy.E. group design project requiring problem definition and analysis, synthesis, specification and installation of a designed solution in off-campus, enterprise environments.

I.Sy.E. 4105. I.Sy.E. Design II
0-9-3. Prerequisite: I.Sy.E. 4103, 4104.
Senior continuation of I.Sy.E. group design project sequence (I.Sy.E. 4104) requiring problem definition and analysis, and synthesis, specification, and installation of a designed solution.

I.Sy.E. 4157. Evaluation of Complex Service Systems
3-0-3. Prerequisite: I.Sy.E. 3028 or equivalents.
Design and analysis of evaluation systems, development and measurement of evaluation criteria, classical methods both qualitative and quantitative, and suggested approaches. Case studies.

I.Sy.E. 4176. Quantitative Methods in Facilities Design
3-0-3. Prerequisite: I.Sy.E. 3131, 3132, 4044 and 4102.
Operations research methodologies applied to facilities planning and design problems. Facilities layout and location problems, assembly line balanced design and automated warehousing problem.

I.Sy.E. 4500. Director's Honor Seminar
3-0-3. Prerequisite: senior standing in I.Sy.E. and a cumulative point average of 3.0 or better.
Informal discussion-study course covering topics selected by course participants, intended to provide an intellectual interchange dealing with issues of significance to the profession.

I.Sy.E. 4725. Engineering Economy
3-0-3. Prerequisite: sophomore standing. Not available to I.Sy.E. students or students with credit for I.Sy.E. 4726.
Fundamental principles and basic techniques of economic analysis of engineering problems, including measures of effectiveness, time value of money, cost estimation, break-even and replacement analysis.

I.Sy.E. 4757. Technology Assessment
3-0-3. Prerequisite: junior standing.
Systematic efforts to anticipate impacts on society that may occur when a technology is introduced, extended or modified. Considers concepts, organization and uses of various specific assessment methods.

I.Sy.E. 4765. Industrial Engineering in Hospitals
3-0-3. Prerequisite: senior standing or consent of school.
Study of hospital management systems and means of improvement by application of industrial engineering principles and techniques. Introduction to health systems and survey of medical terminology. Cross-listed as H.S. 4765.

I.Sy.E. 4897. Special Topics
3-0-3 each. Prerequisite: consent of school.
Courses in special topics of timely interest to the profession conducted by resident or visiting faculty.

I.Sy.E. 4991-2-3. Special Problems
Credit to be arranged. Prerequisite: senior standing in I.Sy.E. and prior faculty topic approval.
A one to three hour credit opportunity to develop initiative and apply fundamental principles by performing seminomrallatory or research work in industrial and systems engineering.

I.Sy.E. 4994-5-6. Research and Projects
Credit to be arranged. Prerequisite: senior standing in I.Sy.E. and prior faculty topic approval.
Research or project work in conjunction with faculty investigations, which may result in undergraduate thesis. Limited to six hours for students with less than a 3.0 cumulative point average.

I.Sy.E. 6101. Modern Organizations
3-0-3. Prerequisite: I.Sy.E. 3014 or equivalent with consent of school.
A comprehensive study of the theories of industrial organization with particular emphasis on analyzing, evaluating and integrating organizational activities.

I.Sy.E. 6103. Organizational Decision-Making
3-0-3. Prerequisite: I.Sy.E. 6101, 6734.
A course integrating behavioral findings with mathematical models of the decision process. The major focus is on these processes in organizational settings.

I.Sy.E. 6107. Management of Improvement
3-0-3.
Concepts of the management of improvement endeavors, strategies and tactics for achieving continuous improvement within organizations. Theoretical bases and approaches to encourage innovation are studied.

I.Sy.E. 6211. Analysis and Evaluation of Industrial Projects
3-0-3. Prerequisite: I.Sy.E. 3025 or equivalent.
This course deals with the financial feasibility analysis of new ventures and other industrial projects. Starting with the generation of venture ideas for new ventures, all steps involved in feasibility analysis are covered. The final topic is the preparation of the investment proposal.

I.Sy.E. 6218. Work Systems Design
3-0-3. Prerequisite: I.Sy.E. 6217 or consent of school.
Advanced study of the design of work systems with emphasis on the human operator and that role in the work system.

I.Sy.E. 6219. Human Factors Engineering
3-0-3.
Application of information on human capabilities and limitations in the design process. Design problems are used to aid understanding of application of human factors data.

I.Sy.E. 6220. Work Physiology
3-0-3.
An evaluation of the various factors affecting human physical performance in the industrial environment. Topics: anthropometry, biomechanics, energy expenditure, heat stress, fatigue, training, strength,
I.Sy.E. 6221. Man-Machine Control Systems
3-0-3. Prerequisite: consent of school.
An introduction to the application of systems theory and methodology to the analysis and design of man-machine control systems.

I.Sy.E. 6222. Ergonomics Seminar
3-0-3. Prerequisite: I.Sy.E. 6219.
Seminar in the human factors area pertinent to the design of work systems. Topics: shift work, sex difference, aging, rest periods and occupational safety and health.

I.Sy.E. 6225. Advanced Engineering Economy
3-0-3. Prerequisite: I.Sy.E. 3025, 3131.
Advanced engineering economy topics, including measuring economic worth, economic optimization under constraints, analysis of economic risk and uncertainty, foundations of utility theory.

I.Sy.E. 6228. Replacement Analysis
3-0-3. Prerequisite: graduate standing, I.Sy.E. 3025, 6734 or equivalent.
Emphasis on analytical methods utilized to evaluate the economic desirability of replacement and retirement options. Use of asset records and analytical methods for estimating asset service lives.

I.Sy.E. 6301. Quality Control Systems
3-0-3. Prerequisite: I.Sy.E. 4039.
The design of quality control systems for production and service enterprises. Topics include costs of quality, quality control systems design and evaluation of system performance.

I.Sy.E. 6305. Forecasting Systems
3-0-3. Prerequisite: Math. 4241 or equivalent.
Techniques and systems for forecasting time series. Statistical methods for generating short term forecasts, analysis of forecast error and design of forecasting systems.

I.Sy.E. 6306. Inventory Systems
3-0-3. Prerequisite: I.Sy.E. 3027, 3131 or equivalent.
An introductory course in inventory theory. Deterministic lot size models, probabilistic models of continuous and periodic review policies, dynamic models and multiechelon systems.

I.Sy.E. 6307. Scheduling Theory
Analysis of sequencing and scheduling activities. Static scheduling problems, dynamic scheduling systems, simulation studies of priority dispatching rules, priority queuing models.

I.Sy.E. 6308. Analysis of Production Operations
3-0-3. Prerequisite: I.Sy.E. 6306, 6669.
Mathematical models for production planning. Applications of mathematical programming, dynamic programming, network theory and heuristic methods to the analysis of production, inventories and capacity.

I.Sy.E. 6400. Design of Experiments
3-0-3. Prerequisite: I.Sy.E. 6739 or equivalent.
Analysis and application of standard experimental designs, including factorial, randomized blocks, latin squares, confounded and fractional replication. Orthogonal polynomials and multiple comparisons are also discussed.

I.Sy.E. 6401. Applied Regression Analysis
3-0-3. Prerequisite: I.Sy.E. 3028 or I.Sy.E. 6739 or equivalent.
Analysis of data from unplanned experiments. Emphasis on the application of statistical methods to problems for distributive services. Analysis of distribution alternatives, stress, emphasized design of economic and control systems encountered.

I.Sy.E. 6402. Time Series Analysis
3-0-3. Prerequisite: I.Sy.E. 3029 or equivalent.
Building empirical-stochastic models of the autoregressive moving-average form for stationary and nonstationary phenomena. Topics include identification procedures, parameter estimation, diagnostic checking and model forecasting.

I.Sy.E. 6404. Nonparametric Statistics
3-0-3. Prerequisite: I.Sy.E. 6739 or equivalent.
Basic concepts and applications of nonparametric statistics. Order statistics, runs, goodness of fit tests, one-sample, two-sample and k-sample tests for location and scale.

I.Sy.E. 6405. Response Surfaces I
3-0-3. Prerequisite: I.Sy.E. 6400.
Introduction to response surface methodology. Topics include canonical analysis, second order response surface designs, canonical forms of rotation and uniform precision designs.

I.Sy.E. 6406. Response Surfaces II
3-0-3. Prerequisite: I.Sy.E. 6405.
A continuation of I.Sy.E. 6405. Topics include orthogonal blocking in response surface designs, alternative design criteria, the mixture problems and current research problems.

I.Sy.E. 6407. Sampling Techniques
3-0-3. Prerequisite: I.Sy.E. 3029 or equivalent.
Survey sampling techniques. Topics include simple random and stratified random sampling, ratio estimation, regression tech-
I.Sy.E. 6800. Systems Research and Application I
3-0-3. Prerequisite: I.Sy.E. 4000 or consent of school.
Individual work and study of cases reflecting the application of the systems engineering process to the modeling, analysis, design and improvement of various classes of man-machine, socioeconomic and ecological systems.
I.Sy.E. 6801. Systems Research and Applications II
3-0-3. Prerequisite: I.Sy.E. 6800.
An interdisciplinary class project requiring small team organization and directed at the application of the systems engineering process to a single problem area.
I.Sy.E. 6802. Advanced Systems Theory I
3-0-3. Prerequisite: I.Sy.E. 4000.
A course extending linear, continuous, deterministic methodologies to nonlinear, discrete and stochastic dynamic system representations and analysis.
I.Sy.E. 6805. Reliability Engineering
3-0-3. Prerequisite: Math. 4215, 4221 or equivalent.
Reliability prediction for nonmaintained systems, availability prediction for maintained systems, life demonstration test design, the concept of system effectiveness.
I.Sy.E. 6806. Introduction to Feedback Dynamics
3-0-3. Philosophy of feedback causality. Methodology for formulation, analysis and synthesis of feedback models and real implementation. Emphasis on large scale systems with intangible variables. Student project.
I.Sy.E. 6807. Feedback Dynamics Principles
3-0-3. Prerequisite: I.Sy.E. 6806.
A course on model building, simulation by hand and DYNAMO. Study of oscillation, growth, frequency sensitivity, phasing, noise in feedback models. Model troubleshooting and improvement. Student project.
I.Sy.E. 6808. Feedback Dynamics Applications
3-0-3. I.Sy.E. 6806, 6807 suggested, but not required.
Design/Modification of human organization. The project illustrates principles presented in I.Sy.E. 6800-6807 and provides exercise in creative real-system synthesis and recommendation implementation.
I.Sy.E. 6831. Advanced Simulation
Extention of discrete and digital simulation methods presented in I.Sy.E. 4044. Emphasis on model building and the design and analysis of simulation experiments for complex systems.
I.Sy.E. 7000. Master’s Thesis
required of degree candidates.
I.Sy.E. 7441. Linear Statistical Models I
3-0-3. Prerequisite: Math. 4241 and I.Sy.E. 6400.
Introduction to full rank linear statistical models, including least squares and maximum likelihood estimation, interval estimation and hypothesis testing. Regression models are discussed. Text: at the level of Graybill, *Linear Statistical Models*.
I.Sy.E. 7442. Linear Statistical Models II
3-0-3. Prerequisite: I.Sy.E. 7441.
A continuation of I.Sy.E. 7441 emphasizing linear statistical models of less than full rank. Balanced designs, including fixed, mixed and random models are stressed. Text: at the level of Graybill, *Linear Statistical Models*.
I.Sy.E. 7656. Advanced Queueing Theory
3-0-3. Prerequisite: I.Sy.E. 6566.
For those interested in advanced work and research. Topics include imbedded Markov chain queuing models, waiting times under various queuing disciplines and current research problems. Text: at the level of Gross and Harris, *Fundamental of Queueing Theory*.
I.Sy.E. 7671. Foundations of Optimization
3-0-3. Prerequisite: Math. 4311.
Conditions for optimality and nonlinear duality generalized to nonconvex functions, and its use in nonlinear programming. Emphasis on large scale systems with intangible variables. Student project.
I.Sy.E. 7672. Optimization: Adjacent Extreme Point Methods
3-0-3. Prerequisite: I.Sy.E. 6669.
A study of current literature in adjacent extreme point methods including quasi concavity, recent duality results, complementary pivot theory, quadratic and stochastic programming.
I.Sy.E. 7673. Nonlinear Programming
3-0-3. Prerequisite: I.Sy.E. 6670.
Nonlinear programming algorithms with emphasis on strategy and convergence at the level of Zangwill, *Nonlinear Programming*. Derivative and derivative-free methods, Lagrange multipliers, penalty functions, conjugate directions, feasible directions and cutting planes.
I.Sy.E. 7674. Dynamic Programming I
3-0-3. Prerequisite: I.Sy.E. 6669 or equivalent.
Advanced treatment of discrete and continuous dynamic programming methods and formations in the area of operations research. Problem formulation, computational aspects and dimensionality reduction. Application to various fields.
I.Sy.E. 7675. Network Flows
3-0-3. Prerequisite: I.Sy.E. 6669.
Current literature in networks including characterization theorems and algorithms for flow problems, flow with gains, multicommodity flows, disconnections sets and matching theory.
I.Sy.E. 7677. Integer Programming
3-0-3. Prerequisite: I.Sy.E. 6669.
The methods and applications of integer programming including cutting plane methods, implicit enumeration, heuristic techniques, group theoretic and other developments. Prerequisite: I.Sy.E. 7600.
I.Sy.E. 7678. Advanced Location Theory
3-0-3. Prerequisite: I.Sy.E. 6670, 6680, or consent of school.
Theoretical aspects of location problems are emphasized, drawing upon results from linear and nonlinear programming, graph theory and network analysis. Recent research literature is covered.
I.Sy.E. 7765. Hospital Management Systems
1-6-3. Prerequisite: I.Sy.E. 6785 or consent of school.
Research projects addressed to real-life problems confronting operational healthcare institutions and employing modern principles and approaches of health systems analysis. Project report. Cross-listed as H.S. 7765.
1-0-0 each.
I.Sy.E. 8100-1-2. Special Topics
3-0-3 each. Prerequisite: consent of school. Special topics offerings not included in regular courses.
I.Sy.E. 8120-1-2. Topics in Safety Engineering
3-0-3 each. Prerequisite: consent of school. This course will be devoted to special topics offerings in the field of safety engineering.
Credit to be arranged. Prerequisite: I.Sy.E. 6801.
Specific systems will be selected for detailed and in depth data collection, simulation, and analysis utilizing the theory provided in the systems research and application courses.
I.Sy.E. 8601-2. Projects In Operations Research
Credit to be arranged. Prerequisite: consent of school.
This course provides, through project work, experience in the application of operations research methods to real-world systems.
I.Sy.E. 8704-5-6. Special Problems in Industrial Engineering
Credit to be arranged. Prerequisite: consent of school.
I.Sy.E. 9000. Doctoral Thesis

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**Information and Computer Science**

Note: the four-digit course numbering system of the School of Information and Computer Science has several mnemonic features. The first digit indicates the course level (x1xx to x4xx, x0xx to x3xx, x5xx to x7xx). The second digit designates the subject orientation of the course: theory and foundations (x1xx), professional milieu (x2xx), computer software (x3xx), information technology (x4xx), computer hardware and systems (x5xx), computer networks and telecommunications (x6xx), and service courses (x7xx). The last three digits in the range x100 through x999 are identical with the subject codes of Computing Reviews, thus facilitating the student's access to the current literature related to these courses.

I.C.S. 1000. Information and Society
1-0-1.

I.C.S. 1001. Computing Facilities
0-3-1.
Introduction to the equipment and facilities of the school and of the Office of Computing Services. Emphasis on the effective use of the timesharing systems.
I.C.S. 1116. Introduction to Linguistics
3-0-3.
Study of selected topics from grammar and semantics that are of importance to the processing of natural language.

I.C.S. 1400. Introduction to Algorithms and Computing
2-3-3.
First course on problem solving using computers. The concept and notation of algorithms. Problem analysis, development of algorithms and their implementation in a procedure oriented language.

I.C.S. 1700. Digital Computer Organization and Programming
2-3-3.
Algorithmic processes of problem solving, properties of algorithms, development of algorithms for the solution of numerical and non-numerical problems. The FORTRAN programming language. No credit for I.C.S. majors.

I.C.S. 2150. Introduction to Discrete Structures
3-0-3. Prerequisite: Math. 1308. An introduction to concepts fundamental to the analysis of algorithms and their realizations. Topics include induction, recursion, graphs, machines, Boolean algebras and combinations.

Introduction to the literature and information services of science, engineering and management. Effective uses of the Georgia Tech library.

I.C.S. 2400. Computer Programming
2-3-3. Prerequisite: I.C.S. 1400.
In-depth, description of the syntax and semantics of FORTRAN and PASCAL and their effective use in the solution of nonnumeric problems. Prior experience with PASCAL required.

I.C.S. 2600. Computer Organization and Programming
3-0-3. Prerequisite: I.C.S. 1400 or 1700.
Introduction to computer organization, machine-language programming and assembly systems. Internal data structures, selected programming techniques.

I.C.S. 2700. Computer and Programming Systems
3-0-3. Prerequisite: I.C.S. 1400 or 1700.
Introduction to digital computer systems, computer organization, assembly language programming and the structuring and processing of information. No credit for I.C.S. majors.

I.C.S. 3110. Semiotics
3-0-3.
Basic concepts of signs relevant to natural and artificial sign processing systems. The representation relation, classification of signs. Analysis of sign systems.

I.C.S. 3113. Information Structures and Processes
3-0-3. Prerequisite: I.C.S. 2600 (or 2700), 2400. Logical data structures and their machine representation. Processes on data structures, including scanning, searching and sorting, with emphasis on list processing techniques.

I.C.S. 3140. Introduction to Discrete Systems
3-0-3. Prerequisite: I.C.S. 2150.
Basic classical and modern concepts and tools required for modeling, analysis and synthesis of discrete deterministic systems; elements of automata theory.

I.C.S. 3150. Introduction to Mathematical Logic
3-0-3. Prerequisite: I.C.S. 2150.
Introduction to formal systems for the logical appraisal of inferences, including quantification and identity theory, referential and interpretation, first order languages, soundness and completeness.

I.C.S. 3155. Introduction to Theory of Computing I
3-0-3. Prerequisite: I.C.S. 2150.
Study of fundamental concepts in the formal theory of automata emphasizing finite state machines. Turing machines and computational power of machines.

I.C.S. 3342. Introduction to Computational Linguistics
3-0-3. Prerequisite: I.C.S. 1116, 3113.
Approaches to natural language processing by computer. Concordance construction, syntactic analysis, question-answering systems, machine translation and computer programs for linguistic research.

I.C.S. 3400. Automatic Data Processing
2-3-3. Prerequisite: I.C.S. 1700 or equivalent.
Development of algorithms for the solution of business oriented problems. File structure organization and processing on different types of storage devices. The COBOL programming language.

I.C.S. 3422. Survey of Programming Languages
3-0-3. Prerequisite: I.C.S. 3113.
Detailed study of programming techniques using a variety of programming languages such as SNOBOL 4, LISP, APL, COBOL, ALGOL, PL/1 and PASCAL.

I.C.S. 3510. Computer-Oriented Numerical Methods
3-0-3. Prerequisites: I.C.S. 1700 or 2400, Math. 1308. Introduction to computer oriented numerical methods for error analysis, function evaluation, solution of systems of equations, curve-fitting, interpolation, numerical integration and differentiation.

I.C.S. 3600. Computer Systems I
3-0-3. Prerequisite or corequisite: I.C.S. 3113.
Basic hardware components of computer systems, their operation and organization. Topics include system structure, data representation, processors, control, storage, input/output and interrupts.

I.C.S. 3601. Computer Systems II
3-0-3. Prerequisite: I.C.S. 3600.
Background of software components and advanced computer organizations including operating systems, run-time environment, microprogramming, minicomputers, and performance measurements and evaluation.

I.C.S. 3610. Computer Logic Design
3-0-3. Prerequisite: I.C.S. 3600.
Theory and design of digital logic systems, including minimization techniques. Applications to digital computer components. Demonstrations of actual logic systems.

3-0-3. Prerequisite or corequisite: I.C.S. 3113.
Study of software components of digital computer systems emphasizing system software (operating systems and translators) and details of hardware organization. NOTE: This course is a combination of I.C.S. 3600 and 3601. Enrollment without credit as a remedial course for ICS graduate students only.

I.C.S. 4110. Topics in Linguistics
3-0-3.
Study of selected topics in the grammar and semantics of natural language. The course is intended for graduate students with no prior background in linguistics.

I.C.S. 4117. Introduction to Mathematical Linguistics
3-0-3. Prerequisite: I.C.S. 1116, 2150, Math. 3215.
Application of statistical and algebraic approaches to the study of linguistic structures from the viewpoint of their utility to a wide range of problems.

I.C.S. 4120. Introduction to Information Processes I
3-0-3. Prerequisite: I.C.S. 1116, 2150, Math. 3215.
Exposition of the information concept and its properties. Statistical theory of syntactic communication: information sources, information transmission, channel capacity and efficiency, coding, noisy communication channels.

I.C.S. 4121. Introduction to Information Processes II
3-0-3. Prerequisite: I.C.S. 2150.
Computer methods of clustering, identification, systematization and pattern recognition; empirical data processing, choice of measurement, feature selection, data reduction, optimality criteria, analysis of algorithms.

I.C.S. 4138. Problem Solving
3-0-3.
General approaches to problem-solving, with emphasis on methods and techniques of formalizing intuitive heuristics. Structure of problems and goals, generation of alternatives. Incomplete information.

Introduction to formal study of syntax, semantics and logic of programming languages.

I.C.S. 4155. Introduction to Theory of Computing II
3-0-3. Prerequisite: I.C.S. 3155.
Introduction to the mathematical analysis of computer algorithms, correctness, complexity, asymptotic lower bounds, efficient data structures and combinatorial algorithms. NP-complete problems.

I.C.S. 4240. Project Communication and Management
3-0-3.
Application of communication techniques to the management of information systems projects. Practice in proposal preparation, system documentation, project reporting.

I.C.S. 4250. Literature of Science and Engineering
3-0-3. Prerequisite: I.C.S. 2250.
Study of the reference and bibliographic sources of scientific, engineering and management literature, emphasizing strategies of manual and computer searching. Bibliographic project in student's discipline.

I.C.S. 4300. Information Systems
3-0-3. Prerequisite: I.C.S. 1700 or 2400.
Empirical methodology of analysis and design of computer-based information systems, and its relationship with the definition of objectives, planning, analysis design, implementation and evaluation of such systems. Case studies.

I.C.S. 4305 Science Information Systems 3-0-3.
Information and communication in science. Design of science data banks, document repositioning, information transfer services. Science information control at national and international levels.


Information processing applications in health care and biomedical research. Patient records, automation of clinical laboratory, hospital information systems, diagnostic decision-making, biomedical documentation.


Methodology for the design and implementation of management information systems in industrial, business and governmental organizations. Feasibility studies; system development, implementation and evaluation. Project management.


Heuristic vs. algorithmic methods for automatic problem solving. Study of machines and programs that deduce answers to questions from given facts, play games, prove theorems.


Computer-aided organization and retrieval of bibliographic and natural-language information. Topics include statistical, syntactic and logical analysis of information content, evaluation of retrieval effectiveness.


An introduction to data communications for computers and computer terminals, including communications media, codes, data transmission, multiplexing, communications software, protocols, switching and simple networks.


Introduction to computer graphics: underlying principles, devices, systems and applications. Hands-on experience with available hardware and software packages. Programming principles on computer graphics.

I.C.S. 4410. Introduction to Compilers 3-0-3. Prerequisite: I.C.S. 3422, 3600.

Study of the basic techniques of compiler design and implementation with consideration of the implementation characteristics of widely used programming languages.


A qualitative introduction to operating systems including multiprocessing concepts, resource allocation and management, other functions performed and operating system implementation.


Introduction to logical and physical structures of computer data base systems. Topics include file organization, directory decoding, searching, maintenance. Data Base Task Group Report.


Mathematical theory of communication with emphasis on efficient transmission of information through noiseless and noisy channels; coding information sources; properties of codes.

I.C.S. 4600. Computer Systems Laboratory 2-12-6. Prerequisite: I.C.S. 3601, 3610.


General and unified approaches to psychological and computer modeling of human information processes. Emphasis on neural networks, sensory, memory, semantic and conceptual processing. Also listed as Psy. 4754.

I.C.S. 4800. Selected Topics in Information and Computer Science 3-0-3. Prerequisite: consent of school.

Courses in selected topics of timely interest to the profession, conducted by resident or visiting faculty.

I.C.S. 4810-1. Design Project I, II, III 0-6-2 each. Prerequisite: consent of school.

An undergraduate thesis sequence consisting of an analytic or empirical investigation in an approved area of information and computer science.

I.C.S. 4901-2-3. Special Problems Credit to be arranged. Prerequisite: consent of school.

Individual investigation of significant areas of information and computer science. Guided study and research.


Methods of information control, including empirical laws of information science; information measurement; assessment of information needs; data collection; indexing, abstracting and bibliographic services.


Theory of quantitative methods of information measurement. Measure functions, syntactic, semantic and pragmatic dimensions of information measurement. Applications in communication systems, decision-making, economic realms.


Study of the mathematical structure of natural language using statistical and algebraic techniques.

I.C.S. 6130. Philosophy of Mind 3-0-3. Prerequisite: graduate standing.

Higher level techniques for mimicking learning, concept formation, problem solving and perception, considered in relation to artificial intelligence. Linguistic and physiological models of human information processes.


Man-machine communication is analyzed by reference to studies of behavioral decision, conversational systems and interactive measurement methods.

I.C.S. 6140. Systems Theory I 3-0-3. Prerequisite: I.C.S. 3140 or equivalent.

Discrete dynamic processes, state variable characterization, classification. Autonomous processes, open and closed subprocesses and interprocess interdependency. Switching circuits, sequential machines, memory and delay. Linearity.


Analysis and synthesis of information systems, emphasizing mathematical modeling. Study of selected systems in areas such as data processing, management, control and management systems.


Roles of various functions in living systems and their actual or potential realization in computers.


Study of the significant results concerning finite automata, pushdown automata, liveloid automata, bounded automata. Turing machines, recognizers of the four Chomsky phrase-structure languages.


A survey of theoretical topics related to compiler design and implementation: deterministic parsing, table processing, compilation, syntax-directed compiling, global optimization.


Basic techniques for determining and designing efficient algorithms: upper and lower time-space bounds for data structure, sorting and combinatorial problems, algebraic algorithms.


Advanced techniques for analyzing complete time-space complexity of natural computational problems: proving the tractability or intractability of problems from algebra, combinatorics, computer science, geometry and number theory.


Advanced treatment of the theory of computability. Topics include recursive functions, recursively enumerable sets and relations, degrees of unsolvability, the recursion theorem and computational complexity.


I.C.S. 6334. Medical Information Systems 3-0-3. Prerequisite: I.C.S. 4343 or 4450.

Medical information systems for patient care, research and administration. Topics include
the medical environment, current systems and trends, database systems and automated medical records.

I.C.S. 6347. Computer-Aided Modeling
3-0-3. Prerequisite: Math. 3215, I.C.S. 3600.

I.C.S. 6360. Artificial Intelligence
3-0-3. Prerequisite: I.C.S. 4360.
Study of methods of heuristic search, automatic theorem proving, semantic information processing, representation theory and other current areas.

I.C.S. 6363. Pattern Recognition
3-0-3. Prerequisite: Math. 3215 or equivalent.
Selected topics from statistical pattern recognition; feature selection; decision functions; pattern classification; trainable pattern classifiers.

I.C.S. 6370. Information Control Methods
3-0-3.
Study of methods of information control, including assessment of information needs, data collection and reduction, manual and automatic indexing, extracting and classification, evaluation and performance.

I.C.S. 6380. Computer Networks
3-0-3. Prerequisite: I.C.S. 4380, 4430.
In depth examination of the design and operation of computer networks covering computer hardware and software functions and design requirements and communication subsystems.

I.C.S. 6410. Computer Language Design
3-0-3. Prerequisite: I.C.S. 3422 or 4410.
Description, structure, analysis and design high level programming languages. Theoretical treatment of language specification, design aspects of names and types, data and control structures.

I.C.S. 6412. Syntax Directed Compilation
3-0-3. Prerequisite: I.C.S. 4410.
Detailed study of compiler implementation techniques, including table-driven syntax analysis, translation to intermediate language, optimizations and object code generation.

I.C.S. 6430. Computer Operating Systems
3-0-3. Prerequisite: I.C.S. 4430.
A quantitative coverage of operating system functions emphasizing implementation techniques including sequential and concurrent processes, processor and storage management, scheduling and protection.

I.C.S. 6431. Design of Computer Operating Systems
1-3-3. Prerequisite: I.C.S. 6430.
A major systems programming project involving the modification or extension of an existing operating system and an evaluation of the results.

2-3-3. Prerequisite: Math. 3215, I.C.S. 6430.
Methods of evaluating performance of large-scale computer systems, with emphasis on performance analysis through simulation, queueing models and measurement.

I.C.S. 6450. Data Base Design
2-3-3. Prerequisite: I.C.S. 4450.
Study of the state-of-the-art of data base design. Approaches to database formalisms and standardization. Term project.

I.C.S. 6530. Graph Theory
3-0-3. Prerequisite: I.C.S. 2150.
Algorithmic combinatorics, including topics in permutations, combinations, enumerations, graphs and trees, with applications in information and computer science.

I.C.S. 6555. Queuing Theory and Applications I
3-0-3. Prerequisite: Math. 3215, I.C.S. 3601.
Queueing theory and its application in computer performance evaluation, operating systems design, telecommunications and operations research.

I.C.S. 6566. Queuing Theory and Applications II
3-0-3. Prerequisite: I.C.S. 4430, 6555.
Continuation of I.C.S. 6555, emphasizing current research topics. Problems suitable for dissertation research are discussed.

I.C.S. 6600. Advanced Small Scale Computer Systems
1-3-3. Prerequisite: I.C.S. 3601, 3610.
The design and application of software and hardware for actual computer systems is introduced through hands-on laboratory experience with hardware modules, micro-computers and interface sub-systems.

I.C.S. 6620. Advanced Computer Organization
3-0-3. Prerequisite: I.C.S. 3601, 3610.
Studies of computer system organizations: advanced input/output systems, multiprocessors, pipeline processors, other parallel systems.

I.C.S. 7000. Master's Thesis
Credit to be arranged. Prerequisite: consent of school.

I.C.S. 7115. Philosophy of Language
3-0-3. Prerequisite: I.C.S. 6116.
Study of selected topics in linguistics arising from philosophical discussion of language. Emphasis on contributions of Russell, Carnap, Quine and Martin to modern linguistic thought.

Credit to be arranged. Prerequisite: consent of school.

1-0-0 each. Prerequisite: consent of school.

I.C.S. 8111-2-3-4-5. Special Topics
Credit hours equal last digit of course number.
Prerequisites: consent of school.
Special topics of current interest. Treatment of new developments in various areas of information and computer science.

I.C.S. 8501-2-3. Special Problems
Credit to be arranged. Prerequisite: consent of school.
Small-group of individual investigation of advanced topics in information and computer science. Guided study and research. Maximum of 5 credit hours allowed toward the I.C.S. M.S. degree.

I.C.S. 8999. Doctoral Thesis Preparation
Credit to be arranged. Prerequisite: consent of school.

I.C.S. 9000. Doctoral Thesis
Credit to be arranged. Prerequisite: consent of school.

Linguistics
See Modern Languages.

Management
See Industrial Management.

Management Science
See Industrial Management.

Mathematics

Math. 1307. Calculus I
5-0-5. Prerequisite: entrance algebra and trigonometry.
The derivative, derivatives of elementary functions, applications of derivatives. Credit is not allowed for both Math. 1307 and Math. 1712 except in I.M. degree programs.

Math. 1308. Calculus II
5-0-5. Prerequisite: Math. 1307.
The definite integral, fundamental theorem of calculus, techniques of integration, applications of integrals, complex numbers, L'Hopital's Rule. Credit is not allowed for both Math. 1308 and Math. 1713 except in I.M. degree programs.


Math. 1390. Calculus III
5-0-5. Prerequisite: Math. 1308.
First order differential equations, linear differential equations with constant coefficients, infinite series, Taylor approximations, vectors, solid analytic geometry.
Text: at the level of Bonic, DuCasse, Hajian, Lipschutz, Freshman Calculus, second edition; and Flanders, Korfhage and Price, A Second Course in Calculus.

Math. 1317-8-9. Honors Calculus I, II, III
5-0-5 each. Prerequisite: invitation of school.
The topics covered parallel those of Math. 1307-8-9, with a treatment somewhat more intensive and rigorous. Credit is not allowed for both an honors calculus course and the corresponding regular course.

Math. 1710. College Algebra and Trigonometry
5-0-5. Prerequisite: entrance algebra. No credit toward graduation for engineering or science degrees.
The function concept, exponential, logarithmic and trigonometric functions, theory of equations including trigonometric equations.
Text: at the level of Keedy and Bittinger, Algebra and Trigonometry.

Math. 1711. Mathematics for Management I
5-0-5. Prerequisite: entrance algebra.
Sets, counting techniques, binomial theorem, finite sequences and series, probability on finite sample spaces, functions, equations and graphs, basic linear algebra. Credit is not allowed for both Math. 1711 and 1710.

Math. 1712. Mathematics for Management II
5-0-5. Prerequisite: Math. 1711.
Continuous functions and limits, optimization, exponential functions and logarithms, inverse functions, derivatives, definite and indefinite integrals. Credit is not allowed for both Math. 1712 and Math. 1307 except in I.M. degree programs.

Math. 1713. Mathematics for Management III
5-0-5. Prerequisite: Math. 1712 or 1307 and 1308.
Integration techniques, improper integrals and normal density functions, Taylor polynomials and the Poisson process. Credit is not allowed for both Math. 1713 and Math. 1308 except in I.M. degree programs.

Text: at the level of Baxter and Sloyer, Calculus with Probability for the Life and Management Sciences.

Elements of logic, set theory, probability and linear algebra, with an introduction to convex sets and linear programming. Credit not allowed for both Math. 2010 and 1711.

Algebra of sets, cartesian products, relations, equivalence relations, functions, sequences, mathematical induction, equipotence of sets, partially ordered sets.


Higher partial derivatives, maximum minimum problems, multiple integrals, line integrals, Green's theorem. Text: at the level of Flanders, Khorzage and Price, A Second Course in Calculus.

Linear differential equations and applications in the engineering and the natural sciences, systems of linear differential equations, series solutions, simple nonlinear equations. Credit is not allowed for both Math. 2029 and 3528.

Text: at the level of Ross, Introduction to Ordinary Differential Equations.


Vector spaces, matrices, systems of linear equations, linear transformations and matrices, change of basis, characteristic roots and vectors, quadratic forms and diagonalization. Text: at the level of Kolman, Elementary Linear Algebra.

Problem-oriented introduction to probability with applications (see Math. 4215), including models and problems in statistical inference. Credit is not allowed for both Math. 3215 and 4215.

Text: at the level of Meyer, Introductory Probability and Statistical Applications.


Math. 3643. Introduction to Numerical Computation 5-0-5. Prerequisite: Math. 2308, E.E. 1010 or equivalent.
Problem-oriented course covering solution of linear systems and of nonlinear equations, interpolation and approximation, approximate methods of integration, differentiation and solution of ordinary differential equations.

Math. 3710. Introduction to Statistics 5-0-5. Prerequisite: Math. 1308 or 1712.
Introduction to probability theory with applications, discrete and nondescrete distributions, moments, laws of large numbers, central limit theorem, inference, correlation. Credit is not allowed for both Math. 3215 and 3217.

Text: at the level of Walpole, Introduction to Statistics.

Unified approach to statistical inferences through decision methods, and to regression and experimental design through least squares. Topics are introduced with discipline-oriented problems. Text: at the level of Walpole, Introduction to Statistics.

Fundamental concepts, results and applications of graph theory and combinatorics, including trees, circuits, cutsets, incidence and adjacency matrices, planarity, coloring problems and basic combinatorial tools. Text: at the level of Wilson, Introduction to Graph Theory.

Math. 4038. Mathematical Logic 3-0-3. Prerequisite: Math. 2308 or 1713.
The propositional and predicate calculus, developed as formal systems of symbol manipulation. Introduction to the related decision problems, recursive functions and automata. Text: at the level of Stoll, Introduction to Set Theory and Logic.

An introduction to basic algebraic systems with emphasis on groups, rings and fields. Text: at the level of Herstein, Topics in Algebra.

A continuation of Math. 4101 with emphasis on modules, polynomial rings and linear associative algebras. Text: at the level of Herstein, Topics in Algebra.

Basic topics from group theory including some representation theory. Text: at the level of Rotman, The Theory of Groups, an Introduction.

Math. 4215. Introduction to Probability 3-0-3. Prerequisite: Math. 2308 or 1713.
Introduction to probability theory with applications, discrete and nondescrete distributions, moments, laws of large numbers, central limit theorem, elements of inference. Credit is not allowed for both Math. 3215 and 3217.

Text: at the level of Meyer, Introductory Probability and Statistical Applications.

Math. 4221. Probability with Applications 3-0-3. Prerequisite: Math. 3215 or 4215.
Introduction to discrete and Markov chains with applications. Text: at the level of Hoel, Port and Stone, Introduction to Stochastic Processes.

Introduction to continuous-time Markov chains with applications. Text: at the level of Hoel, Port and Stone, Introduction to Stochastic Processes.

Math. 4241. Mathematical Statistics 3-0-3. Prerequisite: Math. 2308 and either 3215 or 4215.
Unified approach to statistical estimation and hypothesis testing of populations, including introduction to Bayesian methods. Exact and asymptotic sampling distributions. Applications. Text: at the level of Hoel, Port and Stone, Introduction to Statistical Theory.


Math. 4280. Elements of Information Theory 3-0-3. Prerequisite: Math. 3215 or 4215.


Math. 4282. Introduction to Stochastic Processes 3-0-3. Prerequisite: Math. 3215 or 4215.

Math. 4283. Introduction to Game Theory 3-0-3. Prerequisite: one of Math. 2010, 3110, 4580 or consent of department.
Introduction to game theory with emphasis on zero-sum two person games, economic applications, connections with linear programming and decision functions. Text: at the level of Dresher, Games of Strategy.


Applications of linear algebra with topics selected from the areas of convex sets, positive matrices, quadratic forms, linear differential equations and generalized inverses.
Math. 4308. Ordinary Differential Equations
4-0-4. Prerequisite: Math. 2309 or 3308. Math. 3110 and either 4311 or 4319.
Systems of differential equations, linear systems and phase plane analysis, existence
theory, stability of linear systems, Liapunov theorems, stability of automatic control systems.
Text: at the level of Brauer and Nohel, Qualitative Theory of Ordinary Differential Equations.

Math. 4311. Introduction to Analysis I
3-2-4. Prerequisite: Math. 2309 or 3308 or equivalent.
Real numbers, order completeness, normed vector spaces and notions of completeness
and compactness, functions and continuity, sequences and series.
Text: at the level of Bartle, The Elements of Real Analysis.

Math. 4312. Introduction to Analysis II
3-2-4. Prerequisite: Math. 4311.
Limits of functions, differentiation of functions of one variable, Reimann-Stieltjes inte­
gral, improper integrals, absolute and conditional convergence, integrals of sequences and series.
Text: at the level of Bartle, The Elements of Real Analysis.

Math. 4313. Introduction to Analysis III
3-4-3. Prerequisite: Math. 4312.
Differentiation in IR^n, local inverse function theorem, implicit function theorem, extremum
problems and Lagrange multipliers, integration in IR^n, change of variables in multiple inte­
grals.
Text: at the level of Bartle, The Elements of Real Analysis.

Math. 4320. Complex Analysis
3-0-3. Prerequisite: Math. 2309 or 3308.
Complex numbers, analytic functions, Cauchy's theorem and integral formula, residues,
conformal mapping.
Text: at the level of Churchill, Complex Variables with Applications.

Math. 4347. Introduction to Partial Differential Equations
3-0-3. Prerequisite: Math. 4347.
A continuation of Math. 4347. Sturm-Liouville theory and general Fourier expansions,
Green's functions, elementary theory of analytic functions of a complex variable.
Text: at the level of Weinberger, A First Course in Partial Differential Equations.

Math. 4349. Introduction to Partial Differential Equations
3-0-3. Prerequisite: Math. 4348.
A continuation of Math. 4347. Applications of complex variables, theory and application
of Fourier and Laplace transforms.
Approximation methods.
Text: at the level of Weinberger, A First Course in Partial Differential Equations.

Math. 4391. Topics in Advanced Calculus II
3-0-3. Prerequisite: Math. 2308.
Partial differentiation, applications of partial differentiation, infinite series, improper inte­
grals, uniform convergence.
Text: at the level of Taylor and Mann, Advanced Calculus.

Math. 4392. Topics in Advanced Calculus II
3-0-3. Prerequisite: Math. 4391.
Continuation of Math. 4391. Main topic is integration and applications. Also, Riemann,
Stieltjes, multiple, line and surface integrals and the gamma function.
Text: at the level of Taylor and Mann, Advanced Calculus.

Math. 4343. Introductory Topology
3-0-3. Prerequisite: Math. 4311 or consent of school.
This course provides background for use of topological methods in analysis. Metric
spaces, continuity, topological spaces.
Text: at the level of Kasriel, Undergraduate Topology.

Math. 4342. Introduction to Algebraic Topology
3-0-3. Prerequisite: Math. 4431 and 4011 or 4301.
Introduction to algebraic methods in topology. Includes topics such as the fundamental
group, covering spaces, simplicial complexes. Applications to fixed point theory and graph
theory.
Text: at the level of Singer and Thorpe, Elementary Topology and Geometry.

Math. 4441. Differential Geometry
3-0-3. Prerequisite: Math. 2308.
The theory of curves and surfaces, including the first and second fundamental forms of
a surface and topological studies.
Text: at the level of O'Neill, Elementary Differential Geometry.

Math. 4580. Linear Programming
3-0-3. Prerequisite or corequisite: Math. 2308.
Mathematical structure of the linear programming problem. Requires topics in linear
algebra. Simplex method. Applications.
Text: at the level of Smythe and Johnson, Introduction to Linear Programming.

Math. 4581. Advanced Engineering Mathematics
3-0-3. Prerequisite: Math. 2309 or 3308.
The Laplace transform and its properties, applications to physical systems involving the
solution of ordinary and partial differential equations.
Text: at the level of Churchill, Operational Mathematics.

Math. 4582. Advanced Engineering Mathematics
3-0-3. Prerequisite: Math. 2309 or 3308.
Fourier series, boundary value problems for partial differential equations, applications of
Legendre polynomials and Bessel functions.
Text: at the level of Powers, Boundary Value Problems.

Math. 4583. Vector Analysis
3-0-3. Prerequisite: Math. 2308.
Vector calculus. Line, surface and volume integrals. Radial divergence, curl, Theorems
of Green, Gauss and Stokes. Curvilinear coordinate systems. Introduction to tensors.
Text: at the level of Davis, Snider, Introduction to Vector Analysis.

3-0-3. Prerequisite: Math. 2308.
An elementary tensorial treatment of various geometrical and mechanical concepts
needed in the study of hydrodynamics, elasticity and plasticity.
Text: at the level of Prager, Introduction to Mechanics of Continua.

Math. 4591. Introduction to Mathematical Optimization
3-0-3. Prerequisite: Math. 2308.
Introduction to various linear and nonlinear optimization problems in finite-dimensional
topologies. Mathematical properties of the objective function will be examined and appro­
priate algorithms developed.
Text: at the level of Cooper and Steinberg, Introduction to Methods of Optimization.

Math. 4643. Numerical Analysis I
3-0-3. Prerequisite: Math. 2308 and knowledge of a programming language.
Numerical solution of linear and nonlinear systems of equations with direct and iterative
methods including factorization, matrix eigenvalue problems.
Text: at the level of Davis, and Stewart, Introduction to Numerical Linear Algebra.

Math. 4644. Numerical Analysis II
3-0-3. Prerequisite: Math. 4643 or consent of school.
Numerical approximation of functions; by polynomials, splines, and least squares fit; nu­
merical integration and differentiation; solution of initial value problems with Runge-Kutta
and other methods.

Math. 4645. Numerical Analysis III
3-0-3. Prerequisite: Math. 4644 or consent of school.
Solution of boundary value problems for ordinary and partial differential equations with
finite difference and finite element methods, discussion of consistency, convergence and
numerical stability.

Math 4790. Intensive Review of the Elementary Calculus
10-6-9. Prerequisite: consent of school.
This course enables the School of Mathematics to comply with prerequisites for courses in
special topics. Given upon sufficient demand.

Math. 4805. Special Topics
5-0-5.

Math. 4899. Reading or Research
1 to 3 credits.
Prerequisite: junior standing or above, consent of school.
Pass/fail basis only. Not more than seven hours can be counted toward bachelor's de­
gree. At most three hours can be counted as mathematics elective.

Math. 6121. Modern Abstract Algebra I
3-0-3. Prerequisite: Math. 4101, 4301.
An introduction to algebraic systems with emphasis on group theory and matrix algebra.
Text: at the level of Lang, Algebra.

Math. 6122. Modern Abstract Algebra II
3-0-3. Prerequisite: Math. 6121.
Rings, ideals and related concepts, field theory, unique factorization.
Text: at the level of Lang, Algebra.

Math. 6123. Modern Abstract Algebra III
3-0-3. Prerequisite: Math. 6122.
Concept of the total matrix algebra. Introduction to linear associative algebras.
Text: at the level of Lang, Algebra.

3-0-3 each.
Prerequisite: Math. 6510 or equivalent.
This sequence develops the probability basis requisite in modern statistical theories and
stochastic processes. It includes a selection of topics from measure and integration theory.
distribution functions, convergence concepts, Fourier integrals and central limit theory, conditional distributions and dependence and random analysis.

3-0-3 each. Prerequisite: Math. 3110, 4313.

Math 6310. Real Analysis
5-0-5. Prerequisite: Math. 4311, 4312, 4313.

Math 6315. Real Analysis II
3-0-3. Prerequisite: Math. 6310.
Such topics as structure of the real number system, axiom of choice, Zorn's Lemma, Hamel basis, Baire category theorem, Stone-Weierstrass theorem and the Daniell integral.

Math. 6320. Complex Analysis
5-0-5. Prerequisite: Math. 4311, 4312, 4313, 4320.
Analytic functions, harmonic functions, conformal mapping, Cauchy's theorem, Cauchy's formulas for derivatives, maximum principle, power series, argument principle, residue theory, contour integration, analytic continuation, applications.

Math 6325. Complex Analysis II
3-0-3. Prerequisite: Math. 6320.
Analytic continuation, product and partial fraction representation of meromorphic functions, Mittag-Leffler theorem, conformal mapping. Schwarz-Christoffel transformations, application to Dirichlet's Problem, normal families. Riemann mapping theorem.

Math. 6330. Functional Analysis
5-0-5. Prerequisite: Math. 4301, 4311, 4312, 4313.
Hilbert and Banach spaces, strong and weak convergence, Riesz representation theorem, Hahn-Banach theorem, linear operators, open mapping and closed graph theorems, compact operators, spectral theory.

Math. 6335. Functional Analysis II
3-0-3. Prerequisite: Math. 6330.
Elements of nonlinear functional analysis, fixed point theorems; locally convex linear topological spaces, Krein Milman theorem; spectral decomposition theorems, Banach algebras.

Math. 6341. Partial Differential Equations I
3-0-3. Prerequisite: Math. 4311, 4312, 4313, 4582.
Classification of partial differential equations, canonical forms, well posed problems, wave equation, heat equation, maximum principle, potential equation, heat equation, strong maximum principles, fundamental solutions.

Math. 6342. Partial Differential Equations II
3-0-3. Prerequisite: Math. 6341.
Existence theory for elliptic equations, single and double layer potentials, Schwarz alternating procedure, subharmonic functions, weak solutions in a Sobolev space, regularity of weak solutions.

Math. 6343. Partial Differential Equations III
3-0-3. Prerequisite: Math. 6342.

3-0-3 each. Prerequisite: Math. 4431 or consent of school
Basics and subbases, filters, nets and convergence, continuous functions, separation axioms, metrizability, compactness, sup and weak topologies, products and quotients, compactifications and other embeddings, completeness and Baire category, uniform spaces, metrization, function spaces, topological groups.

Text: at the level of Wilansky, Topology for Analysis

3-0-3 each. Prerequisite: Math. 4431, 4431 and 4301 or consent of school
Introduction to homological algebra, Cech and singular homology and cohomology theories. Applications to fixed points of maps, spheres, invariance of domain, etc., homotopy, the fundamental group, covering spaces. Introduction to sheaf theory, category theory, spectral sequences.

Text: at the level of Spanier, Algebraic Topology

Math. 6510. Deterministic Models from the Physical Sciences and Technology
5-0-5. Prerequisite: Math. 3121, Math. 4582.
Electrical, mechanical, thermal systems leading to difference equations. Lumped parameter electrical, mechanical systems leading to ordinary differential equations.

5-0-5. Prerequisite: Math. 2309 or 3308 and 3110 or consent of school.
The first of three courses providing quick access to mathematical techniques important in science and engineering. Complex variables, linear algebra, linear differential and difference equations. Credit not allowed toward graduate degrees in mathematics.

Math. 6512. Mathematical Methods of Applied Science II
5-0-5. Prerequisite: Math. 6511.

Math. 6513. Mathematics Methods of Applied Science III
5-0-5. Prerequisite: Math. 6512 or consent of school.
Approximate methods, nonlinear problems, variational techniques. Credit not allowed toward graduate degrees in mathematics.

Math. 6520. Stochastic Models
5-0-5. Prerequisite: Math. 4222 or 4242, six hours in applied fields at the upper undergraduate level.
Formulation of stochastic models appropriate for specific problems of description, prediction and decision, which are posed and analyzed in the context of applied fields.

Math. 6530. Equilibrium and Optimization Models
5-0-5. Prerequisite: six hours in applied fields at the upper undergraduate level, Math. 6330 or concurrently.
Formulation of linear and nonlinear operator models to solve equilibrium or optimal control problems with applications of more applied fields and analyzed in the context of applied fields.

Math. 6581. Calculus of Variations
3-0-3. Prerequisite: Math. 2309 or 3308 and 3110, 4391, or consent of school.

Math. 6582. Integral Transforms
3-0-3. Prerequisites: Math. 4582, 4320, 4391 or consent of school.
Classical Fourier, Laplace and Mellin transform theory with applications to boundary-value problems. Special attention to the judicious choice of transform. Successful use of transforms.

Math. 6583. Integral Equations
3-0-3. Prerequisite: Math. 2309 or 3308 and 3110, 4391, or consent of school.

Math. 6584. Special Functions of Higher Mathematics
3-0-3. Prerequisite: Math. 4320, 4582, or consent of school.
The gamma function, Bessel functions, spherical harmonics, orthogonal polynomials and other functions of particular interest in science and technology.

Math. 6586. Tensor Analysis
5-0-5. Prerequisite: Math. 3110, 4583, 4391 or consent of school.
Tensor algebra, covariant differentiation, Riemannian tensors, curvilinear coordinates, introduction to differential forms.

Text: at the level of Borisenko and Tarapov, Vector and Tensor Analysis

Math 6587. Field Theory with Applications
3-0-3. Prerequisite: Math. 4582, 4583, or consent of school.
Solution of field equations of mathematical physics by separation of variables in spherical, cylindrical and other curvilinear coordinates with attention to advantageous choice of coordinates.

Math. 7000. Master's Thesis
7.211-23. Advanced Topics in Algebra
3-0-3 each. Prerequisite: Math. 6121, 6122, 6123 or consent of school.
Courses directed toward research in algebra. Areas of current research interests include homological algebra, finite groups, semi-groups, loop theory.

3-0-3 each. Prerequisite: Math. 6241, 6242, 6243 or consent of school.
Courses organized around recent broad advances in probability and statistics basic to research in these fields, content of courses varying from year to year. Typical courses would emphasize stochastic processes, ergodic theorem, limits laws of probability, statistical decision theory, theories of estimation and hypothesis testing, etc.

3-0-3 each. Prerequisite: Math. 6307, 6308, 6309 or consent of school.
Courses directed toward research in differ-
ential equations, the content varying from year to year. Representative topics include singular boundary-value problems, asymptotic solutions, differential equations containing a large parameter, Poincaré-Liapounov stability theory and differential equations in the large.

Math. 7311-23. Advanced Topics in Real Analysis
3-0-3 each. Prerequisite: Math. 6310 or consent of school.

Courses directed toward research in real analysis and related areas, the topics varying from year to year. Topics will be selected from areas such as Hilbert space theory, theory of distributions, abstract harmonic analysis, ergodic theory; Denjoy and Perron integrals.

Math. 7321-23. Advanced Problems in Complex Variables
3-0-3. Prerequisite: Math. 6320 or consent of school.

Courses directed toward research in complex variables. Representative topics include topics from functions of several complex variables, conformal mapping.

Math. 7431-23. Advanced Topics in Topology
3-0-3. Prerequisite: consent of school.

The course content will vary from year to year. Topics selected from topological groups, algebraic topology, mapping theory, topological analysis, dimension theory, fixed point theory.

Math. 7501-23. Methods of Applied Mathematics
3-0-3. Prerequisite: consent of school.

Topics in a particular year may include some or all of variational techniques, asymptotic methods, differential operators of mathematical physics. Fourier transforms, nonlinear and singular integral equations.

Math. 7643-4. Advanced Topics in Numerical Analysis
3-0-3 each. Prerequisite: consent of school.

Discussion of topics of current interest in numerical analysis and related fields with content varying from year to year. Representative topics include matrix iterative analysis, numerical approximations of function, problem stability and convergence of difference methods, optimum seeking methods, etc.

Math. 7999. Preparation for Doctoral Examinations
Credit to be arranged. Prerequisite: consent of adviser. Audit only.

Math. 8001-2. Seminar
1-0-0 each.

Math. 8101-11. 23-11-41-45. Special Topics
1-0-1. Prerequisite: consent of school.

These courses enable the School of Mathematics to comply with requests for courses in selected topics.

Math. 8102-12-22-32-42-52. Special Topics
2-0-2.

3-0-3.

Math. 8104-14-24-34-44-54. Special Topics
4-0-4.

5-0-5.

Math. 8501-8599. Special Problems
Credit to be arranged. Prerequisite: consent of adviser.

Math. 9000. Doctoral Thesis

Mechanical Engineering

M.E. 1011. Introduction to Mechanical Engineering
1-0-1. Prerequisite: Math. 1307.

Survey of the field to acquaint the student with the profession, nature, function and working tools, curriculum and topic orientation, engineering in a social context.

M.E. 1110. Creative Decisions and Design
2-3-3.

Basic concepts for creative decisions in engineering problem solving and design. Exposure to practicing engineers, their industries, problems and accomplishments. Field trips.

M.E. 1750. Introduction to Bioengineering
3-0-3.

Aspects of science and technology pertinent to bioengineering. Cross-listed with A.E. 1750, E.E. 1750, E.S.M. 1750.

M.E. 2212. Materials Science
3-0-3. Prerequisite or corequisite: Math. 2309, Phys. 2123.

Mechanical behavior, elastic and plastic properties, annealing of cold-worked materials leading from atomic concepts, crystallography and relation of crystal defects to properties.

M.E. 3016. Computer Applications
2-3-3. Prerequisite: Math. 2309.

Organization and application of digital and analog computers. Mechanical engineering problems are solved through numerical techniques. Electrical analogs and circuits are used to simulate deterministic systems. Previous experience in computer programming is recommended.

M.E. 3055. Experimental Methodology
2-3-2. Prerequisite: Math. 2309, M.E. 3322, prerequisite or corequisite: M.E. 3016.

Practical application of experimental methodology. Basic instrumentation used in mechanical engineering and its calibration and use. Accuracy and uncertainty in experimental measurements, engineering report writing.

M.E. 3113. Mechanics and Analysis
3-0-3. Prerequisite: E.S.M. 3021.

Analysis and synthesis of the motion of links, cam and gears by graphic and analytical methods.

M.E. 3114. Dynamics of Machinery
3-0-3. Prerequisite or corequisite: M.E. 1113, Math. 2309.

Mechanism analysis with emphasis on inertial and balancing of rotating and reciprocating systems. Vibrations of linear systems.

M.E. 3133. Rational Descriptions and Engineering Design
3-0-3. Prerequisite: junior standing in engineering.

Information-theory decision analysis for engineering design with practical applications to the design of mechanical, thermal and electrical components and systems.

M.E. 3212. Materials Technology
3-3-4. Prerequisite: M.E. 2212.

Mechanical and thermal properties of metallic and nonmetallic materials related to behavior under service conditions. Phase equilibrium, microstructure, steels, heat treatment, annealing, fracture, fatigue, creep.

M.E. 3322. Thermodynamics
3-0-3. Prerequisite or corequisite: Phys. 2123, Math. 2308.

An introduction to thermodynamics. Thermodynamic properties, state postulate, work interactions, steady state and transient energy and mass conservation, entropy and the second law.

M.E. 3323. Thermodynamics
3-0-3. Prerequisite: M.E. 3322.


M.E. 3324. Thermodynamics
3-0-3. Prerequisite: M.E. 3323.


M.E. 3342. Transport Phenomena I
3-0-3. Prerequisite: Math. 2309. Prerequisite or corequisite: M.E. 3322.

Introduction to one-dimensional heat, momentum and mass transport, developing rate equations and applying conservation principles, fundamentals of steady and transient heat conduction, including one- and three-dimensional, sources and extended surfaces, electrical analogies, practical applications.

M.E. 3343. Transport Phenomena II
3-0-3. Prerequisite: M.E. 3342, E.S.M. 2201.

Corequisite: M.E. 3323.

Basic conservation concepts in integral form for real fluids, fluid properties and flow characteristics, fluid statics, ideal flows, Ruijer, Bernoulli and Navié-Stokes equations, practical examples.

M.E. 3344. Transport Phenomena III
3-3-4. Prerequisite: M.E. 3343. Corequisite: M.S. 3324, 3055.

Compressible and incompressible flows, ducted flows, nozzles and shock waves. Radiative transport. Applications.

M.E. 3720. Thermodynamics

Fundamentals of engineering thermodynamics, thermodynamic properties of matter, the concept of conservation of energy, the second law of thermodynamics and application to engineering processes.

M.E. 3726-7. Thermodynamics
4-0-4. 3-0-3. Prerequisite or corequisite: Phys. 2123, Math. 2309.

Not for M.E. students.

Concepts and principles of thermodynamics. Applications to engineering systems and processes. Evaluation of thermodynamic properties of solids and polyatomic gases from statistical and quantum mechanics.

M.E. 3734. Environmental Technology in Architecture I
3-0-3. Prerequisite: Phys. 2113 or 2123. Not for M.E. students.


M.E. 3735. Environmental Technology in Architecture II
2-3-3. Prerequisite: M.E. 3734. Not for M.E. students.

M.E. 4025. Engineering Analysis
3-0-3. Prerequisite: consent of school.
Emphasis is placed on well-ordered analytical thought processes required in the application of fundamental principles of engineering sciences to the analysis of unfamiliar engineering situations.

M.E. 4055. Experimental Engineering
1-3-2. Prerequisite: M.E. final quarter standing.
Engineering situations involving various disciplines are solved by experimental means. Students must plan experimental approach, gather data, interpret results and prepare a formal engineering report.

M.E. 4091. Seminar
1-0-1. Prerequisite: senior standing in mechanical engineering. Fall quarter only. Civic and professional responsibilities and opportunities are brought to students by gathering data, interpreting results and preparing a formal engineering report.

M.E. 4181. Design of Machine Elements
3-3-4. Prerequisite: E.S.M. 3301, M.E. 3212.
Methodology and practice in designing machine components are by means of integrating the general principles and empirisms of solid mechanics, materials, metal fatigue and other disciplines.

M.E. 4183. Design Theory
3-3-4. Prerequisite or corequisite: M.E. 4181.
The design process including the topics of creativity, probability, the use of statistical methods, reliability theory, decision theory, optimization and the patent system.

M.E. 4184. Design Engineering
3-2-2. Prerequisite: final quarter standing.
The design process is applied to real multi-disciplinary problems by a team. Problems selected from a broad spectrum of interest areas including biomedical, ecological, environmental.

M.E. 4185. Mechanics of Machines
3-3-4. Prerequisite: M.E. 3114, Math. 2309.
Continuation of M.E. 3114 with emphasis on the analysis of complex machines. Instrumentation and analog computer simulation of mechanism.

M.E. 4186. Biomechanical Design
3-3-4. Prerequisite: M.E. 4445 or equivalent.
Development of systems utilizing human operator dynamics in the loop. Biological systems treated as structures, power sources and information systems, operator modeling.

M.E. 4187. Kinematic Design
2-3-3. Prerequisite: M.E. 3113 or consent of school.
The design of mechanisms to generate specified point paths or analytical functions. Graphical and analytic design methods are shown.

M.E. 4188. Cams and Gears
3-3-3. Prerequisite: M.E. 3113 or equivalent.
Selection of cam mechanisms, gear, helical, worm and worm gears are treated. Cam design with applications including high speed systems.

M.E. 4204. Manufacturing Processing: Machining and Joining
2-3-3. Prerequisite: M.E. 4212, E.S.M. 3301.
Theory and application of metal machining. Effects of work material, tool material and geometry, feed, speed and other variables are studied.

M.E. 4205. Manufacturing Processing: Casting and Joining
2-3-3. Prerequisite: M.E. 4212, E.S.M. 3301.
An intermediate level treatment of two important manufacturing operations, emphasis on the engineering and technological aspects of these processes, applications and design criteria.

M.E. 4212. Material Processes
3-3-4. Prerequisite: 9th Dtr. Standing. Consent of instructor for non-M.E. students.
Fundamentals of various techniques for solidification, working and shaping materials. Machining, casting and metal forming are major topics. Laboratory practice supplements classroom treatment.

M.E. 4263. Mechanical Testing of Materials
3-3-4. Prerequisite: either Met. 3301, M.E. 3212 or consent of school.
Destructive and nondestructive test methods for metallic and nonmetallic materials. Emphasis on the significance of results and the choice of materials based on test data.

M.E. 4265. Materials Science and Engineering
3-3-4. Prerequisite: M.E. 3114.
Advanced studies of metals, polymers, ceramics. Atomic and molecular structure, crystal binding, defects, relationship of properties to microstructures. Phase equilibrium, strengthening, failure, steel constituents, hardenability.

M.E. 4316. Thermal Systems Analysis
3-0-3. Prerequisite or corequisite: M.E. 3324.
Analysis, design and optimization of systems and components with examples from power generation, propulsion and refrigeration, including influence of working fluid on system and component performance.

M.E. 4317. Thermal Systems Design
2-3-3. Prerequisite: M.E. 4316.
Energy conservation schemes, total energy systems and their characteristics. Laboratory work is related to prediction and experimental verification of system and component performance.

M.E. 4320. Internal Combustion Engines
3-3-4. Prerequisite: M.E. 3324, 3343.
Principles, practice and characteristics of internal combustion engines with experimental laboratory in engine testing and performance.

M.E. 4321. Principles of Air Conditioning
3-3-4. Prerequisite: M.E. 3324, 3344 or consent of school.

M.E. 4322. Power Plant Engineering
3-3-4. Prerequisite: M.E. 3324, 3344 or consent of school.

M.E. 4326. Principles of Turbomachinery
3-0-3. Prerequisite: M.E. 3344 or consent of school.
Head, flow and power relationships for turbomachines and their designs. Design of impellers and casings for various types of compressors, turbines and pumps.

M.E. 4327. Combustion and Flames
3-0-3. Prerequisite: M.E. 3324, 3344 or equivalent.
Stoichiometric and thermochemical analysis of fuel-oxidant reactions. Heat and mass transfer with chemical reaction applied to combustion of gas jets, solid and liquid fuels.

M.E. 4328. Elements of Rocket Systems
3-0-3. Prerequisite or corequisite: M.E. 4344.
Basic elements, ballistics and technical problems associated with the design of propulsion systems for solid and liquid propellant rockets are studied.

M.E. 4329. One-Dimensional Compressible Flow
3-0-3. Prerequisite or corequisite: M.E. 4344.
Fundamentals of one-dimensional steady and unsteady compressible flows. Isentropic flows, flows with friction and heat transfer and shocks are examined.

M.E. 4331. Refrigeration
3-0-3. Prerequisite: M.E. 3324.

M.E. 4339. Gas Turbines
3-0-3. Prerequisite: M.E. 3324, 3344.
Applications of gas turbines, including limitations and advantages as compared with other prime movers. Design of compressor, combustor and turbine components.

M.E. 4343. Heating, Ventilating and Air Conditioning Design
3-0-3. Prerequisite: M.E. 4321.
Sizing of equipment for environmental control. Design of transportation and delivery systems. Energy recovery schemes. Total energy concepts and design features.

M.E. 4344. Transport Phenomena IV
3-0-3. Prerequisite: M.E. 3344.
Fundamentals of transport process applied to free and forced convection, boundary layer applications, similarity and modeling, external and internal flows, change of phase, heat exchangers. Applications.

M.E. 4347. Elements of Nuclear Power
3-0-3. Prerequisite: M.E. 4344 or equivalent.
Advanced studies of nuclear energy generation, fission, fusion, radiation damage, shielding and safety. Nuclear reactors: boiling water, pressurized water, gas cooled and fast breeder reactors.

M.E. 4357. Plasmas and Engineering Applications
3-0-3. Prerequisite: undergraduate thermodynamics, senior standing.
Occurrence of plasmas, review of electromagnetic theory, thermodynamics of ionized gases, equations of magnet hydrodynamics, MHD waves, channel flow, application to electroarc, MHD energy conversion and fusion.

M.E. 4445. Automatic Control
3-0-3. Prerequisite: Math. 2309, M.E. 3016.
Analysis and modeling of linear systems and compensation of feedback controlled systems using classical methods. Hydraulic, pneumatic, thermal, electrical, nuclear, chemical and biomechanical examples.

M.E. 4449. Numerical Control of Machine Tools
3-0-3. Prerequisite or corequisite: M.E. 4445.
Study of design and operation of typical digital control utilizing machine tools, including the flow of signals through the system.

M.E. 4714. Heat Transfer
3-0-3. Prerequisite: M.E. 3720, 3016 or equivalent. Not for M.E. students.
Transport processes, concepts of conduction, convection and radiation. Boundary layer analysis in convective laminar and turbulent
flows. Stationary systems, including external/ internal resistance criteria.

M.E. 4760. Engineering Acoustics and Noise Control 3-0-3. Prerequisite: senior standing.
Study of acoustics related to noise and its control, acoustic terminology, wave propagation, solutions to the wave equation, instrumentation, sound fields in large and small rooms, noise legislation.

M.E. 4761. Engineering Acoustics and Noise Control II 3-0-3. Prerequisite: M.E. 4761 or equivalent.
Continuation of M.E. 4760 emphasizing techniques for the solution of noise problems. Vibration isolation, energy absorption, dissipative and reactive mufflers, enclosures, barriers, properties of materials, panel damping.

A survey of the processes in a kraft pulp mill necessary to convert raw material to sulfate pulp. Wood preparation, wood chemistry and morphology. The chemical and mechanical characteristics of kraft pulping and chemical recovery processes. Cross listed with Ch.E.

The major pulping processes other than kraft pulping. General knowledge of the various factors affecting each pulping process and pulp bleaching. The unique advantages and disadvantages of each pulping and bleaching process. Cross listed with Ch.E.

The processes in the fabrication of paper and paper products from pulp. The effects on paper properties of chemical and mechanical pre-treatment of pulp. The measurement of paper properties. Cross listed with Ch.E.

M.E. 4780. Energy Conversion Engineering 3-0-3. Prerequisite: M.E. 3720 or equivalent.
Energy sources, basic principles of semiconductors, thermoelectric converters, solar power, thermionic systems, MHD, applications of device features for power generation, environmental effects, cost factors.

M.E. 4801-2-3-4-5. Special Topics, Mechanical Engineering 1-0-1 to 5-0-5 respectively.
Special topic offerings of current interest and not included in regular courses.

M.E. 4901 through 4912. Special Problems, Mechanical Engineering
Credit to be arranged.
Individual studies in certain specialized areas, and mathematical analyses and/or experimental investigations of problems of current interest in mechanical engineering.

M.E. 6014. Engineering Instrumentation 3-0-3. Prerequisite: M.E. 3055 or equivalent or graduate standing.
Methods and techniques of modern instrumentation in engineering research. Emphasis on analytical instrumentation and evaluation of experiments, integration of experimental and evaluation theory with practical aspects of instrumentation problems.

M.E. 6024-5. Variational Methods in Engineering 3-0-3 each. Prerequisite: M.E. 4344, E.S.M. 3302 or equivalent.
Variational methods applied to the optimization engineering systems, the formulation and approximation techniques with application to nonlinear vibration, fluid mechanics, heat transfer, hydrodynamic stability and automatic control.

M.E. 6121. Advanced Dynamics of Machinery 3-0-3. Prerequisite: consent of school.
Design-oriented dynamics. Dynamics of systems with constraints, application of virtual work-minimum potential to systems, dynamical equations of Lagrange, Hamilton.

Application of dynamic theory to practical situations, natural frequencies of systems, impact, impulse and momentum, discrete and continuous system techniques, periodic and random sources.

M.E. 6125. Mechanism Synthesis I 3-0-3. Prerequisite: M.E. 4187 or equivalent.

Analogue-computer simulation of linkages. Complex-number approach to linkage synthesis. Digital computer programs of Sandor-Freudenstein and Bloch. "Best fit" by Chebychev polynomial approximations.

M.E. 6127. Spatial Mechanisms 3-0-3. Prerequisite: M.E. 6125.
The analysis and synthesis of three-dimensional linkage fields, general. Extension of the Grubler theory, number theory, special mechanisms.

The methods of strain-energy, virtual work, area moment and Castigliano's theorem are applied to the design of machine members against excessive deformation.

M.E. 6170. Engineering Design 3-0-3. Prerequisite: consent of school.
Design concepts, life design, fatigue and failure, thermal stress and the elements of optimum design are studied.

M.E. 6175. Fundamentals of Computer-Aided Design 3-0-3. Prerequisite: M.E. 4175 or consent of instructor.
An in-depth study of necessary hardware and software for development of computer-aided design systems. Special emphasis on man-machine interface.

M.E. 6239. Materials for Design Systems — Components and Techniques 3-0-3. Prerequisite: M.E. 6175 or consent of instructor.
A study of the development of necessary hardware and software for development of computer-aided design systems. Special emphasis on man-machine interface.

Properties, behavior and selection of materials for practical design applications. Topics include effects of elastic and plastic deformation, brittle fracture, fatigue, creep and corrosion.

Advanced studies of materials, their properties, selection and applications to high and low temperature environments. Economic, engineering, and design considerations are emphasized.

M.E. 6271. Deformation of Metals 3-0-3. Prerequisite: M.E. 6212.
Advanced study of atomic structure and imperfections in crystalline solids. Topics include plastic deformation, strain hardening, annealing processes, creep, fatigue, ductile and brittle fracture.

M.E. 6272-3. Fabrication of Metals 3-0-3 each. Prerequisite: M.E. 6271.
Fabrication processes of metals including forging, rolling, extrusion, drawing, deep drawing and pressing. Frictional phenomena, slip line fields, general. Extension of the Griffith theory, number theory, special mechanisms.

M.E. 6322. Thermodynamics I 3-0-3. Prerequisite: undergraduate thermodynamics.
Through study of the principles of macroscopic formalism of thermodynamics. Thermodynamic systems, pure substance, multiphase mixtures, reactive systems.

M.E. 6323. Thermodynamics II 3-0-3. Prerequisite: undergraduate thermodynamics.
Microscopic thermodynamics based on classical mechanics, quantum mechanics and information theory. Prediction of macroscopic properties and system behavior from statistical considerations.

M.E. 6324. Thermodynamics III 3-0-3. Prerequisite: M.E. 6323 or equivalent.
Statistical thermodynamic formulation of properties of ideal gases, real gases, solids and liquids, kinetic theory and interactions. Thermodynamics of special systems.

M.E. 6325. Information Theory Thermodynamics 3-0-3. Prerequisite: M.E. 6323 or consent of school.
A derivation from information theory of the fundamentals of thermodynamics and statistical mechanics. Applications to irreversible thermodynamics and heat design of thermosystems.

M.E. 6332. Heat Transfer I 3-0-3. Prerequisite: M.E. 4344 or consent of school.
Conduction—steady state and transient, one and multi-dimensional geometries. Emphasis on analytical methods—exact and approximate, on numerical and graphic techniques.

M.E. 6333. Heat Transfer II 3-0-3. Prerequisite: M.E. 6332 or consent of school.
Convection—forced and free, in laminar and turbulent, internal and external flows. Analogy between momentum and heat transfer. Scaling laws and partial modeling.

M.E. 6334. Heat Transfer III 3-0-3. Prerequisite: graduate standing.
Radiation—electrodynamics, radiation optics, photon gas concept, black body radiation, surface characteristics, exchange in enclosures, radiation through continua, experimental methods.
M.E. 6338. Advanced Theory of Heat Transfer
3-0-3. Prerequisite: M.E. 6332, 6333.
Advanced mathematical methods in conduction and convection, ablation, solidification, packed and fluidized beds, condensation, boiling heat transfer, heat transfer in porous media, transient boundary layers.

M.E. 6342. Fluid Flow I
3-0-3. Prerequisite: M.E. 3343 or consent of school.
A general development of the continuity, linear and angular momentum and energy equations followed by the fundamentals of perfect fluid theory.

M.E. 6343. Fluid Flow II
3-0-3. Prerequisite: M.E. 6342 or equivalent.
Viscous flow theory including derivation of Navier-Stokes equations, a study of their general properties and their applications to creeping flow and to laminar and turbulent boundary layers.

M.E. 6344. Fluid Flow III
3-0-3. Prerequisite: M.E. 6343 or equivalent.
Turbulent flow theory, origins of turbulence, turbulent stress, mixing-length models, free turbulent flow, flow in pipes and boundary layers, statistical description of turbulence.

M.E. 6351. Direct Energy Conversion
3-0-3. Prerequisite: M.E. 3720 or equivalent.
Analysis of performance characteristics, based on thermodynamic and fluid flow principles of direct energy conversion devices such as thermionic, thermoelectric, photovoltaic, magnetohydrodynamic, electrohydrodynamic generators and fuel cells.

M.E. 6352. Energy Conversion Systems
3-0-3. Prerequisite: M.E. 3324 or equivalent.
A study of alternative energy conversion systems and analysis of their economic and commercial performance characteristics. Comparative analysis of Otto, Diesel, Brayton, Rankine, solar and direct energy conversion systems.

M.E. 6353. Diagnostics of Combustion Gases and Plasmas
3-0-3. Prerequisite: statistical thermodynamics.
Study of diagnostic techniques for combustion gases and plasmas and relevant physical phenomena. Spectroscopic, interferometric, laser and probe techniques. Treatment includes latest techniques and procedures.

M.E. 6355. Combustion I
3-0-3. Prerequisite: graduate standing.
Conservation laws and constitutive equations in reactive media. Reactions kinetics, laminar and turbulent diffusion flames.

M.E. 6356. Combustion II
3-0-3. Prerequisite: M.E. 6355 or equivalent.

M.E. 6357. Combustion III
3-0-3. Prerequisite: M.E. 6356 or equivalent.
Combustion in turbulent boundary layers. Spontaneous ignition and explosions. Flame propagation and flammability limits.

M.E. 6360. Solar Energy Engineering
3-0-3. Prerequisite: M.E. 6365 or equivalent.

M.E. 6370. Thermal Environmental Control
3-0-3. Prerequisite: consent of school.

M.E. 6371. Advanced Refrigeration
3-0-3. Prerequisite: consent of school.
Develop and design and performance characteristics of vapor compression, absorption and several other work and heat input refrigeration cycles. Specification of desirable refrigerant properties.

M.E. 6376. Internal Combustion Engine Design
3-0-3. Prerequisite: undergraduate design, M.E. 4320 or equivalent.
Internal combustion engine design practice to accommodate challenges of application, efficiency, emissions and balance.

M.E. 6377. Internal Combustion Engines
3-0-3. Prerequisite: M.E. 6355 or equivalent.
Principles of operation of reciprocating and rotating engines including analysis of pollutant formation and methods of its control.

M.E. 6379. Turbines
3-0-3. Prerequisite: either M.E. 4339, 4328 or consent of school.
Basic fluid mechanics and thermodynamics of the expansion processes in various types of radial and axial flow turbines. Current literature is discussed.

M.E. 6383. Lubrication
3-0-3. Prerequisite: consent of school.
Hydrodynamic, hydrostatic, liquid and gas lubrication, elastohydrodynamic lubrication, lubricant properties, boundary lubrication, friction and solid lubricants are covered from fundamental development through design considerations.

M.E. 6424. Feedback Control Systems I
3-0-3. Prerequisite: graduate standing.
Linear systems. Integration of classical (root loci, r.esponses, feedback, observers) techniques. Mechanical, thermal, fluid, chemical and nuclear examples.

M.E. 6425. Feedback Control Systems II
3-0-3. Prerequisite: either M.E. 4445, 6424 or equivalent.
Discrete time and nonlinear systems. Sampled data and digital control. Plane phase, describing functions and Lyapunov methods.

M.E. 6426. Feedback Control Systems III
3-0-3. Prerequisite: M.E. 6424 or equivalent.

M.E. 6437-8. Digital Control Systems I and II
3-0-3. Prerequisite: graduate standing or consent of school. M.E. 6437 is prerequisite for 6438.
The basic technique and techniques employed in the design of control systems for numerically controlled machine tool and digital computers.

M.E. 6439. Control System Components
2-1-3. Prerequisite: M.E. 4445 or equivalent.
The performance characteristics and the mathematical theory of control system components, including transient and frequency response tests.

M.E. 6440. Fluid-Power Control Systems
3-0-3. Prerequisite: M.E. 4445 or equivalent.
Analysis and synthesis of control systems using fluids and gases. Dynamic characteristics and specifications of fluid-power control systems.

M.E. 6471. Control of Engineering Processes
3-0-3. Prerequisite: M.E. 6424 or equivalent.

M.E. 6750. Systems Design Methodology
2-3-3. Prerequisite: graduate standing or consent of school.

M.E. 6751-2. Complex Systems Design
2-4-3. Prerequisite: graduate standing in any school or senior with consent of school.
Interdisciplinary team design of systems of current interest to society which have large technological factors. Individual research and interaction with noninstitute resource persons and faculty. Grades based on oral and written reports. Cross-listed with A.E., E.E., C.E., C.P., I.Sy.E.

M.E. 6750-1. Acoustics I and II
3-0-3 each. Prerequisite: Math. 4349 or consent of school.
Governing equations of sound waves from the conservation laws. Acoustic momentum, energy and intensity, propagation, reflection, absorption and scattering. Effects of the physical properties. Application of the theory of sound to real systems. Transmission of sound in real media.

M.E. 6762. Acoustics III
3-0-3. Prerequisite: M.E. 6761.
Advanced duct acoustics, wave dispersion and attenuation, acoustics in moving media, geometrical acoustics, nonlinear acoustics.

M.E. 6763. Noise Reduction and Control (Industrial Applications)
3-0-3. Prerequisite: M.E./A.E./E.S.M. 6760, M.E. 4023 or equivalent.
Methods of noise reduction and control applied to systems in detriment of sound power, material acoustic properties, barriers, enclosures, mufflers, vibration reduction and damping methods.

M.E. 6764. Ocean Acoustics
3-0-3. Prerequisite: either M.E. 6424 or consent of school. Math. 4321, 4582, E.S.M. 6760 recommended.
Propagation of sound waves in the oceans, stress-strain relations, asymptotic ray theory. Propagation in shallow water and deep water. Cross-listed with A.E., Geo.S., E.S.M.

M.E. 7000. Master's Thesis
7010-1-2-3. Seminars in Mechanical Engineering
1-0-1. Prerequisite: graduate standing.
Seminars involving current research projects presented by graduate students. M.E. faculty and invited industrial speakers.

M.E. 7035. Numerical Methods in Mechanical Engineering
3-0-3. Prerequisite: graduate standing.

M.E. 7122. Advanced Machine Vibrations
3-0-3. Prerequisite: M.E. 6122 or consent of school.

M.E. 7140. Decision Theory for Engineering Design
3-0-3. Prerequisite: M.E. 4265.

M.E. 7220. High Temperature Deformation Processes
3-0-3. Prerequisite: M.E. 6221.

M.E. 7222-3. Fracture and Fatigue of Material I, II
3-0-3 each. Prerequisite: M.E. 6221.

M.E. 7321. Thermodynamics of Irreversible Processes I
3-0-3. Prerequisite: graduate standing.

M.E. 7322. Thermodynamics of Irreversible Processes II
3-0-3. Prerequisite: M.E. 7321 or equivalent.

M.E. 7336. Forced Convection Heat Exchange
3-0-3. Prerequisite: M.E. 6333.

M.E. 7338. Advanced Topics in Heat Transfer
3-0-3. Prerequisite: M.E. 6332, 6333, 6334.

M.E. 7341. Transport Phenomena in Two-Phase Flow I
3-0-3. Prerequisite: consent of school.

M.E. 7342. Transport Phenomena in Two-Phase Flow II
3-0-3. Prerequisite: consent of school.

M.E. 8010-1-2-3. Seminar in Mechanical Engineering
1-0-1. Prerequisite: graduate standing.

M.E. 8039. Heat Transfer Seminar
1-0-1.

M.E. 8041-2-3-4-5. Fluid Mechanics Seminar 1, 2, 3, 4, 5 credit hours respectively. Prerequisite: consent of school.

M.E. 8101-2-3-4-5. Special Topics in Design 1, 2, 3, 4, 5 credit hours respectively. Prerequisite: consent of school.

M.E. 8201-2-3-4-5. Special Topics in Materials 1, 2, 3, 4, 5 credit hours respectively. Prerequisite: consent of school.

M.E. 8301-2-3-4-5. Special Topics in Energetics 1, 2, 3, 4, 5 credit hours respectively. Prerequisite: consent of school.

M.E. 8401-2-3-4-5. Special Topics in Systems and Controls 1, 2, 3, 4, 5 credit hours respectively. Prerequisite: consent of school.

M.E. 8501 through 8517. Special Problems in Mechanical Engineering
Credit to be arranged. Prerequisite: consent of school.

M.E. 9000. Doctoral Thesis

M.S. 0110. Competitive Marksmanship
1-1-0.

M.S. 0120. Survival Techniques
1-1-0.

M.S. 0130. Ranger Company
1-1-0.

M.S. 0140. Drill Team/Honor Guard
1-1-0.

M.S. 1010. Phase Flow II
1-0-1.

M.S. 1040. Leadership Development
0-1-0.

M.S. 2020. Military Skills
1-0.

M.S. 2040. Leadership Development
0-1-0.

M.S. 3000. Analysis of Command and Leadership
2-1-2.

M.S. 3100. Tactical Decision-Making
3-1-3.

M.S. 4000. The Military Team and the Junior Officer
3-1-3.

M.S. 4040. Leadership Development
0-1-0.

M.S. 1200. Terrain Analysis and Military Navigation
1-1-1.

M.S. 2040. Leadership Development
0-1-0.

M.S. 2200. Seminar on Communications and Instructional Methods
2-1-2.

M.S. 3000. Analysis of Command and Leadership
2-1-2.

M.S. 3100. Tactical Decision-Making
3-1-3.

M.S. 4000. The Military Team and the Junior Officer
3-1-3.

M.S. 4040. Leadership Development
0-1-0.
M.S. 4100. Military Administrative Operations
2-3. Prerequisite: advanced ROTC standing.
Basic concepts and fundamentals of military administration, logistics and military justice.

M.S. 4330. Military Engineering
3-1-3. Prerequisite: advanced ROTC standing.
Prerequisite: M.L. 1013 or equivalent.

M.S. 4630. Tactical and Strategic Communications-Electronics Systems
3-1-3. Prerequisite: advanced ROTC standing.
Prerequisite: none.

F.L. 1001. Elementary Hebrew I
3-0-3. Prerequisite: none.
Continuation of Hebrew.

F.L. 1002. Elementary Hebrew II
3-0-3. Prerequisite: Hebrew 1001 or equivalent.
Continuation of Hebrew.

F.L. 1003. Elementary Hebrew III
3-0-3. Prerequisite: Hebrew 1002 or equivalent.
Continuation of Hebrew.

F.L. 1011. Elementary Portuguese I
3-0-3. Prerequisite: none.

F.L. 1012. Elementary Portuguese II
3-0-3. Prerequisite: M.L. 1011 or equivalent.
Continuation of M.L. 1011.

F.L. 1013. Elementary Portuguese III
3-0-3. Prerequisite: F.L. 1012 or equivalent.
Continuation of F.L. 1012.

F.L. 1011. Colonial Brazil and the Portuguese Empire, 1500-1808
3-0-3. Prerequisite: F.L. 1013 or equivalent.
Can be applied toward fulfillment of humanities requirements for graduation in all colleges. Exceptions: in engineering and architecture will count as elective credit unless the entire first-year sequence and three 2000, 3000 or 4000-level courses are completed.

Can be applied toward fulfillment of humanities requirements for graduation in College of Sciences and Liberal Studies and College of Industrial Management. Counts as elective credit in Colleges of Engineering and Architecture.

Cultural history of Portuguese America from conquest and settlement to the end of the colonial period. Indian wars, African slavery, sugar plantations, cattle ranches, gold mines. Includes grammar review. Conducted in Portuguese.

F.L. 1202. Development of Independent Brazil, 1808-1930
3-0-3. Prerequisite: M.L. 1013 or equivalent.
Cultural history of Brazil from independence through the Empire and the Old Republic. The coffee-export boom, abolition of slavery, mass immigration, and the beginnings of industrialization and social change. Includes grammar review. Conducted in Portuguese.

F.L. 2012. Brazil since 1930; The Giant Emerges
3-0-3. Prerequisite: F.L. 1013 or equivalent.
Cultural history of contemporary Brazil from the rise of Vargas to the present day. Urbanization, industrialization, social revolution, military dictatorship. Conducted in Portuguese.

F.L. 3801-2-3-4. Special Topics in Modern Languages
3-0-3. Prerequisite: consent of head of department.
Permits students to do work in languages not treated in other courses and/or to engage in special research and/or experimental studies.

French

Fren. 1001. Elementary French I
3-0-3. Prerequisite: none.
Essential principles of French grammar and phonetics, acquisition of vocabulary through simple conversational exercises and the reading of simple selections.

Fren. 1002. Elementary French II
3-0-3. Prerequisite: Fren. 1001 or equivalent.
Continuation of Fren. 1001, extension of the survey of French grammar, acquisition of a general vocabulary through conversation and reading.

Fren. 1003. Elementary French III
3-0-3. Prerequisite: Fren. 1002 or equivalent.
Reading of selected texts, composition, completion of the survey of French grammar.

Fren. 2001. Cultural History of France to 1610
3-0-3. Prerequisite: Fren. 1003 or equivalent or two years in high school.
Development and evolution of social structures of France as reflected in literature, history and art. Includes a review of grammar. Conducted in French.

3-0-3. Prerequisite: Fren. 1003 or equivalent.
Development and evolution of social structures of France from 1610 to 1800, as reflected in literature, history and art. Continuation of a review of grammar. Conducted in French.

Fren. 2003. Cultural History of France since 1800
3-0-3. Prerequisite: Fren. 1003 or equivalent.
Development and evolution of social structures of France during the nineteenth and twentieth centuries as reflected in literature, history and art. Continuation of a review of grammar. Conducted in French.

Fren. 3001. French Literature from 1800-1850
3-0-3. Prerequisite: Fren. 2003 or equivalent.
Romanticism, the reappearance of lyric poetry, the importance of the individual as opposed to classical anonymity. Conducted in French.

Fren. 3002. French Literature from 1850-1900
3-0-3. Prerequisite: Fren. 2003 or equivalent.
Parnassianism and symbolism, developments in poetry, realism and naturalism, trends in prose, with emphasis on the development of the novel. Conducted in French.

Fren. 3003. French Literature since 1900
3-0-3. Prerequisite: Fren. 2003 or equivalent.
Exploration of currents in modern prose, poetry and drama. Conducted in French.

Fren. 3011. France Today
3-0-3. Prerequisite: Fren. 2003 or equivalent. Culture, history and geography of modern France in lectures and class discussions, short papers on assigned topics; conducted in French.

Fren. 3012. France Today II
3-0-3. Prerequisite: Fren. 3003 or equivalent. Continuation of Fren. 3011.

Fren. 3013. France Today III
3-0-3. Prerequisite: Fren. 3003 or equivalent. Continuation of Fren. 3012.

Fren. 4001. French Stylistics
3-0-3. Prerequisite: Fren. 3003 or equivalent.

Advanced study of syntax and semantics, aimed at development of stylistic sensitivity. Compositions in French.

Fren. 4002. Classical French Literature
3-0-3. Prerequisite: Fren. 3003 or equivalent.
Survey of French classical literature, readings in Malherbe, Deschartes, Pascal, La Roche­ foucauld, La Fontaine, La Bruyere, Corneille, Moliere and Racine. Lectures on the Classical Age; term report. Conducted in French.

Fren. 4003. The French Novel
3-0-3. Prerequisite: Fren. 3003 or equivalent.
Survey of the development of the French novel from the late seventeenth century through the twentieth century; term report. Conducted in French.

Fren. 4075. Intensive Readings in French I
3-0-3. Prerequisite: junior standing or consent of department.
Primarily for graduate students preparing for the Ph.D. reading knowledge examination. Emphasizes structures pertinent to reading comprehension particularly of scientific literature. Can also serve any students desiring a rapid review of basic French.

Fren. 4076. Intensive Readings in French II
3-0-3. Prerequisite: Fren. 4075. Continuation of Fren. 4075.

Fren. 4077. Intensive Readings in French III
3-0-3. Prerequisite: Fren. 4078. Continuation of Fren. 4076.

Fren. 4091-2. French Study Abroad
5-0-5 each. Prerequisite: junior standing.
The Study Abroad Program of the University of Paris. Georgia. Fifteen quarter hours credit for summer study abroad.

Fren. 4091-2-3. Special Problems in French Credit to be arranged. Provides the special instruction required under special programs.

Fren. 7053. Contemporary French Media
4-3-5. Prerequisite: graduate standing. Introduction to the significant French media and their usage in the classroom setting. Survey of teaching strategies, especially in relation to media. Conducted in French.

Fren. 7054. Advanced French Communicative Skills
3-4-5. Prerequisite: graduate standing. For the improvement of teacher competency in the oral and written communicative
skills. Intensive review and practice with native informants.

German

Ger. 1001. Elementary German I
3-0-3. Prerequisite: None.
Introduction to the study of German grammar and pronunciation.

Ger. 1002. Elementary German II
3-0-3. Prerequisite: Ger. 1001 or equivalent.
Continuation of Ger. 1001.

Ger. 1003. Elementary German III
3-0-3. Prerequisite: Ger. 1002 or equivalent.
Continuation of Ger. 1002 and 1003.

Ger. 2001. Introduction to Modern German Culture I
3-0-3. Prerequisite: Ger. 1003 or equivalent.
Introduction to the study of modern German literature and culture.

Ger. 2002. Introduction to Modern German Culture II
3-0-3. Prerequisite: Ger. 1003 or equivalent.
Continuation of Ger. 2001.

Ger. 2003. Introduction to Modern German Culture III
3-0-3. Prerequisite: Ger. 1003 or equivalent.
Continuation of Ger. 2002.

Ger. 3001. Introduction to German Literature I
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Introduction to modern German literature.

Ger. 3002. Introduction to German Literature II
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Continuation of Ger. 3001.

Ger. 3003. Introduction to German Literature III
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Continuation of Ger. 3002.

Ger. 3004. German Stylistics
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of stylistic devices in modern German literature.

Ger. 3011. Germany Today I
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of contemporary German society and politics.

Ger. 3012. Germany Today II
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of contemporary German culture and politics.

Ger. 3013. Germany Today III
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of contemporary German literature.

Ger. 3031. The German Novel I
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of the novel in German literature.

Ger. 3032. The German Novel II
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of modern German novelists and their works.

Ger. 3051. The German Folk Song
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of German folk songs and their historical significance.

Ger. 4001. German Writers of the Twentieth Century
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of the works of major modern German writers.

Ger. 4002. German Writers of the Twentieth Century II
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of contemporary German writers and their works.

Ger. 4003. Modern German Drama
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of modern German drama and its historical context.

Ger. 4023. Selected Readings in German Literature
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Selection of works by modern German writers.

Ger. 4075. Intensive Readings in German I
3-0-3. Prerequisite: Ger. 2003 or equivalent.
Study of specific literary topics.

Ling. 1001. Introduction to Language I
3-0-3. Prerequisite: none.
Introduction to the study of linguistics.

Ling. 1002. Introduction to Language II
3-0-3. Prerequisite: Ling. 2001 or consent of department.
Introduction to linguistics.

Ling. 2001. Introduction to Articulatory Phonetics
3-0-3. Prerequisite: Ling. 2003 or consent of department.
Introduction to phonetics.

Ling. 3001. Introduction to Structural Linguistics I
3-0-3. Prerequisite: Ling. 3001 or consent of department.
Introduction to structural linguistics.
Methodology for phonological analysis of language, examination of phonological data from hypothetic and natural languages. Collateral readings, problems.¹

Ling. 3003. Introduction to Structural Linguistics II 3-0-3. Prerequisite: Ling. 3002 or consent of department. Survey of the theoretical developments in linguistic science with major emphasis on the developments of the nineteenth and early twentieth centuries.¹,²

Ling. 4001. History of Linguistics 3-0-3. Prerequisite: prior study of linguistics or consent of department. The major Romance languages. Ling. 4077 treats the major Germanic languages. Ling. 4077-2-3-4. Special Problems In Linguistics Credit to be arranged. Provides the special instruction required under special programs.¹,²

Portuguese See F.L. 1011.

Russian
Russ. 1001. Elementary Russian I 3-2-4. Prerequisite: none. Pronunciation, essential principles of Russian grammar, acquisition of vocabulary through illustrative readings, intensive familiarization with recorded material.²

Russ. 1002. Elementary Russian II 3-2-4. Prerequisite: Russ. 1001 or equivalent. Continuation of Russ. 1001, introduction of additional reading material as progress of class permits.²

Russ. 1003. Elementary Russian III 3-2-4. Prerequisite: Russ. 1002 or equivalent. Continuation of Russ. 1002, emphasis on the reading of simple prose.¹

Russ. 2001. History and Culture of Russia 3-0-3. Prerequisite: Russ. 1003 or equivalent. Period: Ninth century to eighteenth. Review of grammar and oral practice.²


Russ. 2003. History and Culture of Russia III 3-0-3. Prerequisite: Russ. 1003 or equivalent. Period: 1917 to the present. Review of grammar and oral practice.²


Russ. 3002. Period: 1850-1900. The Golden Age of Russian Prose, Realism 3-0-3. Prerequisite: Russ. 3003 or equivalent. Readings in Russian.¹

Russ. 3003. Period: 1900 to the Present. Symbolism, Futurism, Soviet Literature 3-0-3. Prerequisite: Russ. 3003 or equivalent. Readings in Russian.¹

Russ. 4075. Intensive Readings in Russian I 3-0-3. Prerequisite: at least junior standing or consent of department. Primarily for graduate students preparing for the Ph.D. reading knowledge examination. Emphasizes structures pertinent to reading comprehension particularly of scientific literature. Can also serve any students desiring a rapid review of basic Russian.¹,²

Russ. 4076. Intensive Readings in Russian II 3-0-3. Prerequisite: Russ. 4075. Continuation of Russ. 4075.¹,²

Russ. 4901-2-3-4. Special Problems In Russian Credit to be arranged. Provides the special instruction required under special programs.¹,²

Spanish
Span. 1001. Elementary Spanish I 3-0-3. Prerequisite: none. The beginning course. Pronunciation, grammar, reading, composition. Conversations with student assistants who are native speakers of Spanish.³

Span. 1002. Elementary Spanish II 3-0-3. Prerequisite: Span. 1001 or equivalent. Continuation of Span. 1001.³

Span. 1003. Elementary Spanish III 3-0-3. Prerequisite: Span. 1002 or equivalent. Continuation of Span. 1002.³

Span. 2011. Discovery and Conquest of the New World, 1492-1600 3-0-3. Prerequisite: Span. 1003 or equivalent. The voyages of discovery and expeditions of conquest in sixteenth century Spanish America, with an introduction to the important Indian civilizations. Includes grammar review. Conducted in Spanish.³

Span. 2012. Colonial Spanish America and the Wars of Independence, 1600-1900 3-0-3. Prerequisite: Span. 1003 or equivalent. Spanish America from the period of the viceregalies and Caribbean pirates to the Wars of Independence in the 1800s. Includes grammar review. Conducted in Spanish.³

Span. 2013. Twentieth Century Spanish America 3-0-3. Prerequisite: Span. 1003 or equivalent. Twentieth century Spanish America as a fusion of Spanish and European traditions. Focuses on selected aspects of contemporary life in the Latin American countries. Conducted in Spanish.³

Span. 3001. Spanish-American Literature Before 1890 3-0-3. Prerequisite: Span. 2013 or equivalent. Conducted in Spanish.³

Span. 3002. Spanish-American Literature Since 1895 3-0-3. Prerequisite: Span. 2013 or equivalent. Conducted in Spanish.³

Span. 3003. Introduction to Spanish Literature 3-0-3. Prerequisite: Span. 2013 or equivalent. The cultural heritage of Spanish America as reflected in representative European and Spanish-American literary works. Conducted in Spanish.³

Span. 3004. Cultural History of Mexico 3-0-3. Prerequisite: Span. 2013 or equivalent. Readings from representative authors. Vocabulary building, lectures, discussions, conversation and composition.²

Span. 3005. Contemporary Latin America 3-0-3. Prerequisite: Span. 2013 or equivalent. Selected contemporary essays, speeches and diverse documents reflecting social, economic and political problems. Conducted in Spanish.²

Span. 3006. Stylistics 3-0-3. Prerequisite: Span. 2013 or equivalent. Advanced study of syntax and semantics, aimed at development of stylistic sensitivity. Compositions in Spanish.³

¹This course may be applied toward the fulfillment of the undergraduate humanities requirements.
²This course may be applied toward the fulfillment of the undergraduate social sciences requirements.
³Can be applied toward fulfillment of humanities requirements for graduation in all colleges. Exceptions: in engineering and architecture will count as elective credit unless the entire first-year sequence and three 2000, 3000 or 4000-level courses are completed.
⁴Can be applied toward fulfillment of humanities requirements for graduation in all colleges. Exceptions: in engineering and architecture will count as elective credit unless the entire first-year sequence and three 2000, 3000 or 4000-level courses are completed.
This course may be applied toward the fulfillment of the undergraduate humanities requirements.

1 This course may be applied toward the fulfillment of the undergraduate humanities requirements.

2 This course may be applied toward the fulfillment of the undergraduate social sciences requirements.
Marine Corps Option

Marine Corps leadership laboratory. Grade of S given for satisfactory completion. Taken by all junior Marine option midshipmen during spring quarter.

N.S. 3005-6. Evolution of Warfare I and II 3-2-3 each.
Two-quarter sequence explores forms of warfare practiced by great peoples in history. Selected campaigns are studied, emphasis on impact of leadership, evolution of tactics, weaponry, principles of war.

N.S. 4004-5. Amphibious Warfare I and II 3-2-3 each.
Two-quarter sequence designed to study projection of seapower ashore, emphasis on evolution of amphibious warfare in 20th century. Strategic concepts, current doctrine discussed.

N.S. 4006. Naval Science Laboratory 0-0-2.
Marine Corps leadership laboratory to prepare senior Marine option for commissioning. Grade of S given for satisfactory completion.

Credited to be arranged.

Naval organization and management practices and the concepts that lie behind them are examined. This includes lines of command and control, organization for logistic functions and shipboard organization. Emphasis is placed on management and leadership functions.

N.S. 4012. Junior Naval Officer I 2-1-2.
Essential elements of military law peculiar to the naval service are discussed. International law pertinent to maritime affairs and the Code of Conduct are covered. Emphasis is placed upon the responsibility and authority of watch and division officers with respect to Military Law.

N.S. 4013. Junior Naval Officer II 2-1-2 Prerequisite: N.S. 4011.
Broad areas of personnel administration and management are covered, using the case method. Topics include promotion, evaluation of personnel performance, training and leadership requirements.

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N.S. 4013. Junior Naval Officer II 2-1-2 Prerequisite: N.S. 4011.
Broad areas of personnel administration and management are covered, using the case method. Topics include promotion, evaluation of personnel performance, training and leadership requirements.
N.E. 4440. Effects of Nonionizing Radiation and Protection Standards
3-0-3. Prerequisite: consent of school and N.E. 4412 or equivalent.
A study of methods of production and control of exposure to nonionizing radiations and a review of effects of human exposure and the radiation protection standards.

N.E. 4610. Introduction to Fusion Power
3-0-3. Prerequisite: senior standing in science or engineering.
An introduction to the concepts of fusion power. Basic plasma physics and technology of magnetic confinement fusion devices. Current reactor designs are discussed.

N.E. 4620. Nuclear Technology and the Environment
3-0-3. Prerequisite: senior standing in science or engineering or consent of school.
Survey of technical and social aspects of nuclear technology that relate to the natural environment and of nuclear techniques that are of value in pollution studies.

N.E. 4830. Isotopic Tracer Methodology
2-3-3. Prerequisite: senior standing in science or engineering or consent of school.
Introduction to isotopic tracer techniques for scientific and industrial applications in the biological, physical, medical or environmental sciences.

N.E. 4701. Nuclear Reactor Engineering I
3-0-3. Prerequisite: Math 2309.
N.E. 4701-2-3 are designed to provide a comprehensive sequence in nuclear reactor engineering. Topics include nuclear reactions, interaction of radiation with matter and diffusion of neutrons.

N.E. 4702. Nuclear Reactor Engineering II
3-0-3. Prerequisite: N.E. 4701.
N.E. 4702 provides nuclear reactor theory, use of multiprocess reactor diffusion theory computer codes, reactor kinetics, effects of fission product poisoning, field trips to nuclear installations.

N.E. 4703. Nuclear Reactor Engineering III
3-0-3. Prerequisite: N.E. 4702.
N.E. 4703 covers reactor control, reactor operation, energy removal, reactor design, reactor system decontamination, and field trips.

N.E. 4780. Energy Conversion Engineering
3-0-3. Prerequisite: N.E. 3720 or equivalent.
N.E. 4780 provides energy conversion, semiconductors, thermoelectric converters, photovoltaic generators, thermionic systems, magnetohydrodynamics and fuel cells.

N.E. 4810-2-3. Special Topics
3-0-3. Prerequisite: consent of school.
The topics of this course are to School of Nuclear Engineering to offer formal courses on topics of special interest on an ad hoc basis.

N.E. 4901-2-3-4. Special Problems
Credit to be arranged. Prerequisite: consent of school.
Special engineering problems will be assigned to the student according to his or her needs and capabilities.

N.E. 6101. Introduction to Nuclear Materials
3-0-3.
Introduction to the nuclear fuel cycle, raw materials, extraction, enrichment, fabrication, reprocessing. Metallurgy of uranium, ceramic fuels, cladding and control materials and coolants.

N.E. 6102. Nuclear Fuel Elements
3-0-3. Prerequisite: N.E. 6101 or consent of school.
Reactor fuel technology, including fuel preparation, assembly and testing, in-core performance of fuel elements and fuel design procedures.

N.E. 6103. Nuclear Reactor Analysis I
3-0-3. Prerequisite: graduate standing or consent of school.
Covers nuclear reactor physics at the graduate level. Major topics include neutron thermalization, diffusion theory and energy group constants.
Text: at the level of A. Henry, Nuclear Reactor Analysis.

N.E. 6104. Nuclear Reactor Analysis II
3-0-3. Prerequisite: N.E. 6103.
Topics include the reactivity variation with lifetime, reactor kinetics, neutron transport theory and derivation of diffusion theory from transport theory.
Text: at the level of A. Henry, Nuclear Reactor Analysis.

N.E. 6110. Radiation Detection I
2-6-4. Prerequisite: Phys. 6011 or equivalent.
Principles of radiation detection systems in common use, including interaction mechanisms, detector response, design and selection criteria for detectors and radiators.

N.E. 6111. Advanced Radiation Detection
3-0-3. Prerequisite: N.E. 6110 or equivalent.
Selected topics on modern radiation detection methods and fast pulse-circuit systems. Emphasis on neutron detection methods, scintillation detectors and semiconductor devices.

N.E. 6113. Radiation Effects on Materials
3-0-3. Prerequisite: N.E. 6101 or equivalent.
Reviews methods of radiation damage and related structural changes in solids. Semiconductors, organic materials and reactor components are covered.

N.E. 6125. Nuclear Engineering Calculations with Digital Computers II
3-0-3. Prerequisite: N.E. 6115 or equivalent.
Reviews numerical analysis with application to problems of nuclear reactors and associated nuclear physics and engineering. Programs are written and run in FORTRAN.

N.E. 6126. Monte Carlo Methods in Nuclear Engineering
3-0-3. Prerequisite: consent of school.
Introductory course with application to radiation transport. Statistical background, generation and testing of pseudorandom numbers, random variables, applications to shielding and reactor physics, variance reduction methods.

N.E. 6163. Nuclear Cycle 3-0-3. Prerequisite: consent of school.
Survey of the nuclear fuel cycle. Technologies of raw materials production, uranium conversion and enrichment, fuel fabrication and reprocessing, waste management, economic and safety analyses.

N.E. 6201. Advanced Nuclear Reactor Physics
3-0-3. Prerequisite: N.E. 6104.
The course covers the neutron transport equation and its solution by spherical harmonics, Fourier transforms and discrete ordinates methods. Multigroup methods are also covered.

N.E. 6202. Advanced Nuclear Reactor Physics II
3-0-3. Prerequisite: N.E. 6201.
A continuation of N.E. 6201. Topics include: adjoint equation, perturbation theory, variational methods, neutron thermalization, resonance absorption and reactor dynamics.

N.E. 6205. Nuclear Engineering Laboratory
1-6-3. Prerequisite: N.E. 6104.
Sequence of experiments elucidating reactor physics principles. Nuclear reactors, subcritical assembly, pulsed neutron generators and isotopic neutron sources are used.

N.E. 6211. Nuclear Reactor Technology I
3-0-3. Prerequisite: M.E. 3720 or equivalent.
Current and proposed nuclear reactor power plants. Thermodynamic and fluid flow aspects of reactor system design. Heat generation and conduction in nuclear reactor systems.

N.E. 6212. Nuclear Reactor Technology II
3-0-3. Prerequisite: N.E. 6211 or 4211.

N.E. 6220. Advanced Engineering Design
2-6-4. Prerequisite: N.E. 4022 and 4212 or 6212.
Course intended to give experience in the synthesis of principles of nuclear engineering in the design of nuclear reactors.

N.E. 6229. Applied Reactor Theory
3-0-3. Prerequisite: N.E. 4202 or 6104.
The course covers the physical principles employed in computer codes used in the design of fast and thermal reactors. The codes will be used by the students to calculate design parameters.

N.E. 6230. Reactor Kinetics and Control
3-0-3. Prerequisite: N.E. 4202 or equivalent.
Nuclear fuel procurement options will be examined with regard to financing, scheduling, guarantees, risk and cost. Calculation emphasis will be on in-core fuel management.

N.E. 6235. Nuclear Reactor Safety
3-0-3. Prerequisite: consent of school.
Nuclear licensing procedures, sources of potential hazard, accident transients, engineered guards, incontinent failure, diagnostic techniques and safety analysis reports are discussed.

N.E. 6237. Fast Reactor Physics and Technology
3-0-3. Prerequisite: N.E. 6104.
The course covers reactor physics and design topics of importance for fast breeder reactors.

N.E. 6251. Fundamentals of Nuclear Engineering
3-0-3. Prerequisite: Phys. 6011.
Reactor principles, operation, materials, control and use.

N.E. 6260. Radiation Attenuation
3-0-3. Prerequisite: N.E. 6104.
Interaction of radiation with matter in bulk, absorption, scattering and attenuation of nuclear radiation, radiation transport theory, geometrical considerations and transport solution methods.
N.E. 6401. Radiological Health Physics
3-0-3. Prerequisite: consent of school. Corequisite: Phys. 6011 or equivalent.
A laboratory of radiation protection standards, their development and enforcement. Covers topics such as effects of radiation, internal and external exposure, health physics practice and dosimetry.

N.E. 6405. Health Physics Practice
1-6-3. Prerequisite: N.E. 4413 or 6401, Phys. 4211 or equivalent.
A review of many types of radiation problems—both basic and applied—relating to the qualifications of a certified health physicist.

N.E. 6410. Radiation Dosimetry
3-0-3. Prerequisite: N.E. 6401 or 6110, or consent of school.
Fundamental principles of dosimetry of ionizing radiations. Includes Bragg-Gray theory, absorbed and integral dose, influence of field size and dosimetry of internal emitters.

N.E. 6411. Applied Radiation Physics
2-3-3. Prerequisite: Phys. 6011.
Standardization of radiation sources, measurement of absorbed dose and interaction of ionizing radiation with scattering medium.

N.E. 6412. Radiation Dosimetry Systems
1-6-3. Prerequisite: consent of school.
Deals with calibration of ionizing radiation sources, the evaluation of the dose distribution produced by them, or mixtures of them, in biological materials.

N.E. 6413. Radiation Technology Laboratory
1-6-3. Prerequisite: N.E. 6110.
Advanced laboratory course covering various techniques in the field of radiation technology, such as electrostatic generators, betatrons, linear accelerators, cyclotrons, synchrotrons and synchrocyclotrons. Design and operation of X-ray and neutron generators covered in laboratory.

N.E. 6429. Particle Accelerators
2-3-3. Prerequisite: Phys. 6011 or consent of school.
Principles of particle accelerators including acceleration methods, ion sources and targets, characteristics of machines such as electrostatic generators, betatrons, linear accelerators, cyclotrons, synchrotrons and synchrocyclotrons. Design and operation of X-ray and neutron generators covered in laboratory.

N.E. 6430. Radiation Protection In Nuclear Facilities
3-0-3. Prerequisite: N.E. 6405 or 4413 and N.E. 4710 or equivalent.
Review of radiation protection requirements at nuclear facilities, radiation monitoring, environmental surveillance planning and procedures for sample analyses and waste management.

N.E. 6442. Applied Health Physics Laboratory
1-4-3. Corequisite: N.E. 6430.
A laboratory of practical aspects of monitoring problems in nuclear facilities and environmental surveillance analyses.

N.E. 6601. Radiostopes Engineering I
3-0-3. Prerequisite: Phys. 6011 or equivalent.
Production and handling of radiostopes sources, industrial uses of various methods and radiation sources. Design procedures for radiation gauges and high-level irradiation facilities.

N.E. 6602. Radiostopes Engineering II
3-0-3. Prerequisite: N.E. 6601.
Production and economics of large-scale irradiation facilities for process systems and power sources. Analysis and design of practical systems and cases study.

N.E. 6623. Fusion Plasma Analysis I
3-0-3. Prerequisite: N.E. 4610 or equivalent.
Fundamental fusion plasma properties, motion of charged particles in magnetic fields, fluid description of plasmas and transport processes in magnetically confined plasmas.

N.E. 6624. Fusion Plasma Analysis II
3-0-3. Prerequisite: N.E. 6623.
Plasma equilibrium and stability, waves in plasmas, plasma heating and fusion, radiative processes, plasma-wall interaction, plasma dynamics, fusion reactor plasma parameters.

N.E. 6625. Fusion Reactor Technology
3-0-3. Prerequisite: N.E. 6624 and N.E. 6632.
Technology and physics aspects of fusion reactor plant analysis and design, superconducting magnets, vacuum systems, confinement concepts, economics and analysis optimization.

N.E. 6626. Plasma Equilibrium and Transport
3-0-3. Prerequisite: N.E. 6624.
Advanced treatment of plasma equilibria with flows, fluid kinetic theory of plasma transport, and the evolution of flux surface configurations.

N.E. 6631. Fusion Nuclear Engineering I
3-0-3. Prerequisite: N.E. 4610, N.E. 6615, N.E. 6103 or equivalent.
Neutronics and photonics analysis and design of the blanket and shield for fusion reactors, tritium breeding, nuclear heating, response functions induced activation, radiation transport and protection.

N.E. 6632. Fusion Nuclear Engineering II
3-0-3. Prerequisites: N.E. 6631, Met. 4403 or M.E. 3212, N.E. 4714 or equivalent.
Materials and thermal-hydraulics analysis and design of the first wall and blanket for fusion reactors, radiation damage and radiation effects, heat transfer and transport.

N.E. 6641. Environmental Surveillance and Radioactive Waste Disposal
3-0-3. Prerequisite: consent of school.
Advanced course on environmental radioactivity and environmental aspects of nuclear power. Radiation waste treatment, reactor effluents and waste disposal. Identical to N.E. 683 but without the laboratory.

N.E. 6643. Environmental Impact of Nuclear Power Stations
3-0-3. Prerequisite: N.E. 6641 or consent of school.
Specific impact of nuclear facilities on the environment. Practical and regulatory aspects of reactor siting and the precaution of environmental impact statements.

Topics include energy sources, dynamic systems, thermoelectric conversion, fuel cells, solar power, MHD and the design of practical and useful power systems.

Explores the topics covered in N.E. 6680 in greater depth. Current programs aimed at developing advanced power sources are discussed.

Topics include nuclear reactor and fuel cycle, electrical power systems and utility economics, financial management and system modeling. Identical to Econ. 6760.

The use of computers in data acquisition and control digital logic, interfacing, computer structures and the hardware-software trade-off are covered. First course in computer engineering options.

Computer programming for real-time process control systems in complex multiple-task device-oriented environments. Subjects include assembler programming, operating systems and real-time systems on minicomputers.

A study of system design using MSI and LSI chips and programmable digital devices as system modules. Subjects include Boolean optimization and register transfer design techniques.

N.E. 6773. Computer Control of Real-time Systems 3-3-4. Prerequisite: N.E. 6770, E.E. 4077 or equivalent.
A study of concepts common to all computer controlled real-time systems. Subjects include evolution of time sets, vectored interrupts and statistical alarm conditions.

N.E. 6775. Advanced Engineering Programming Methods 3-3-4. Prerequisite: FORTRAN programming knowledge.
Advanced engineering programming concepts and their implementation on large scale digital computers. Dynamic data, dynamic programs, engineering data management, primary memory management, engineering problem-oriented language development and ICES.

N.E. 6783. Environmental Surveillance and Radioactive Waste Disposal 3-3-4. Prerequisite: C.E. 6133, N.E. 6401 or consent of school.
Advanced course on environmental radioactivity and environmental aspects of nuclear power. Radioactive waste treatment, reactor effluents and waste disposal. Lecture portion of this course is identical to N.E. 6641.

N.E. 7000. Master's Thesis 3-3-4. Prerequisite: consent of school.
N.E. 7999. Preparation for Doctoral Qualifying Examination 3-3-4. Noncredit. Prerequisite: consent of school.
Regularly scheduled, noncredit course required of all N.E. majors. Various topics presented by graduate students, faculty members and guest speakers.

Purpose of this course is to permit the School of Nuclear Engineering to offer formal courses on topics of special interest on an ad hoc basis.

E.E. 8501-2-3-4. Special Problems Credit to be arranged. Prerequisite: consent of school.
The student is encouraged to exercise resourcefulness and originality in attacking a problem of special interest to himself or herself and a member of the N.E. faculty.
Philosophy and History of Science
See Social Sciences

Physical Education and Recreation
Unless medically disqualified, all students will be required to complete swimming (P.E. 1010) plus two additional courses. One of these must be selected from the remaining courses at the 1000 level and one must be selected from the 2000 level.

P.E. 1010. Swimming
0-4-1.
Each student strives for maximum safety by thoughtful experimentation with simulated water emergencies. Drownproofing evolves as the basic method for survival.

P.E. 1020. Physical Fitness and Gymnastics
0-4-1.
Gymnastic movement is the medium through which students develop and learn to maintain essential elements of fitness including flexibility, coordination, strength, balance and kinesthetic awareness.

P.E. 1030. Women's Gymnastics
0-4-1.
Instruction, demonstration and practice of basic women's gymnastics skills utilizing the four Olympic women's events. Flexibility and general physical conditioning exercises will be included.

P.E. 1040. Health Education
3-0-3.
Guest lecturers from the medical and allied health profession acquaint the student with the contemporary personal health concerns including drugs, nutrition, emotional health and sex education.

P.E. 1050. Aerobic Conditioning
0-4-1.
Primary emphasis is placed on the improvement of endurance and of cardiovascular and respiratory system efficiency through an individually tailored program of jogging and recreational sports.

P.E. 1090. Physical Conditioning
0-4-1.
Instruction, demonstration and practice of basic physical conditioning. Course covers various types of calisthenics, weight training, flexibility, running and circuit training to give the individual a total physical fitness concept.

P.E. 2010. Archery
0-4-1.
Instruction in fundamental skills such as proper stance, grip of bow sight, release and follow through.

P.E. 2020. Intermediate and Advanced Gymnastics
0-4-1. Prerequisite: P.E. 1020 or 1030 or prior gymnastics experience.
The primary goal will be to develop a sufficient diversity of gymnastic skills beyond the beginning levels so that one may participate on recreational basis or as an adjunct to a physical fitness program. Instruction in skills in the ten international competitive events for men and women and acrobatics will be included.

P.E. 2050. Tennis
0-4-1.
Demonstration and lecture on fundamentals of the game, followed by practice of essential skills. Singles, doubles and mixed doubles tournaments will be organized.

P.E. 2055. Badminton
0-4-1.
Demonstration and practice of fundamentals including grip, playing positions, footwork, strokes and application of basic techniques and strategy to actual playing situations in singles and doubles.

P.E. 2060. Volleyball
0-4-1.
The serve, spiking, passing, team defensive and offensive play will be demonstrated and practiced after which team competition is organized.

P.E. 2070. Racquetball
0-4-1.
Scoring, defensive and offensive strategy along with basic fundamentals of the serve and volley will be demonstrated and practiced. Singles and doubles competition will be organized.

P.E. 2075. Handball
0-4-1.
Demonstration and practice of fundamentals including serve (lob, power and 2), shots (kill, ceiling and pass) and the importance and technique of each.

P.E. 2080. Bowling
0-4-1.
Team and league bowling competition follows an instructional program utilizing both live and filmed demonstration of basic skills and techniques.

P.E. 2100. Fencing
0-4-1.
Demonstration and practice of fencing fundamentals and rules with the French foil as the weapon. Practice bouts and officiating will follow partial mastery of these skills.

P.E. 2101. Intermediate and Advanced Fencing
0-4-1. Prerequisite: P.E. 2100, or consent of the department.
Review and mastery of the fencing fundamentals, plus instruction in advanced and competitive techniques.

P.E. 2110. Basketball
0-4-1.
The basic fundamentals of the game will be practiced. Team competition will then be organized.

P.E. 2130. Soccer
0-4-1.
Organization of teams and competition follows skills practice and demonstration of offensive and defensive strategy. Position assignments, safety and game rules discussed.

P.E. 2140. Athletic Officiating
2-2-1.
Study of rules with laboratory experience. Instruction and practical application of mechanics of officiating athletic games. Will help meet entrance requirements for professional officiating.

P.E. 2150. Advanced Lifesaving
0-4-1.
Instruction, demonstration and practice of carries, approaches and releases utilized in rescuing victims.

P.E. 2160. Water Safety Instructor Course
1-3-2. Prerequisite: current advanced first aid and swimming certificates or course skills.
Acquisition of motor skills and the mastery of methods of teaching lifesaving and swimming courses. Instruction in other aquatic activities such as pool operations, pool management, lifeguarding and swimming and diving coaching.

Physics

Phys. 1000. Physics Orientation
1-0-1.
Guest lectures will describe career opportunities in physics, the role physicists play in education, government and industrial laboratories, and programs available to physics majors.

Phys. 1001. Survey of Great Advances in Modern Physics
1-0-1.
A series of lectures, each of which deals with an important area of physics research or application; e.g., super conductivity, lasers, nuclear structure and energy, transistors.

3-0-3.

3-0-3.
An introductory treatment of the application of the basic physical laws to the understanding of weather phenomena. The main weather features will be descriptively developed. Text: at the level of Riehl, Introduction to the Atmosphere.

Phys. 2021, Introduction to Astronomy I
3-0-3.
The nature and behavior of the earth and the other members of the solar system will be examined. Text: at the level of Abell, Exploration of the Universe.

*Phys. 2022, Introduction to Astronomy II
3-0-3. (Phys. 2021 is not a prerequisite for Phys. 2022.)
The nature and behavior of the stars and galaxies will be examined. Text: at the level of Abell, Exploration of the Universe.

Phys. 2030. Physics of Music
3-0-3.
A descriptive introduction to the physical principles of the various sources of musical tones, how the sounds are generated, transmitted and received by the listener. Text: at the level of Rigden, Physics and the Sound of Music.

Phys. 2111-2. Elementary College Physics
4-0-4 each. Phys. 2111 should be taken first; Phys. 2112 and 2113 may be taken in either order, but it is preferable that 2112 precede 2113.
Basic study of the physical principles of mechanics, sound, heat, electricity, light and modern physics for students in the less technical curricula. Method of teaching and subject matter chosen to give an understanding of scientific methods and a background of scientific information needed to comprehend the commercial, cultural and political significance of scientific progress.
Text: at the level of Hooper and Gwynne, *Physics and the Physical Perspective*.

**Phys. 2121. Particle Dynamics** 4-3-5. Corequisite: Phys. 2109.
Introduction to classical mechanics. Topics include kinematics, dynamics, energy, momentum and rotational motion. Laboratory based on frictionless surfaces and stroboscopic photographic equipment emphasizes data analysis.
Text: at the level of Halliday and Resnick, *Fundamentals of Physics*.

**Phys. 2122. Electromagnetism** 4-3-5. Prerequisite: Phys. 2121; corequisite: Math. 2321.
Topics include electric field, potential, magnetic field and electromagnetic induction. Calculus and vectors are used. The laboratory stresses use of electrical instruments including oscilloscopes.
Text: at the level of Halliday and Resnick, *Fundamentals of Physics*.

**Phys. 2123. Optics and Modern Physics** 4-3-5. Prerequisite: Phys. 2122 and Math. 2307.
Text: at the level of Halliday and Resnick, *Fundamentals of Physics*.

**Phys. 2141-2.3. General Physics** 5-3-6 each
The sequence parallels Phys. 2121-2.3; courses from the two sequences may be intermixed. In this sequence some topics will be treated in more depth and some additional topics will be included. These courses are intended for students with demonstrated competency in mathematics and who desire a more rigorous foundation in physics.
Text: at the level of Halliday and Resnick, *Fundamentals of Physics*.

**Phys. 2801-2.3-4.5. Special Topics** 1-0-1 to 5-0-5 respectively.
Courses in special topics of current interest in physics are presented from time to time.

**Phys. 2900-1-2. Special Problems** Credit to be arranged. Prerequisite: consent of school.

**Phys. 3001. Introductory Modern Physics** 5-0-5. Prerequisite: Phys. 2123.
Survey of principles and phenomenology of modern physics, including atomic structure, nuclear phenomena and the interaction of radiations with matter.
Text: at the level of Weidner and Sells, *Elementary Modern Physics*.

Nuclear synthesis and energy generation in stars, stellar models and stellar evolution. Formation of elements, supernovae, quasars, neutrons stars, "black-holes" and radio sources. All majors.
Text: at the level of Fowler, *Nuclear Astrophysics*.

**Phys. 3121-2.3. Classical Mechanics, Electricity and Magnetism** 5-0-5. Prerequisite: Phys. 2123, Math. 2309 concurrent with 3121, courses to be taken in sequence.
Dynamics of particles including oscillations and planetary motion, rotation of rigid bodies, collisions, Lagrange's equations. Electric and magnetic fields, potentials, resistivity, induc­tance and capacitance, polarization, magnetic materials, development of Maxwell's equations and their application to the transmission of electromagnetic waves. Text: at the level of Symon, *Mechanics and Lorentz*.

**Phys. 3133 Mechanics** 5-0-5. Prerequisite: Phys. 2123.
Mechanics of particles and rigid bodies, gravitation, moments of inertia, the conservation laws, hydrodynamics, elasticity and stress and strain.
Text: at the level of Kleppner and Kolenkow, *Introduction to Mechanics*.

**Phys. 3134. Intermediate Electricity and Magnetism** 5-0-5. Prerequisite: Phys. 2123.
Maxwell's equations and applications. Electrostatics, dielectrics, magnetostatics, magnetic substances, Ampere's and Faraday's laws, electrical circuits.
Text: at the level of Lorrain and Corson, *Electromagnetism*.

**Phys. 3138. Quantum Physics** 5-0-5. Prerequisite: Phys. 2123.
Background to the development of quantum mechanics. Analysis of one dimensional problems. Applications of quantum mechanical concepts to atomic, molecular and solid state physics.

Text: at the level of Callen, *Thermodynamics*.

**Phys. 3143. Quantum Mechanics I** 5-0-5. Prerequisite: Phys. 3121 or 3133 and Math. 2309.
Historical approach to wave mechanics. Operator, eigenfunction-eigenvalue problem solutions to Schroedinger's equation, free particle, particle in a box, the square well, har­monic oscillator, rigid rotator and hydrogen atom.
Text: at the level of Eisberg, *Fundamentals of Modern Physics*.

Introduction to the concepts and principles of statistical physics necessary for a microscopic understanding of thermodynamics and related macroscopic phenomena.
Text: at the level of Kittel, *Thermal Physics*.

**Phys. 3211. Electronics** 5-6-7. Prerequisite: Phys. 2123.
A.C. circuit theory and basic principles of amplifiers and other electronic circuits.
Text: at the level of Brophy, *Basic Electronics for Scientists*.

Development of optical analysis of lenses and reflectors using matrix theory. Coverage includes image formation, stops, aberrations, photometry and analysis of typical optical systems.
Text: at the level of Blake, *Geometric Optics*.

Use of optical instruments for purposes of observation and measurement. Instrumentation includes spectrometers, interferometers, nodal slides, microscopes and telescopes.
Text: at the level of Lorrain and Corson, *Optical Optics*.

Maxwell equations as the basis for physical optics.
Text: at the level of Klein, *Optics*.

**Phys. 3226. Advanced Optical Physics Laboratory** 3-1-4. Prerequisite: Phys. 3225.
Optional laboratory taken with Phys. 3225. A small number of experiments designed to ex­ploit the material presented in lecture course.

**Phys. 3229. Vacuum Ultraviolet Optics** 3-1-2. Prerequisite: Phys. 2123.
Laboratory and lecture concerned with sources, dispersion techniques and detectors in the approximate wavelength region of 100 to 2000 Angstrom units.
Text: at the level of Thompson, *Techniques of Vacuum Ultraviolet Spectroscopy*.

**Phys. 3230. Photographic Principles.** 2-3-3. Prerequisite: Phys. 2113 or 2123.
Lectures and demonstration (laboratory) period. Relationship of photographic practice to scientific principles of photographic optics, photometry, perspective control, monochrome and color image processing, image quality.
Text: at the level of Langford, *Basic Photography and Advanced Photography*.

Applications of the principles and techniques of the physical sciences to areas of the life sciences.
Text: at the level of Stanford, *Foundations of Biophysics*.

A continuation of topics from Physics 3241. Physics of viruses, the central nervous system and biophysical instrumentation.
Text: at the level of Stanford, *Foundations of Biophysics*.

This laboratory is taken at the student's option with Phys. 3243. Selected exercises exemplifying and reinforcing material presented in the lecture course.

**Phys. 3261. Introduction to Elementary Particle Physics** 3-0-3. Prerequisite: Phys. 2123.
Phenomenology of elementary particles. Historical introduction, list of particles, quan­tum numbers, conservation laws, selection rules, cross sections, decays, strong, electro­magnetic, weak interactions: S-matrix, quantum field theory, models.

**Phys. 3263-4. Selected Problems in Physics I, II** 1-6-3 each. Prerequisite: Phys. 2123, courses may be taken in either order.
The numerical treatment of physics problems and experimental data pursued through the aid of computer facilities. Phys. 3263 will emphasize the numerical solution of realistic physics problems illustrating diverse physical
principles. Phys. 3264 will emphasize the treatment of data arising from physics experiments, including an introduction to on-line experiment control.

Phys. 3265. Introduction to Acoustics 3-0-3. Prerequisite: Phys. 2112 or 2122. An introduction to the art and science of acoustics for students of varied backgrounds and interests. The emphasis is on the basic physical mechanisms which underlie all acoustical phenomena. Text: at the level of Kinser, Fundamentals of Acoustics.


Phys. 3801-2-3. Special Topics. 1-0-1 to 5-0-5 respectively. Courses in special topics of current interest in physics are presented from time to time.

Phys. 3900-1-2. Special Problems Credit to be arranged. Prerequisite: consent of school.


Phys. 4206. Interfacing Laboratory I 3-3-4. Prerequisite: Phys. 3211 or equivalent. Introduction to the interfacing of computers with scientific apparatus. A computer and a variety of interfacing logic are available for the laboratory.

Phys. 4211. Electronic Instruments for Scientific Research 2-3-3. Prerequisite: Phys. 3211 or equivalent. An intermediate course in electronic instruments and instrumentation as employed in research and general laboratory measurements.

Text: at the level of Littauer, Pulse Electronics.

Phys. 4212. Electronics Laboratory 3-0-1. Prerequisite: Phys. 3211 or equivalent. Problems and techniques associated with the construction, calibration and maintenance of electronic instruments. Experience gained through actual construction, calibration and troubleshooting exercises.


Phys. 4216. Interfacing Laboratory II 1-0-3. Prerequisite: Phys. 4206 or consent of school. A continuation of Phys. 4206. Emphasis on individual student design and construction of interfaces for on-line control of experiments.

Phys. 4220. Optical Design 3-3-3. Prerequisite: Phys. 3223 or consent of school. Principles of optical design, ray tracing and third order aberrations; laboratory stresses optical testing using conventional resolution tests and modulation transfer function. Text: at the level of Smith, Optical Engineering.


Phys. 4229. Seminar in Contemporary Optics 1-0-1. Prerequisite: consent of school. Recent developments in optics discussed orally and summarized in written reports.

Phys. 4251. Biophysics I 3-0-1. Prerequisite: Phys. 2123, Biol. 2211. An introduction to biophysical systems, first through the study of physical properties of biological macromolecules and then through selected sensory systems in animals. Text: at the level of Lehninger, Bioenergetics.

Phys. 4252. Biophysics II 3-0-3. Prerequisite: Phys. 4251. Selections that stress the application of the measurement and analytical techniques of the physical sciences to studies of living systems.

Phys. 4253. Biophysics Laboratory 3-0-3. Corequisite: Phys. 4252. This laboratory is taken at the student's option with Phys. 4252. Selected exercises exemplifying and reinforcing material presented in the lecture course.


Phys. 4265. Transport Phenomena in Solids 3-0-5. Prerequisite: Phys. 2123; Phys. 3141 or Chem. 2123; Phys. 3264. This course emphasizes an experimental approach to transport phenomena. Topics include electrical and thermal conductivity and related phenomena in metals, semiconductors and insulators.

Phys. 4266. Introductory Diffraction Studies 2-6-4. Prerequisite: senior standing or consent of school. Introductory theory and practice of the most widely applicable X-ray and neutron diffraction techniques. Topics emphasized include identification, lattice parameters, textures, line breadth and crystal orientation. Text: at the level of Azaroff, Elements of X-ray Crystallography.


Phys. 4321-2. Advanced Laboratory I, II 1-6-3 each. Corequisite: Phys. 3138 or 3143. May be scheduled in either order. Experiments of classical and contemporary importance selected from various fields of physics. Experiments from topics that have not been treated in other courses. Students will be expected to acquire an understanding of significance of experiments through independent study.

Phys. 4801-2-3-4-5. Special Topics 1-0-1 to 5-0-5 respectively. Courses in special topics of current interest in physics are presented from time to time.

Phys. 4900-1-2. Special Problems Credit to be arranged. Prerequisite: consent of school.

Phys. 5005. Computer Facilities for Graduate Research in Physics 1-6-3. Introduction to the computational aspects of physics research and the characteristics of the computing systems available.


Text: at the level of Goldstein, *Classical Mechanics*.

**Phys. 6122. Electrodynamics** 5-0-5.
- Discussion of Maxwell's equations, scalar, and vector potentials, conservation laws, multipole moments and multipole radiation, dispersion.
- Text: at the level of Jackson, *Classical Electrodynamics*.

- Physical applications of probability theory, classical and quantum statistical mechanics with numerous applications: ideal gas, imperfect gas, liquids and solids.
- Text: at the level of Reif, *Fundamentals of Statistical and Thermal Physics*.

- Dynamics of deformable bodies. Strain and stress, waves. Hydrodynamics of fluids: Bernoulli's theorem, Stokes' law, waves, vortex motion, viscous fluids.
- Text: at the level of Trefftz, *Introduction to the Physics of Fluids and Solids*.

**Phys. 6132. Advanced Electricity and Magnetism** 5-0-5.
- A study of Maxwell's equations with applications to problems in electrical power systems, communications, signal processing, radiation and electrical measurements.

**Phys. 6141. Quantum Mechanics I** 5-0-5. Corequisite: Phys. 6143 or equivalent.
- Nonrelativistic quantum mechanics. Representation of dynamical variables as operators or matrices, theory of angular momentum, perturbation theory, selected topics from radiation and scattering theory.
- Text: at the level of Merzbacher, *Quantum Mechanics*.

**Phys. 6142. Quantum Mechanics II** 5-0-5. Prerequisite: Phys. 6141.
- Relativistic quantum mechanics, Dirac theory, the Lorentz group, antiparticles, relativistic Hamiltonians, propagators, Feynman graphs.
- Text: at the level of Borken and Drell, *Relativistic Quantum Mechanics*.

**Phys. 6143. Quantum Mechanics III** 5-0-5. Prerequisite: Phys. 6141.
- A problem-solving course that applies principles of quantum mechanics to atomic, molecular, solid-state and nuclear physics.

- Text: at the level of Kittel, *Introduction to Solid State Physics*.

**Phys. 6233. Physical Crystallography** 3-0-3. Prerequisite: Phys. 6266 or equivalent.
- Experimental and analytical aspects of X-ray, neutron and electron diffraction crystallography applied to problems such as physical property mechanisms, defects and other topics of current physical interest.

**Phys. 6235. Physics of Surfaces** 3-0-5.
- Fundamentals of physical methods for studying the structure, composition, vibrational and electronic properties of solid surfaces including the verification of principles in laboratory experiments.

**Phys. 6251. Diatomic Molecules** 3-0-3. Prerequisite: Phys. 4143 or equivalent.
- Electronic structure, calculation of potential energy curves, absorption parameters, emission parameters, rotational line strengths, vibrational band strengths, calculation of Franck-Condon factors.

**Phys. 6263. An Introduction to Collision Theory** 3-0-3. Prerequisite: Phys. 4143 or equivalent.
- Quantum theory of nonrelativistic elastic and inelastic scattering, rearrangement collisions, central, nonlocal, absorptive interactions, phase shift analysis, variational methods, semiclassical and impulse approximations, transition probabilities.

- Collisional excitation and ionization involving electrons, atoms and molecules. Charge transfer, recombination, ion-molecule reactions. Atomic processes in planetary atmospheres in astrophysics and in laboratory plasmas.

**Phys. 6267. Atomic Collisions** 3-0-3.
- A discussion of the techniques by which atomic collisions phenomena are studied, includes scattering of ions and electrons in gases and scattering from solid surfaces. Also taught as E.E. 6760.

**Phys. 6300. Graduate Laboratory** 1-0-3.
- Students choose a program of several experiments from those available in varied fields such as nuclear physics, solid state physics.

**X-ray diffraction, optics and physics instrumentation.**

**Phys. 6753. Surface Science and Technology Laboratory** 3-18-9. Prerequisite: consent of school.
- A highly specialized laboratory course using modern analytic and research instrumentation to characterize and study the surface properties of materials. Also listed as Ch. E. and Chem. 6753.

**Phys. 7000. Master's Thesis**

- An advanced course in statistical mechanics, including problems of biological significance.

**Phys. 7125. Introduction to Relativity** 5-0-5. Prerequisite: Phys. 6121, 6122.
- Reference frames and transformations, tensor calculus, review of special relativity, electrodynamics, the principle of equivalence, general relativity and gravitation, cosmologies and black holes.

**Phys. 7141. Quantum Mechanics of Many-Particle Systems** 5-0-5. Prerequisite: Phys. 6141.
- Interacting systems of particles described quantum mechanically using the method of second quantization. Application to Fermi and Bose systems.

**Phys. 7143. Group Theory and Quantum Mechanics** 5-0-5. Prerequisite: Phys. 6141 or equivalent.
- Basic principles of group theory and the representation of groups by matrices. Applications will include atomic and molecular structures.

**Phys. 7147. Quantum Field Theory** 5-0-5. Prerequisite: Phys. 6141, 6122.


**Phys. 7263. Nuclear Physics** 5-0-5. Prerequisite: Phys. 6141.
- Use of nuclear models in computation of observables, nuclear phenomena, including static and dynamic electromagnetic properties of nuclei.

- Time-dependent correlation functions and dynamic structure factors. Coherent and incoherent, elastic and inelastic scattering cross sections. Applications to neutron scattering by photons, magnetic interactions, fluids.

**Phys. 7799. Preparation for the Comprehensive Examination**

- Intended mainly for beginning graduate students. There are two series of seminars. Representative research programs in the school are described by advanced graduate students, postdoctoral and faculty members. The experimental basis of physics is illustrated through accounts of great experiments of importance to contemporary research.


**Phys. 8101-2-3. Special Topics** 1-0-1 to 5-0-5 respectively.

**Phys. 8501-2. Special Problems** Credit to be arranged.

**Phys. 8511-2. Special Problems** Credit to be arranged.

**Phys. 8521-2. Special Problems in Condensed Matter Physics** Credit to be arranged.

**Phys. 8531-2. Special Problems in Acoustics** Credit to be arranged.

**Phys. 8541-2. Special Problems in Applied Optics** Credit to be arranged.

**Phys. 8551-2. Special Problems in Physics Instrumentation** Credit to be arranged.
Political Science

See Social Sciences.

Psychology

Psy 3300. Psychology and Contemporary issues in Society
3-0-3
Contributions of psychology to an appreciation of selected contemporary issues. Topics may vary from quarter to quarter.

Psy 3303. General Psychology A
3-0-3
An intensive coverage of the methods and findings of contemporary psychology. Includes such topics as psychological development, learning, conditioning and biological bases of behavior.

Psy 3304. General Psychology B
3-0-3
Prerequisite: Psy 3303.
A continuation of Psy 3303. Such topics as individual differences, perception, personality and social psychology will be discussed.

Psy 4400. Developmental Psychology
3-0-3
Prerequisite: Psy 3303.
A comprehensive study of human behavior and psychological development from infancy through adolescence. Emphasis is placed on empirical and cross-species contributions.

Psy 4401. Industrial Psychology
3-0-3
A survey of methods and findings in the scientific study of humans at work. Considered are: statistics as selection, training, motivation, accidents and environmental effects.

Psy 4402. Psychology of Adjustment
3-0-3
Prerequisite: Psy 3303.
Consideration of characteristics and etiology of typical and atypical human behavior. A principal objective is an increased understanding of self and others.

Psy 4403. Introduction to Psychological Testing
3-0-3
Prerequisite: Psy 3304 or 4401.
Consideration of the theoretical and practical issues in psychological measurement, with particular reference to psychological testing.

Psy 4404. Psychology of Advertising
3-0-3
Prerequisite: Psy 3303, 4401.
An analysis of psychological principles and techniques which serve as a foundation for effective advertising. The scientific study of consumer behavior is emphasized.

Psy 4405. Seminar in Organizational Psychology
3-0-3
Prerequisite: Psy 4401 or 4410.
Study of psychological factors in organizational functioning, including theoretical and research-oriented materials, consent of school.

Psy 4406. Psychological Statistics
2-3-3
Prerequisite: consent of school.
Application of statistical techniques to the design and analysis of psychological studies.

Psy 4407. Experimental Psychology I
2-3-3
Prerequisite: Psy 3303.
An introduction to psychological measurement and laboratory techniques used in the experimental study of topics such as sensory processes, perception, psychomotor performance and learning.

Psy 4409. Introduction to Engineering Psychology
3-0-3
Engineering psychology is presented as an integral component in the design and evaluation of man/machine systems. Applied problems and general methodological questions are examined.

Psy 4410. Social Psychology
3-0-3
Prerequisite: Psy 3303.
Consideration of the behavior of the individual in relation to other individuals and groups.

Psy 4411. Experimental Psychology II
3-0-3
Prerequisite: Psy 3304, 4407 and consent of school.
Consideration of principles and research methods in the areas of learning and motivation with special emphasis on classical and operant conditioning of nonhuman animals.

Psy 4412. Psychology of Learning
3-0-3
Prerequisite: Psy 3304, 4406, 4407 and consent of school.
An empirical and theoretical analysis of human learning, memory and cognitive processes.

Psy 4413. Applied Experimental Psychology
3-0-3
Prerequisite: Psy 4406, 4412 and consent of school.
Consideration of the applications of the methods and data of experimental psychology.

Psy 4421. Physiological Psychology
3-0-3
Prerequisite: Psy 3304, Biol 2211.
Neurophysiological, endocrinological and biochemical bases of sensory and motor functioning, learning, memory, motivation and behavior disorders.

Psy 4422. Comparative Psychology
2-2-3
Prerequisite: Biol 2211, Psy 3304 and consent of school.
Consideration of principles and research methods of animal psychology and ethology. Literature reviews and reports, field trips and laboratory studies.

Psy 4423. Introduction to Psycholinguistics
3-0-3
Prerequisite: consent of school.
A critical examination of current psychological research and theory in language development and behavior.

Psy 4424. Introduction to Personality
3-0-3
Prerequisite: Psy 3304 or Psy 4410 and consent of school.
Introduction to and survey of major theories of personality.

Psy 4750. Social Psychology-Sociology Measurement Seminar
3-0-3
Prerequisite: Psy 4410 or equivalent and consent of school.
Problems, implications and methodologies relating to the measurement of individual and group behavior in social situations. Students will receive supervised project experience. Also taught as Soc 4750.

Psy 4751. Psychology and Environmental Design
3-3-4
Prerequisite: consent of school.
Introduction to psychological concepts relevant to environmental design. Survey of selected methods for assessing man-made environments. Taught jointly by psychology and architecture faculty. Cross-listed as Arch 4751.

Psy 4752. Psychology and Environmental Design II
3-3-4
Prerequisite: Psy 4751 and consent of school.
Continuation of Psy 4751 with greater emphasis on independent research and development of design solutions to selected problems. Taught jointly by psychology and architecture faculty. Also taught as Arch 4752.

Psy 4754. Models of Human Information Processing
3-0-3
Prerequisite: Psy 3303, 3304, I.C.S. 1700 or equivalent.
Practical and unified approaches to psychological and computer modeling of human information processes. Emphasis on neural, sensory, memory, semantic and conceptual processing. Also offered as I.C.S. 4754.

Psy 4755. Sex Roles: Their Development and Cultural Influence
3-0-3
Prerequisite: consent of school.
Psychological principles, legal facts and literary evidence have been integrated in an examination of the roles of men and women from three time perspectives: historical, current and future. Readings, lectures, discussions and invited panelists. Also listed as Engl 4755 and Soc. Sci. 4755.

Psy 4800. Special Topics
1-3-2
Prerequisite: Psy 3304, 4407 and consent of school.
Guided independent study in an area of psychology not represented in departmental course offerings.

Psy 4802-3-4. Special Topics
2-0-2 through 4-0-4 respectively. Prerequisite: consent of school.
Special topics of current interest.

Psy 4814. Special Topics
0-3-1
Prerequisite: Psy 4406, 4411 and consent of school.
The student will, under the direction of a staff member, do seminardependent work in literature review and/or experimental design.

Psy 4815. Special Topics
3-3-4
Prerequisite: consent of school.
Students will work, under the direction of the instructor, on projects adding to their development beyond the scope of existing courses.

Psy 4900-1-2-3. Special Problems
Credit to be arranged. Prerequisite: consent of school.
Students engage in individual and group projects under the direction of a faculty member.

Psy 4953. Special Problems in Psychological Aspects of Environmental Design
Credit to be arranged. Prerequisite: Psy 4751, 4752 and consent of school.
Supervised individual study of problem relating to the integration of environmental design and behavior.

Psy 5601. Advanced Industrial Psychology
3-0-3
Prerequisite: Psy 4401.
A survey of theoretical and pragmatic issues in industrial psychology. Recent developments and experimental findings will be discussed.

Psy 5602. Applied Experimental Psychology
3-0-3
Prerequisite: Psy 3304.
Consideration of the application of the methods and data of experimental psychology to the problems of man and the environment, emphasizing the engineering psychology approach.

Psy 6603. Social Psychology
3-0-3
Prerequisite: six hours of psychology and consent of school.
A study of principles of social learning, motivation and perception and of attitudes and
beliefs as they relate to behavior of individuals in groups.

Psy. 6604. Human Information Processing 3-0-3. Prerequisite: consent of school. A study of information processing theories and measurement techniques as applied to psychological problems, emphasizing human perceptual, communication and learning processes.

Psy. 6605. Proseminar in General Psychology 3-0-3. Prerequisite: graduate standing and consent of school. A comprehensive, advanced consideration of general psychology including such topics as conditioning, learning, memory and cognitive processes.

Psy. 6606. Proseminar in General Psychology 3-0-3. Prerequisite: graduate standing and consent of school. A comprehensive consideration of general psychology including such topics as psychological development, perception and physiological psychology.

Psy. 6607. Proseminar in General Psychology 3-0-3. Prerequisite: Psy. 6605, 6606 or equivalent and consent of school. A continuation of Psy. 6605 and 6606 involving consideration of such topics as personality, individual differences and social psychology.

Psy. 6608. Human Motivation 3-0-3. Prerequisite: graduate standing, Psy. 6605 and consent of school. Examine theoretical and pragmatic issues in the description and prediction of motivated behavior with special emphasis on factor analysis and reporting experiments.

Psy. 6610. Psychoacoustics 3-0-3. Prerequisite: Psy. 3304 or equivalent and consent of school. A comprehensive coverage of physiological and psychological acoustics, including analyses of auditory and extra-auditory response mechanisms and evaluation of research and theories in hearing.

Psy. 6621-2. Foundations of Psychology 3-0-3 each. Prerequisite: graduate standing and consent of school. A sequence involving historical and current points of view in psychology, emphasizing issues important for psychological theory.

Psy. 6623-4. Design of Psychological Experiments 2-3-3 each. Prerequisite: graduate standing, Math. 3710, Psy. 4406 or equivalent and consent of school. A two-quarter sequence on the planning and implementation of research based on linear models, with reference to statistical considerations in data reduction and analysis.

Psy. 6625. Experimental Methods in Psychology 2-3-3. Prerequisite: graduate standing, Psy. 6605, 6606, 6623 or equivalent and consent of school. Measuring the dependent variable in psychological experiments. Discussion is supplemented by practice in designing, conducting and reporting experiments.

Psy. 6626. Response Evaluation 3-0-3. Prerequisite: graduate standing, Psy. 4406 or equivalent and consent of school. Intensive consideration of theoretical and pragmatic problems in the description and evaluation of human responses in such areas as task analysis and performance measurement.

Psy. 6627. Human Learning 3-0-3. Prerequisite: graduate standing, Psy. 3303 or equivalent and consent of school. A comprehensive consideration of principles, problems, methods and experimental data in the study of human learning, including discussion of applications of theory and experimental findings.

Psy. 6629. Psychomotor Skill Learning and Performance 3-0-3. Prerequisite: Psy. 4406, 6605, 6606 or equivalent. Human capabilities and limitations for learning and performing psychomotor skills are studied and experiments in performance measurement and assessment of skill proficiency, prediction and control.

Psy. 6630. Psychometric Theory 3-0-3. Prerequisite: Psy. 4403, 6624 or equivalent. Preparation of students in statistical theory and techniques relevant to becoming professionally involved in construction, analysis and evaluation of psychological and personnel tests.

Psy. 6631. Personality and Social Development 3-0-3. Prerequisite: Psy. 6607 or equivalent. The developmental aspects of personality and socialization in children are examined. Particular attention will be given to empirically derived data, assessment techniques and theoretical explanations.

Psy. 6632. Perceptual Development 3-0-3. Prerequisite: Psy. 6606 or equivalent. Perceptual abilities and experience are examined as they change across the life span. Special attention will be given to early development, infancy and childhood.

Psy. 6680. Multivariate Analysis 5-5. Prerequisite: Psy. 6624 or equivalent and consent of school. Introduction to multivariate analysis in psychology with special emphasis on factor analysis.

Psy. 7000. Master’s Thesis.

Psy. 7010. Seminar in Industrial Psychology 3-0-3. Prerequisite: Psy. 6601, 6607 and consent of school. Critical and comprehensive examination of current problems in a selected area of industrial psychology. The area to be covered may vary from year to year.

Psy. 7011. Seminar in Experimental Psychology 3-0-3. Prerequisite: Psy. 6607, 6625 and consent of school. Critical examination of current problems in a selected area of general experimental psychology. Area to be discussed may vary each time the course is offered.

Psy. 7012. Seminar in Engineering Psychology 3-0-3. Prerequisite: Psy. 6602, 6607 and consent of school. Critical examination of current problems in a selected area of engineering psychology. The area to be discussed may vary each time the course is offered.

Psy. 7020. Advanced Learning 4-0-4. Prerequisite: graduate standing, Psy. 6605 or equivalent and consent of school. An advanced and systematic examination of selected topics dealing with the experimental psychology of learning and memory. Theoretical approaches to learning, transfer and reten­tion will be discussed.

Psy. 7021. Sensation and Perception 4-0-4. Prerequisite: Psy. 6606 or equivalent and consent of school. An examination of human interpretation of physical stimulation. The student studies in some detail the nature of perceptual processes, including human sensory processes.

Psy. 7022. Vision 3-0-3. Prerequisite: Psy. 6606 or equivalent. An advanced examination of the visual processes and the fundamental role they play in human behavior. Emphasis is placed upon objectively obtained data.

Psy. 7023. Operant Conditioning 4-0-4. Prerequisite: Psy. 6605 or equivalent. Intensive treatment of methods, data and problem areas of operant conditioning. Among the topics covered are response differentiation, schedules of reinforcement and stimulus control.

Psy. 7050. Professional Problems 2-0-2. Prerequisite: graduate standing and consent of school. Introduces the student to professional problems which he or she may face as a psychologist, including teaching, professional practice and research. Ethical issues will be examined.

Psy. 7750. Seminar on Psychology and Management 3-0-3. Prerequisite: Psy. 6601, 6609, M. C. 6150 or 6150 and consent of school. Preparation and presentation of papers on management problems involving psychological complexities. Jointly taught by members of the psychology and industrial management faculties.

Psy. 8504. Special Problems in Industrial Psychology Credit to be arranged. Prerequisite: Psy. 6601, 6602 or 6603. Students will be expected to plan and execute a research project involving investigation of some psychological aspect of management problems.

Psy. 8505. Special Problems in Experimental Psychology Credit to be arranged. Prerequisite: consent of school. Students conduct research under direction of a faculty member on problems in the general area of experimental psychology.

Psy. 8506. Special Problems in Engineering Psychology Credit to be arranged. Prerequisite: Psy. 6602 or equivalent and consent of school. Students conduct research under direction of a faculty member on problems in the area of engineering psychology.

Psy. 9000. Doctoral Thesis
Russian
See Modern Languages.

Social Sciences

History

Hist. 1001. History of the United States to 1865
3-0-3.
A survey of the social, political and economic history of the United States through the Civil War with emphasis on selected topics. Gives exemption from the U.S. and Georgia history examination.

Hist. 1002. History of the United States from 1865 to the Present
3-0-3.
A survey of the social, political and economic history of the United States from the Civil War to the present with emphasis on selected topics. Gives exemption from U.S. and Georgia history examination.

Hist. 1003. History of Georgia
3-0-3.
 Normally taken by juniors and seniors. Not open to students who have had Hist. 1001. A survey of the special, political and economic history of the United States through the Civil War period with emphasis on selected topics. Gives exemption from the U.S. and Georgia history examination.

Hist. 1028. Introduction to the History of Science and Technology
3-0-3.
An introductory survey of the development of science and technology from antiquity to the present. Emphasis placed on sociocultural context and scientific and technological revolutions.

Hist. 3001. Origins of Modern Times: Western Civilization, 1500–1789
3-0-3.
The course traces consolidation of the national monarchies and formation of the modern state system. In intellectual history, it follows the growth of secular culture.

Hist. 3003. Nineteenth Century Europe
3-0-3.
Europe from the French Revolution to World War I. Special emphasis given to problems arising from the growth of nationalism, power politics, rapid industrialization and the race for colonies.

Hist. 3004. World Problems Since 1914
3-0-3.
The continuation of Hist. 3003 with emphasis on the failure of the Treaty of Versailles, the rise of fascism and communism, and the coming of World War II.

Hist. 3010. History of the United States to 1865
3-0-3.
Normally taken by juniors and seniors. Not open to students who have had Hist. 1001. A survey of the special, political and economic history of the United States through the Civil War period with emphasis on selected topics. Gives exemption from the U.S. and Georgia history examination.

Hist. 3011. History of the United States from 1865 to the Present
3-0-3.
A survey of the social, political and economic history of the United States from the Civil War to the present with emphasis on selected topics. Gives exemption from U.S. and Georgia history examination.

Hist. 3012. History of Georgia
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

The problems which have confronted Georgia are examined in their historical setting. Relationship to the national scene is perspective to the state's place in the nation.

Hist. 3013. United States Colonial History
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

Settlement and growth of the English colonies in North America with emphasis on the foundation of American political and economic institutions.

Hist. 3015. Survey of Sciences in the Sixteenth and Seventeenth Centuries
3-0-3.
An interpretative study of the scientific revolution including the social, economic and cultural context and origins of science in America.

Hist. 3016. Survey of Sciences in the Eighteenth and Nineteenth Centuries
3-0-3.
The evolution of science and scientific institutions in Europe and the United States including rise of industrial research.

Hist. 3017. History of the Old South to 1865
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

A study of social, political and economic developments in the South from the colonial period through the Civil War.

Hist. 3018. History of the New South Since 1865
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

An examination of social, political and economic developments from the Reconstruction period to the present.

Hist. 3020. American Diplomatic History
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

American diplomatic history since the Revolutionary War with emphasis on developments in the twentieth century.

Hist. 3022. Afro-American History
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

Historical analysis of the American Negro to the present. Special attention given to the Negro's contribution to American letters, music and other performing arts.

Hist. 3024. The American Civil War
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

A survey, with major emphasis on the military history of the war. Individual research is stressed.

Hist. 3025. American Economic History
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

Special attention given to the rise of technology, our industrial system, the westward movement, development of our banking system and government regulation of industry.

Hist. 3028. United States Social and Intellectual History
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

Studies in the social and intellectual traditions of the United States with emphasis on the more recent period. Assigned readings.

Hist. 3030. Technology and Economic Change
3-0-3.
Growth of technology in the modern world in its relationship to economic and social change.

Hist. 3037-8-9. History of Technology
3-0-3 each.
The development of technology from the beginnings of man to the present, with emphasis upon interrelations between technology and society.

Hist. 3040. Recent Latin American History
3-0-3.
Historical evolution of Latin America in recent times with particular attention to social change.

Hist. 3076. The Immigrant Experience
3-0-3.
Prerequisite: Engl. 1001-2.
The history and literature of the immigrant, stressing life in the Old World and reasons for emigrating, the passage to America, impressions of the New World and problems of assimilation. Lectures, reports, papers.

Hist. 4008. History of Technology in the United States
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

A study of technology in America from the colonial period to the present, including industrial and engineering history.

Hist. 4018. History of Electrical Science and Technology
3-0-3.
The origins and evolution of electrical science, technology and engineering. Emphasis placed on impact of major innovations in power, communications and electronics.

Hist. 4025. The United States Since 1917
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

A social, political, economic and diplomatic history of the United States in the middle of the twentieth century is examined as to causes, results and movements.

Hist. 4050. Twentieth Century Black History
3-0-3.
Prerequisite: any one of Hist. 1001, 1002, 3010, 3011 or history examination.

Selected topics concerning the social, economic and political history of African Americans with emphasis on the role of technology in urban development.

Hist. 4925-6-7-8-9. Special Problems in History
Credit to be arranged.

Philosophy of Science and Technology

P.S.T. 1126. Introduction to Philosophical Analysis
3-0-3.
An introduction to the nature of philosophy through critical study of selected works. The relation of philosophy to science, religion and society will be emphasized.

P.S.T. 1127. Science, Technology and Human Values
3-0-3.
An examination of the ways engineering technology shapes and is shaped by societal values. Also considers the appropriate and intermediate technology movements.

P.S.T. 3100. Introduction to Philosophical Analysis
3-0-3.
Through critical study of selected works the relation of philosophy to science, religion and society will be emphasized.

P.S.T. 3102. History of Ancient Philosophy
3-0-3.
A study of the development of philosophy from early preSocratic science to Christian thought. The works of Plato and Aristotle stressed.

P.S.T. 3103. History of Modern Philosophy 3-0-3. The development of Western thought from Bacon to Kant, with emphasis on the philosophical dimensions of the rise of modern science.


P.S.T. 3107. Comparative Religions 3-0-3. Introduction to the development of the most important concepts in modern religious systems. Emphasis will be placed on the contributions of philosophical analysis and theological debate.


P.S.T. 3120-1. Philosophy of Science 3-0-3 each. A study of the main problems of philosophy of science including theories, explanation, prediction, causality, development of scientific knowledge, social and ethical aspects of science.

P.S.T. 4106. Philosophy of the Behavioral and Social Sciences 3-0-3. Prerequisite: senior standing or consent of the department. Examination of philosophical views of social science, structural aspects of social science, relationship between natural and social science and other selected philosophical problems.

P.S.T. 4107. Philosophy of Technology 3-0-3. Prerequisite: senior standing or consent of the department. A critical analysis of the methods, values and underlying philosophy of technology. Examines theories of social change and the role played by technology.

P.S.T. 4110. Theories of Knowledge 3-0-3. Critical examination of perception, verification, a priori and a posteriori knowledge, meaning and criteria of truth, presuppositions and cognitive significance of scientific and philosophical propositions.

P.S.T. 4115. Philosophy of Science 3-0-3. Examination of selected problems such as causality, inductions, scientific explanation, development of scientific knowledge, social and philosophical import of scientific theories.


P.S.T. 4944-5. Selected Problems in the History of Science Credit to be arranged.

P.S.T. 4949. Special Problems. Credit to be arranged.

P.S.T. 5849. Special Problems 3-0-3. Topics to be selected.

Political Science


Pol. 1253. Comparative Political Systems 3-0-3. Examination of current empirical political frameworks and conceptual vocabularies for purpose of developing common approach in analysis of individual political systems.

Pol. 2270. Introduction to Analysis of Political Behavior 3-0-3. Prerequisite: Pol. 1251 or consent of the department. Introduction to political analysis; behavioral and post-behavioral perspectives. Explores basic concepts and methods employed in selected theoretical approaches.

Pol. 2271. American Political Thought 3-0-3. Prerequisite: Pol. 1251 or consent of the department. Examination and analysis of fundamental political ideas which have shaped the American political system.


Pol. 3204. United States Military Policies 3-0-3. Prerequisite: Pol. 1251 or consent of the department. Examination of the armed forces' relationship to society, with particular emphasis on the development of the military-industrial complex.

Pol. 3205. American Foreign Policy 3-0-3. Prerequisite: Pol. 1251 or consent of the department. Study of formulation and implementation of U.S. foreign policy, stressing economic, political and strategic factors.

Pol. 3210. National Legislative Processes 3-0-3. Prerequisite: Pol. 2270 or consent of the department. Empirical and systematic analysis of national legislative branch with attention to relationships among executive branch, interest groups and Congress.

Pol. 3211. The American Presidency 3-0-3. Prerequisite: Pol. 1251, 2270 or consent of the department. Source, nature and use of presidential power, the roles of the president. Recent historical examples emphasized.

Pol. 3215. Public Opinion 3-0-3. Prerequisite: Pol. 1251 or consent of the department. Focus on opinion polling techniques, including sampling, questionnaire construction and interpretation. Analysis of actual opinion data collected on a national basis.

Pol. 3216. American Political Parties 3-0-3. Prerequisite: Pol. 1251 or consent of the department. Study of political party developments and their role in the electoral process.

Pol. 3217. State and Local Government 3-0-3. Prerequisite: Pol. 1251 or consent of the department. Analysis of structure and function of state, county and municipal government.

Pol. 3220. Urban Government and Political Problems 3-0-3. Prerequisite: Pol. 1251 or consent of the department. An examination of political institutions and processes in the urban setting, including metropolitan government and intergovernmental relations.

Pol. 3221. Urban Political Problems 3-0-3. Prerequisite: Pol. 1251 or consent of the department. A consideration of urban political behavior, including brokerage politics, politics in sub-urban and community power structures.

Pol. 3222. Urban Public Policy 3-0-3. Prerequisite: Pol. 3220, 3221 or consent of the department. An empirical and systematic analysis of selected urban public policy areas, including such policy areas as education, housing and crime control.

Pol. 3250. Public Administration and Public Policy 3-0-3. Prerequisite: Pol. 1251 or consent of the department. Study of decision-making and organization theory, bureaucratic policymaking, intergovernmental relations, taxing and spending policy.


Pol. 3266. The Developing Nations 3-0-3. A study of selected underdeveloped nations including economic and political development.

Pol. 3270. Western European Governments and Politics 3-0-3. Comparative analysis of governmental and political processes in the nations of Western Europe.


Pol. 3276. International Organization 3-0-3. Prerequisite: Pol. 3275 or consent of the department. Study of evolution, impact and future of international organizations.


Pol. 3281. Soviet Foreign Policy 3-0-3. A study of formulation and conduct of So-
Pol. 4200. Political Theory I 3-0-3. A study of ancient, medieval, renaissance and reformation political philosophy.

Pol. 4201. Political Theory II 3-0-3. The development of political philosophy from the seventeenth century age of reason through the nineteenth century age of ideology.


Pol. 4210. Science, Technology and Public Policy 3-0-3. Prerequisite: Pol. 1251 or consent of the department. Examination of relationship between science and government including the effect of each area on the other in decision-making processes.


Pol. 4950. 4953-4-5-6. Special Problems in Political Science Credit to be arranged.

Pol. 4951. Georgia Internship Program Credit to be arranged (15 hours maximum). Work-study program assigning student to project in state or local government. Student prepares research paper under jurisdiction of faculty member.

Pol. 4952. Legislative Intern Program Credit to be arranged. Service learning program combining an academic study of the legislative process with internship at Georgia Legislature in winter quarter. Interns selected competitively each year.


Pol. 6951. Governor's Intern Program Credit to be arranged. Directed reading and research for students to work as interns in departments of state government.

Pol. 6952. Legislative Intern Program Credit to be arranged. Service learning program combining an academic study of the legislative process with internship at Georgia Legislature in winter quarter. Interns selected competitively each year.

Pol. 8574. Special Problems in Political Science Credit to be arranged. Topics to be selected.

Sociology

Soc. 1376. Introduction to the Principles of Sociology 3-0-3. A study of basic social relations, including social structure and functions, analysis of social processes, the foundations of personality and analysis of social organization.

Soc. 1377. Social Institutions 3-0-3. An analysis of the structure and functions of social institutions, including familial, educational, religious, economic and political. A study of institutional change and social disorganization.


Soc. 3306. Urbanization 3-0-3. Prerequisite: Soc. 1376. Growth of metropolitan communities, differentiation of functions, urban complexity, ecological areas, the city as a way of life, measures and trends in the process of urbanization.

Soc. 3308. Statistics for Planning 3-0-3. Statistical principles for analysis of economic, social and population data, sampling, measures of central tendencies, normal curve, testing of findings, correlation and arriving at conclusions.


Soc. 3330. Ethnic Minorities in American Society 3-0-3. Prerequisite: Soc. 1376. The principles of intergroup relations as they relate to the various racial and cultural groups in American society.

Soc. 3334. Social Stratification and Mobility 3-0-3. Prerequisite: Soc. 1376 or consent of the department. Process of stratification, including the criteria for and characteristics of stratification, implications of stratification for the functioning of society.

Soc. 3335. Social Problems of Industry 3-0-3. Prerequisite: Soc. 1376 or consent of the department. A study of the nature of human relations in large-scale organizations, significance of authority, roles, communication, status and group norms in the work situation.

Soc. 3338. Individual and Society 3-0-3. Prerequisite: Soc. 1376 or consent of the department. A study of the nature of interpersonal relations in small groups and in large social settings, a consideration of the problem of alienations and anomie.

Soc. 3339. Urban Sociology 3-0-3. Prerequisite: Soc. 1376. Introduces student to basic concepts of sociology as applied to urban phenomena, nature of urbanism and consequences for social relations and human personality.


Soc. 3975-6-7. Special Topics 1-6-3. Topics to be selected.

Soc. 4308. Technology and Society 3-0-3. Normally taken by seniors or graduate students. Analysis of social conditions which promote or retard technological activity. Particular emphasis on the social role of the scientific and engineering professions in that development.

Soc. 4308. Seminar in Contemporary Urban Sociology 3-0-3. Prerequisite: Soc. 1376 and consent of the department. Extensive and critical review of literature in field in order to keep students abreast of latest thinking concerning urban phenomena and problems.

Soc. 4312. Seminar in Comparative Urban Development 3-0-3. Prerequisite: Soc. 1376 and consent of the department. Entails cross-national comparison of cities and urban regions, appropriate models for understanding cities and urban regions and strategies for handling problems.

Soc. 4750. Social Psychology-Sociology Measurement Seminar 3-0-3. Prerequisite: Psy. 4410 or equivalent and consent of the department. Problems, implications and applications relating to the measurement of individual and group behavior in social situations. Students will receive supervised project experience.

Soc. 4999. Special Problems in Sociology Credit to be arranged. Topics to be selected.

Soc. 6375. Planning for People 3-0-3. Problems of planning with selected subgroups in urban societies: minorities, the aged, residents of the inner city, suburbanites, impact of environment on individuals and families.

Spanish

See Modern Languages.

Textile Engineering

Text. 1100. Introduction to Textile Engineering 3-0-3. Prerequisite or corequisite: Chem. 1101 or 1111. An introduction to textile chemistry, textile engineering and textile management, textiles,
fibers and polymers, and to the textile-fiber-polymer-chemical-equipment-engineering industrial complex. Credit can not be obtained for both Text. 1100 and Text. 2701.

Text. 2100. Introduction to Fiber Science 3-0-3. Introduction to natural and man-made fibers, fiber structure and physical properties including elasticity, recovery, moisture sorption and optical properties.

Text. 2101. Yarn Processing I 3-0-3. Prerequisite: Text. 2100. Fundamental principles of processing natural and man-made staple fibers into yarn and basic properties of spun yarn.

Text. 2102. Yarn Processing II 3-0-3. Prerequisite: Text. 2101 or consent of school. Alternate methods for producing yarns from continuous filament and staple fiber.

Text. 2180 Textile Manufacturing Processes I 0-3-1. Prerequisite or corequisite: Text. 1100. Orientation to manufacturing and management operations in the student operated enterprise.

Text. 2181. Textile Manufacturing Processes II 0-3-1. Prerequisite: Text. 2101 or consent of school. Yarn production operations within the student operated enterprise.

Text. 2182. Textile Manufacturing Processes III 0-3-1. Prerequisite: Text. 3110 or consent of school. Woven fabric production operations within the student operated enterprise.

Text. 2500. Survey of Apparel Manufacturing 3-0-3. Apparel engineering and manufacturing from planning and receipt of raw materials to the distribution of finished garments.


Text. 2701. Textile Industry Survey 3-0-3. Not open to textile students. An overview of textiles, fibers and polymers and the associated complex of industries from raw materials to finished products including textile arts and textile management. Credit can not be obtained for both Text. 1100 and Text. 2701.


Text. 3110. Woven Structures I 3-0-3. Prerequisite: Text. 2101. The weaving process and woven fabric construction, design and properties are studied.

Text. 3111. Woven Structures II 3-0-3. Prerequisite: Text. 3110. Dynamics, operating characteristics and economics of new weaving machines.


Text. 3122. Structures of Organic Polymers 3-0-3. Prerequisite: Chem. 1102 or consent of school. A study of the chemical and physical structures of organic, fiber-forming polymers and the relationship of their structure to properties.

Text. 3400. Computer Applications in Textiles 2-3-3. Prerequisite: Math. 1712 or 1308 or consent of school. Computer techniques are applied to textile engineering problems. An assembler language introduces FORTRAN. Applications include digital and analog interfaces to textile processes.

Text. 3480. Textile Manufacturing Processes IV 0-3-1. Prerequisite or corequisite: Text. 3112 or consent of school. Knit fabric production operations within the student operated enterprise.

Text. 3481. Textile Manufacturing Processes V 0-3-1. Prerequisite: consent of school. Evaluation of products produced by the student operated enterprise.

Text. 3482. Textile Manufacturing Processes VI 0-3-1. Prerequisite: Text. 4305 or consent of school. Fabric finishing operations within the student operated enterprise.

Text. 3483. Problems in Textile Management I 0-3-1. Prerequisite: Mgt. 2000, Mgt. 3300 or consent of school. Production marketing and cost accounting within the student operated enterprise.

Text. 3484. Problems in Textile Management II 0-3-1. Prerequisite: consent of school. Methods of plant maintenance and work studies within the student operated enterprise.

Text. 3485. Problems in Textile Management III 0-3-1. Prerequisite: consent of school. Personnel administration, scheduling and planning within the student operated enterprise.

Text. 3500. Jacquard Design and Weaving 2-3-3. Prerequisite: Text. 3110. The designing of Jacquard patterns and the techniques involved in the transfer of design to the fabric.


Text. 3511. Garment Assembly 4-0-4. Formation and mechanics of seaming including thread properties, stitch formation, sewing machines, heat sealing and ultrasonic, radio frequency, infrared and adhesive bonding.

Text. 3512. Apparel Production, Planning and Engineering 4-0-4. Prerequisite: Text. 3510 or consent of school. Analysis and design of apparel production from raw materials to finished product with emphasis on maximizing quality and productivity and minimizing time, cost and waste.

Text. 3513. Apparel Shaping and Finishing 4-0-4. Prerequisite: Text. 3510, 3511 and 3512 or consent of school. Principles and analysis of processes for shaping and finishing apparel with emphasis on design of systems and equipment for maximizing the quality/cost ratio.

Text. 3700. Survey of Fiber Processing 3-0-3. Not open to textile students. Yarn processing with emphasis on relationships between fiber properties and yarn properties.
Text. 4202. Mechanics of Fibrous Structures II
3-0-3. Prerequisite: Text. 4201 or consent of school.
Processes, properties and mechanisms involved in the manufacture of woven and knitted fabrics.

Text. 4203. Mechanics of Fibrous Structures III
3-0-3. Prerequisite: Text. 4201 or consent of school.
Investigation of production processes, structures and properties of adhesive and mechanically bonded nonwoven fabrics and fiber reinforced materials.

Text. 4300. The Chemistry and Chemical Processing of Fibers and Textiles I
3-0-3. Prerequisite: Text. 4751.
The structure and purification of natural and synthetic fibers with emphasis on the relationship of fiber structure and behavior during chemical processing.

Text. 4301. The Chemistry and Chemical Processing of Fibers and Textiles II
3-0-3. Prerequisite: Text. 4751 or consent of school.
The dyeing and printing of textile materials with emphasis on the relationship of fiber structure and response of textiles to these processes.

Text. 4302. Textile Finishing Processes
3-0-3. Prerequisite: Text. 4751 or consent of school.
The chemical and mechanical finishing of textile materials to impart desired properties with emphasis on the relationship of fiber structure and response of textiles to these processes.

Text. 4305. Chemical Preparation and Finishing of Textiles
3-0-3. Prerequisite: Texts. 3122 or Text. 4751 or consent of school.
The chemical, thermal and mechanical processes used in the preparation and finishing of fibers, yarns and fabrics.

Text. 4306. Dyeing and Printing
3-3-4. Prerequisites: Texts. 3122 or Text. 4751 or consent of school.
The application of dyes and pigments to fibers, yarns and fabrics.

Text. 4310. Textile Instrumental Analysis
2-3-3. Prerequisite: consent of school.
The theory and practice of modern instrumental methods as used in the analysis of textile chemicals with emphasis on spectroscopy, chromatography, colorimetry and differential thermal analysis.

Text. 4401. Introduction to Textile Literature
1-0-1.
Sources of textile information and an introduction to search techniques for the textile information system.

Text. 4402-3. Seminar
1-0-0, 1-0-0, 1-0-1 respectively. Prerequisite: senior standing. 4402-3 are prerequisites for 4404.
Presentations by invited speakers on new developments in textiles, job opportunities and graduate education.

Text. 4420. Analysis of Textile Materials
3-3-4. Prerequisite: Texts. 4200, 3122 or 4751, I.Sy. E. 3749 or consent of school.
Methods used in the textile industry for assessing the effects of process variables on the end use performance of textile products are examined.

Text. 4480. Problems in Production Supervision
0-3-1. Prerequisite: Text. 2180-1-2, 3480-1.
Supervision of the student operated enterprise production operations. Solving day to day problems in logistics, personnel relations and manufacturing technology.

Text. 4481. Advanced Problems in Textile Management
0-3-1. Prerequisite or corequisite: Text. 3483-4-5.
Supervision of one of the student operated enterprise's staff level departments.

Text. 4482. Product Innovation
0-3-1. Prerequisite or corequisite: Text. 4480.
The student is part of a small entrepreneur team developing new products for the student operated enterprise.

Text. 4483. Special Problems in Textile Industrial Operations
0-6-2. Prerequisite: Text. 3702 or consent of school.
Available to textile and non-textile students who want to engage in special projects which involve the personnel or facilities of the student operated enterprise.

Text. 4500. Technology of Carpet Manufacturing
3-0-3.
A study of materials and production systems used in carpet manufacturing. Carpet performance characteristics, dyeing, backcoating and nonwoven carpet manufacturing methods are examined.

Text. 4502. Fiber Reinforced Materials
3-0-3. Prerequisite: consent of school.
Principles and engineering behavior of flexible and rigid fiber reinforced composites. Topics include influence of matrix, interface and voids, fabrication, fracture and fatigue characterization, evaluation of specific composite systems.

Text. 4503. Science of Color
3-0-3. Prerequisite: Chem. 1102, Phys. 2113 or consent of school.
The physical, chemical and biological principles involved in perception, measurement and specification of color.

Text. 4504. Fiber Extrusion, Drawing and Texturing
3-0-3. Prerequisite: Texts. 3122, 4751 or consent of school.
Rheology, mechanics, energetics, kinetics, phase transitions and polymer structure in fiber formation by melt, dry, wet and reactive spinning, and drawing and texturing of fibers.

Text. 4505. Structure and Mechanics of Knit Fabrics
3-0-3. Prerequisite: Text. 3112 or consent of school.
The basic geometries of fabrics produced by warp and weft knitting, overall physical properties of knit fabrics and fabric stress distribution.

Text. 4750. Polymer Science and Engineering I
3-0-3. Prerequisite: Chem. 1102, Phys. 2113 or consent of school.
An introduction to the chemistry and structure of polymers. Polymerization processes, major polymer systems and methods of identification of polymers are presented. Also taught as Ch.E. 4750.

Text. 4751. Polymer Science and Engineering II
3-0-3. Prerequisite: Text. 4750 or Ch.E. 4750 or consent of school.
An introduction to the physical states and transitions, fabrication processes and mechanical properties of polymers. Also taught as Ch.E. 4751.

Text. 4752. Polymer Science and Engineering Laboratory
0-3-1. Prerequisite: Text. 4751 or Ch.E. 4751.
Experiments in polymerization, processing and property evaluation of polymers. Also taught as Ch.E. 4752.

Text. 4753. Survey of Pulp and Paper Technology
3-0-3.
The mechanical systems used in paper manufacture. Chemistry of pulp preparation and nonfibrous additives. Also taught as Ch.E. 4753.

Text. 4773. Paper Formation and Properties
3-0-3. Prerequisite: consent of school.
The processes in the fabrication of paper and paper products from pulp. The effects on paper properties of chemical and mechanical pretreatment of pulp. The measurement of paper properties. Also taught as Ch.E. and M.E. 4773.

Text. 4800-1. Special Topics
3-0-3. Each. Prerequisite: consent of school.
Studies of topics of current interest and concern to the textile industry.

Text. 4900-1. Special Problems
Credit to be arranged. Prerequisite: consent of school.
Special problems involving analytical and/or experimental investigations in the field of textiles.

Text. 6100. Advanced Fiber Science
3-0-3. Prerequisite: graduate standing.
Physical properties, mechanical properties and microstructure of textiles are examined and related to end-use performance.

Text. 6101. Textile Testing and Evaluation
3-3-4. Prerequisite: graduate standing.
Study of methods used to characterize properties that are important to an understanding of behavior of fibers, yarns and fabrics.

Text. 6200. Physical Methods of Investigating Textiles
3-6-5. Prerequisite: I.Sy. E. 3749, Text. 4420 or consent of school.
Study of modern techniques and instrumentation for the evaluation of physical properties of fibers, yarns and fabrics.

Text. 6201. Process Control in the Textile Industry
3-0-3. Prerequisite: Text. 6200 or consent of school.
Computer techniques are applied to problems in scheduling production equipment and in control of quality, inventories and production. Topics include interfacing, costs, programming.

Text. 6210. Dynamics of Fiber Processing Systems I
3-0-3. Prerequisite: Texts. 4200, 4201 or consent of school.
The dynamic interaction of fibers and fiber assemblies during processing is examined. The effects of fiber and bundle properties on processing variables are analyzed.

Text. 6211-2 Dynamics of Fiber Processing Systems II, III
3-0-3 each. Prerequisite: Text. 6210 or consent of school.
The dynamics of fabric forming mechanisms are examined. Weaving, knitting, sewing, heating and drying are typical processes which are considered.

Text 5300. Preparation and Reactions of Polymers
3-0-3. Prerequisite: Text. 4750, 4751.
A detailed treatment of the reactions involved in the synthesis of both man-made and natural polymers including preparative and degradative reactions in polymer systems.

Text 6320. Fundamental Aspects of Dyeing Processes
3-0-3. Prerequisite: Text. 4301 or 4306, 4751 or consent of school.
Models required for the interpretation of the dyeing behavior of textile materials are examined in order to provide useful semiquantitative descriptions of dye processes.

Text 6321. Chemical Technology of Stabilization Processes
3-0-3. Prerequisite: Text. 4302 or 4305, 4751 or consent of school.
A comprehensive treatment of finishing processes used in the textile industry to impart desirable end-use performance characteristics to textile materials.

Text 6400. Information Processes in Textile Science and Engineering
3-0-3. Prerequisite: Text. 3400 or consent of school.
Information aspects of textile science and technology; use of computers in acquisition, processing and utilization of information and knowledge in textile research and production.

Text 6750. Polymer Structure and Physical Properties I
3-0-3. Prerequisite: Text. 4751 or Ch.E. 4751 or consent of school.
Morphology and structure, linear and nonlinear viscoelasticity, anisotropic mechanical properties and yield and fracture behavior of polymers with applications to textile fibers and plastic products. Also taught as Ch.E. 6750.

Text 6751. Polymer Structure and Physical Properties II
3-0-3. Prerequisite: Text. 6750 or Ch.E. 6750.
Structure-property relationships of elastomers, reinforced plastics, fibers, foams and natural polymers emphasizing proteins and the composite nature of all polymers and polymeric materials. Also taught as Ch.E. 6751.

Text 7000. Master's Thesis
Text 7210. Recent Advances in Textile Manufacturing
3-0-3. Prerequisite: consent of school.
A detailed review of significant new processes, techniques and machines in the textile industry.

Text 7220. Fiber Mechanics
3-0-3. Prerequisite: Text. 4751 or consent of school.
The tensile, compressive, bending and torsional response of fibers. Fiber anisotropy and linear and nonlinear time dependent response are studied.

Text 7221. Mechanics of Linear Assemblies
3-0-3. Prerequisite: Text. 4202 or consent of school.
The tensile, bending and torsional response of continuous filament, staple and blended singles yarns, the tensile response of pleated yarns, cords and ropes, the tensile response of braided cords.

Text 7222. Mechanics of Planar Assemblies
3-0-3. Prerequisite: Text. 7221.

Text 7310. Polymer Degradation
3-0-3. Prerequisite: Text. 4750, 4751 or consent of school.
A study of the physical and chemical changes in polymeric materials exposed to hostile environments during processing and use.

Text 7311. Polymer Synthesis
3-0-3. Prerequisite: consent of school.
The industrial chemistry of dyes and their intermediates is covered. Structure is related to color, fastness and affinity. Lawton nomenclature and recent patents are surveyed.

Text 7400. Information Processes in Textile Science and Engineering
3-0-3. Prerequisite: consent of school.
Informational aspects of textile science and technology; use of computers in acquisition, processing and utilization of information and knowledge in textile research and production.

Text 7750. Surface and Solution Properties of Polymers
3-0-3. Prerequisite: consent of school.
Study of plasticized polymers, solutions and colloids; sorption, polymer characterization, interfacial phenomena and coagulation using thermodynamics, statistical mechanics, information and fluctuation theories and relaxation methods. Also taught as Ch.E. 7750.

Text 7751. Energetics
3-0-3. Prerequisite: consent of school.
Energetics applied to polymers and fibers using Newtonian mechanics, thermodynamics, statistical thermodynamics and quantitative mechanics to relate macroscopic and molecular descriptions of processes and materials.

Text 7752. Kinetics
3-0-3. Prerequisite: consent of school.
Kinetics applied to polymers and fibers including fluid flow, viscoelasticity, heat transfer, diffusion, electrical conductivity, rates of chemical reactions and phase changes and irreversible thermodynamics.

Text 7753. Polymer Flow
3-0-3. Prerequisite: Text. or Ch.E. 6750 or consent of school.
The fluid mechanics, heat transfer and mixing of non-Newtonian fluids. Experimental methods for characterizing fluids and the extrusion of polymer melts are emphasized. Also taught as Ch.E. 7753.

Text 7999. Preparation for Doctoral Qualifying Exams
Text 8000-1-2. Seminar
1-0-0 each.
Text 8100-1-2. Special Topics in Textile Science and Engineering
3-0-3 each. Prerequisite: consent of school.
Topics of current interest in textile science and engineering.

Text 8500-1-2. Special Problems in Textiles and Textile Engineering
Credit to be arranged.

Text 9000. Doctoral Thesis
Student Rules and Regulations


I. General

These regulations are intended to set forth the requirements of the faculty to the end that a large student body may live and work together harmoniously with a minimum of friction and misunderstanding. Each student is expected to be a law-abiding citizen and to obey the laws of the city of Atlanta, Fulton County, the state of Georgia and the United States.

II. Responsibility For Notices

Every student will be required to have a box in the post office of the Georgia Institute of Technology which will be his or her official address, and he or she is expected to check this box each school day. Students are also expected to be aware of the contents of the general notices which appear in The Technique.

Change of address. Students are responsible for reporting changes of residential address, within one week's time, to the Office of the Registrar.

III. Attendance

A. General

1. Classes begin at five minutes after the hour and end at five minutes before the hour.
2. If an instructor should be late in meeting his or her class, the students shall wait for him or her until 20 minutes after the hour. If the instructor has not arrived by that time, they may leave unless specifically notified to await his or her arrival.
B. Class attendance
There are no formal institutional regulations regarding class attendance at the Georgia Institute of Technology. The resources of the institute are provided for the intellectual growth and development of the students who attend. A schedule of courses is provided for the students and faculty to facilitate an orderly arrangement of the program of instruction. The fact that classes are scheduled is evidence that attendance is important and students should, therefore, maintain regular attendance if they are to attain maximum success in the pursuit of their studies.

It is recognized that the degree of class attendance may vary with the student, the instructor or the course. It is also recognized that, on occasions, it may be necessary for the student to be absent from scheduled classes or laboratories for personal reasons. On such occasions, all matters related to the student's absences, including the making up of work missed, are to be arranged between the student and the instructor.

All instructors will, at the beginning of each quarter, make a clear statement to all their classes regarding their policies in handling absences. Instructors will also be responsible for counseling with their students regarding the academic consequences of absences from their classes or laboratories.

Students must not be absent from announced quizzes, laboratory periods, or final examinations unless the reasons for the absences are acceptable to the instructors concerned. Students should also understand that they are responsible for all material covered during their absences and that they are responsible for the academic consequences of their absences.

Students who are absent because of participation in approved institute activities (such as field trips and athletic events) will be permitted to make up work missed during their absences. Approval of such activities will be granted by the student academic and financial affairs committee of the academic senate and statements of the approved absences may be obtained from the Office of the Registrar.

C. Absence from city
Students who leave the city for more than four days, except for official school holidays, must inform the dean of students before their departure.

IV. Grades
Final grades are reported to the registrar at the end of each term. The grades for completed courses used in the calculation of scholastic average are the following:

A—excellent (four quality points)
B—good (three quality points)
C—satisfactory (two quality points)
D—passing (one quality point)
F—failure, must be repeated if in a required course (no quality points)

The following grades will be used in the cases indicated and will not be included in the calculation of scholastic average.

P—passing of a course taken under pass-fail or completion of a course in which no other letter grade may be assigned.
U—failure of a course taken under pass-fail or unsatisfactory performance in a course in which no letter grade may be assigned and must be repeated if in a required course.
V—assigned when the course has been audited. No credit given. Implies no academic achievement on the part of the student and cannot be changed to W or serve as the basis for credit by examination at any future date.

The following grades will be used in the cases indicated.
I—incomplete. Assigned when a student is incomplete in some part of the course for reasons deemed satisfactory by the instructor, or is absent from the final examination for reasons deemed satisfactory by the instructor. If the student's record is so poor as to preclude his or her passing, the instructor shall assign the grade of F.
W—out before the end of the fifth week. This symbol indicates that a student was permitted to withdraw without penalty. Withdrawals without penalty will not be permitted after the fifth week except in cases of hardship as determined by the registrar. Students who withdraw from school and receive all grades of W will not ordinarily be permitted to reenroll the next succeeding quarter.

Errors in grades must be reported to the Office of the Registrar immediately. In general, no changes will be made after the end of the student's next quarter in residence.

V. Deficiencies
A. General
1. A student who has received a grade of I, F or U in a course has a deficiency in the course.
2. A student whose final grade is F or U has a failure in that course. He or she must repeat and pass the course in class before credit will be allowed. (See B.4. below)

B. Removal of deficiencies
1. An incomplete in a course must be removed and the grade change reported to the registrar not later than the end of student's next quarter of residence.
2. The grade of I will not be counted in the computation of the student's point average at the end of the quarter in which he or she received the grade, nor in any quarter immediately following in which he or she is not enrolled. If the I is not removed and the change of grade reported by the end of the student's next quarter in residence, the grade of I will remain as part of the student's permanent record and be counted thereafter as an F in the computation of point average.
3. A student who has a failure in a required course must schedule that course the next time it is offered while he or she is in residence.
4. A senior who has a single deficiency between him or her and graduation will be permitted one reexamination not later than 72 hours before commencement exercises and thereafter one examination per annum until the deficiency is removed, with the dates of the annual periods beginning 30 calendar days after the end of the final quarter of residence. The reexami-
nation will be graded S or U and grade so recorded. The previously assigned F will remain a part of the record.
5. A senior who has otherwise completed all requirements for graduation and who has an incomplete in laboratory work taken during his or her final quarter in residence may remove the incomplete at the convenience of the department of instruction concerned.

VI. Scholastic Regulations

A. General
1. Academic standing is based on the quarter credit hour system. One quarter credit hour corresponds to one hour per week of classroom work for a quarter or to three clock hours of laboratory work per week for a quarter.
2. Quality points are assigned as follows.
   - A — four points
   - B — three points
   - C — two points
   - D — one point
   - F — no points.

B. Classification of students
1. Undergraduate students shall be classified at the end of each quarter by the Office of the Registrar on the basis of the number of quarter credit hours they have passed in accordance with the following schedule.
   - Freshman — 0–45 credit hours
   - Sophomore — 46–90 credit hours
   - Junior — 91–136 credit hours
   - Senior — 137– graduation

   A student who has completed all requirements for a particular classification as defined by his or her major department may petition for reclassification through his or her major department.

2. Students scheduled for 12 credit hours or more are classified as full-time students.

C. Change of major

Students, by filing the required form, will be permitted free transfer, as space permits, between schools during their first quarter at Georgia Tech. Thereafter, by filing the required form, transfer will be permitted if the student is not on academic warning or probation and not subject to disciplinary action. Students not entitled to free transfer may transfer at the discretion of the school they wish to enter.

D. General requirements

The institute reserves the right to drop from the rolls at any time a student whose record in scholarship is unsatisfactory. The following specific regulations are in addition to this general ruling.

E. Scholastic standing

1. Scholastic average. The scholastic standing of a student shall be determined by his or her scholastic average calculated as the ratio of the total number of quality points earned to the total number of quarter credit hours in which a final grade has been assigned.
2. Dean's list. The institution encourages excellence in scholarship and gives official recognition to students whose work is superior by publishing the dean's list at the end of each academic quarter. The dean's list includes all students who have, during the preceding quarter, made an academic average of 3.0 or higher, carried a load of at least 12 hours of course work on a credit basis and are not on academic warning or probation or subject to any disciplinary action.
   a. A senior who has otherwise completed all requirements for graduation and who has an incomplete in laboratory work taken during his or her final quarter in residence may remove the incomplete at the convenience of the department of instruction concerned.
   b. The record of a student on academic probation whose overall scholastic average is satisfactory but whose quarter average is unsatisfactory may be reviewed by the undergraduate curriculum committee, which may dismiss the student or continue him or her on academic probation.
4. Good academic standing. A student not on academic warning or probation is in good academic standing and may schedule up to 23 credit hours with the approval of his or her school.
5. Academic warning. A student who has an overall scholastic average below the minimum satisfactory scholarship requirement, or whose scholastic average for work taken during any quarter is below this requirement, shall be placed on academic warning and shall be limited to a maximum schedule load of 16 credit hours.
6. Academic probation. A student on academic warning whose scholastic average is below the minimum satisfactory scholarship requirement for any quarter shall be placed on academic probation and shall be limited to a maximum load of 14 credit hours.
7. Dismissal for unsatisfactory scholarship.
   a. A student on academic probation whose scholastic average for the quarter of probation is below the minimum satisfactory scholarship requirement and whose overall scholastic average is below the minimum satisfactory scholarship requirement shall be dismissed for unsatisfactory scholarship and dropped from the rolls.
   b. The record of a student on academic probation whose overall scholastic average is satisfactory but whose quarter average is unsatisfactory may be reviewed by the undergraduate curriculum committee, which may dismiss the student or continue him or her on academic probation.
8. Academic review. A student who normally would be dropped from the rolls for academic deficiencies but appears from the record not to have completed the quarter may be placed on academic review. This is a temporary standing which makes the student ineligible for registration. If no acceptable explanation is given within a reasonable time, the standing is changed to drop.
9. Part-time students. These regulations do not necessarily apply to students receiving grades in less than 12 credit hours. The academic standing
of these students may be determined by the undergraduate curriculum committee based on individual merit in each case.

F. Readmission

1. A student who for any reason has remained out of school one or more quarters excluding the summer quarter must apply for readmission. This application, with any pertinent supporting information, must be submitted to the registrar at least 20 days before the registration date for the quarter for which admission is requested.

2. A student who is dropped for unsatisfactory scholarship will ordinarily not be readmitted, and in no case shall his or her application for readmission be considered unless he or she has remained out of the institute for one regular quarter. (The summer session is considered here to be a regular quarter.)

3. Course work pursued at another institution after dismissal from Georgia Tech for unsatisfactory scholarship may be considered in evidence of readmissibility. If readmitted, a student will not necessarily be given transfer credit for work taken at another institution after dismissal from Georgia Tech for unsatisfactory scholarship. In no case will credit be allowed (except by examination) for courses completed at another institution that have previously been failed at Georgia Tech.*

4. A student who has been dropped a second time for unsatisfactory scholarship will not be readmitted unless approved by the undergraduate curriculum committee.

*Note: Students who have attended another college should plan their readmission so as to allow ample time for official transcripts from other colleges to be sent to Georgia Tech. If official transcripts have not been received prior to the last day of registration, the student seeking readmission will not be allowed to complete registration.

G. Exceptions

Exceptions to the scholastic regulations may be made by the undergraduate curriculum committee or the graduate committee, as appropriate, whenever a consideration of the student's complete record indicates that the application of a specific regulation will result in injustice.

VII. Scheduling

1. Each student is strongly advised each quarter to schedule all prerequisite courses possible, and should schedule all other back courses before scheduling any advanced courses.

2. In dropping courses from his or her schedule, a student must retain back courses in preference to advanced courses, unless permission is otherwise obtained from his or her school director.

3. The scheduling of back courses is the responsibility of the student, and he or she will be held accountable therefor.

4. (a) The normal load scheduled by an undergraduate student in good standing should not exceed 21 credit hours. However, in exceptional cases, a total of 23 credit hours may be scheduled with the approval of his or her school. Any hours above 23 must have prior approval of the undergraduate curriculum committee. (b) Students on academic warning may schedule up to 16 credit hours with the approval of their school. Any hours above 16 must have prior approval of the undergraduate curriculum committee.

5. Auditing of courses will be permitted to a regularly enrolled student who has obtained the approval of his or her adviser and of the departments concerned. Such courses count at full value in computing the student's load. No credit is granted for courses scheduled on an auditing basis, and students are not permitted to change to or from an auditing status except through the regular procedures for schedule changes. The grade for auditing is V (visitor) and this grade should at no time be changed to W on the basis of the auditor's attendance in the course. The grade V will have no effect upon the student's grade point average and students will not be permitted to receive credit at any future date for their participation in a course as an auditor.

6. No course may be repeated for course credit toward a degree in which the student has been assigned a grade of C or better.

VIII. Midterm Deficiency Reports

At the end of the sixth week of each quarter instructors will report to the Office of the Registrar the names and grades of all students in freshman (1000 series) courses whose work is not passing at that time.

IX. Examinations

A. General

All reexaminations, examinations for advanced standing and special examinations must be authorized by the registrar before being scheduled. If the instructor considers it necessary, at the beginning of each examination, a student may be required to present his or her student identification card to the instructor or his or her authorized representative.

B. Examinations for advanced standing

1. A student who offers satisfactory evidence that he or she is qualified to do so may receive credit for a course by examination. Such an examination is called an examination for advanced standing.

2. Examinations for advanced standing must be authorized by the registrar upon the recommendation of the department of instruction in which the course is offered.

3. An examination for advanced standing will be reported with an S or U grade. Neither grade will be included in the calculation of the scholastic average.

4. Examinations for advanced standing will ordinarily be offered during the week of final examinations.

5. For the privilege of taking an examination for advanced standing, a student will be charged the appropriate fee.

6. A student will not be allowed to take an examination for advanced standing in a given course more than twice.
C. Examinations for degree candidates

Students who are candidates for a degree will be exempted from final examinations in those courses required for graduation during final examination week at the end of the quarter immediately preceding commencement. Final examinations in other courses may be required.

D. Regulations covering final examinations

A student reporting to a final examination room more than 15 minutes after the hour shall not be allowed to take the examination, unless he or she can present a satisfactory explanation to the instructor conducting the examination. If unable to present an explanation satisfactory to the instructor, he or she shall receive an I.

X. Degrees

A. Regulations concerning degrees

1. To be considered for admission to candidacy for a degree, a student must make a formal petition for the degree during the quarter preceding his or her final quarter in residence.
2. To be a candidate for a degree, an undergraduate student must have passed all courses required for the degree, must have a scholastic average for his or her entire academic program of at least 2.0, and must have done creditable work in his or her departmental courses so as to merit the recommendation for the degree by the director and faculty of his or her school.
3. A student, with the approval of his or her school of specialization, may satisfy the requirements for an undergraduate degree by meeting all of the requirements listed in any one of the catalogs in effect during the period of his or her enrollment in the institute. A given catalog is in effect for a given student only if the student's date of matriculation is prior to the ending date of the spring quarter shown in the calendar printed in the catalog concerned.
4. No student may be considered a candidate for a degree unless the final 50 credit hours required for the degree are earned in residence at Georgia Tech.
5. All undergraduate degree candidates must have satisfied the Regents Testing Program, the state history and constitution requirement and the major area examination requirement before the degree will be conferred.
6. The diploma of a candidate for a degree shall bear the date of the commencement at which the degree is awarded.
7. For graduation with highest honor the minimum scholastic average shall be 3.6. For graduation with high honor the minimum scholastic average shall be 3.4. For graduation with honor the minimum scholastic average shall be 3.2. A student must have earned at least 100 credit hours at Georgia Tech to graduate with highest honor, with high honor or with honor.
8. No work may be counted toward a degree which has been completed more than 10 years prior to the time at which the degree is to be awarded, unless this work is validated by an examination.

B. Second undergraduate degree

1. A student enrolled for a second undergraduate degree shall be classified an undergraduate student.
2. To be a candidate for a second undergraduate degree, a student must have the recommendation of the director of the school concerned and the approval of the undergraduate curriculum committee.
3. To obtain a second undergraduate degree, a student must complete all major required courses for the degree and earn credit for a total of at least 50 credit hours in excess of the requirement for any previous degrees earned.
4. All regulations outlined in section X.A. above must be followed by students completing second degrees.

XI. Conduct

A. Student Conduct Code

A student enrolling in the Georgia Institute of Technology assumes an obligation to conduct himself or herself in a manner compatible with the institute's function as an educational institution. Actions considered inimicable to the institute and subject to discipline fall into the categories of academic and nonacademic misconduct.

1. Academic Misconduct. Academic misconduct is any act or acts on the part of or in behalf of any student, which does or could improperly distort student grades or other student academic records. Students are prohibited from:
   a. possessing, using or exchanging written or verbal information not authorized by the instructor in the preparation of any essay, laboratory report, examination or other assignment included in an academic course.
   b. unauthorized collaboration with, or substitution for, a student in the commission of their academic requirements.
   c. submission of material which is wholly or substantially identical to that created or published by another person or persons, without adequate credit notation indicating the authorship (plagiarism),
   d. false claims of credit for work which has not been submitted by the claimant,
   e. alteration or insertion of any academic grade or rating so as to obtain unearned academic credit,
   f. willful falsification of a written or verbal statement of fact to a member of the faculty so as to obtain unearned academic credit, and
   g. forgery, alteration or misuse of any institute document relating to the academic status of the student.
2. Nonacademic Misconduct. Nonacademic misconduct includes the following specifically prohibited acts whenever, unless otherwise stated, such acts occur on institute owned or controlled property or institute related premises:
   a. Alcohol
      (1.) Conspicuous or flagrant possession of alcoholic beverage.
      (2.) Intoxication made manifest by boisterousness, rowdiness, obscene or indecent conduct or appearance, or vulgar, profane, lewd or unbecoming language.
   (3.) Disorderly conduct associated with the use of alcoholic beverages.
   b. Physical Abuse of Other Persons.
      (1.) No student shall push, unjustifiably strike or physically assault, or otherwise intentionally threaten or endanger the person or any member of the faculty, administration, staff or student body or any visitor to the campus.
c. Disorderly Conduct
   (1.) Breach of the peace or obstruction or disruption of teaching, research, administration, disciplinary procedures or other institute activities, including its public service functions or other authorized activities.
   (2.) Refusal to vacate a building, street, sidewalk, driveway or other facility when directed to do so by any properly identified institute faculty, administration or staff personnel while these are in the performance of their duties.
   (3.) Lewd, indecent or obscene conduct or expression.
   (4.) Failure to comply with instructions or directions of any properly identified faculty, administration or staff personnel while these persons are acting in the performance of their duties.

d. Drugs
   Use or possession (without valid medical or dental prescriptions), manufacture, furnishing, sales or any distribution of any narcotic or dangerous drug controlled by law. This provision is not intended to regulate alcoholic beverages, which are covered by section 2a.

   e. Entry or Use of College Facilities
   (1.) Unauthorized entry into any institute building, office or other facility, without authorization, or remaining in any building after normal closing hours.
   (2.) Unauthorized use of any institute telephone facility or of any other institute facilities.
   (3.) Possessing, using, making or causing to be made any key or keys for any institute facility without proper authorization.
   (4.) Unauthorized use of another student or faculty member's password to gain access to the computer or computer output. This includes but is not limited to any knowing and willing use of fraudulent means to process computer programs and access computer files.
   f. False Information and Record Falsification
   (1.) Furnishing false information to any institute official, or offering false statement in any institute disciplinary hearing.
   (2.) Forgery, alteration or misuse of any institute document, record or identification.
   g. Hazing.
   Any act which tends to occasion or allow physical or mental suffering in connection with rites or ceremonies of induction, initiation or orientation into institute life or into the life of any institute group or organization.
   h. Repeated Violations
   Repeated violations of these or other published rules or regulations of the institute, which cumulatively indicate an unwillingness or inability to conform to the standards of the institute for student life.

   i. Safety
   (1.) Intentionally false reporting of a fire, or that a bomb or other explosive has been placed in any institute building or elsewhere on institute property.
   (2.) Tampering with fire-fighting equipment, safety devices or other emergency or safety equipment.
   (3.) Setting an unauthorized fire.
   (4.) Possession of unauthorized fireworks, firearms, ammunition or dangerous weapons or materials.

(5.) Unauthorized sale, possession, furnishing or use of any incendiary device or bomb.
(6.) Use of smoking tobacco, in any form, in facilities or areas posted with “No Smoking” signs, or where smoking has been prohibited by any faculty member or other official.

j. Theft
   (1.) Theft of property of the institute or property of a member of the institute community or campus visitor.
   (2.) Unauthorized possession of institute property, or property of a member of the institute community or campus visitor.

k. Property Damage
   Malicious or unauthorized damage or destruction to institute property, or property belonging to any member of the institute community or campus visitor.

l. Complicity
   Knowingly act in concert with any other person to perform an unlawful act or to violate an institute regulation or policy.

m. Residence
   Violation of rules governing residence in institute owned or controlled property (dormitories, family housing, fraternities, organizations, etc.).

n. Gambling
   Playing of cards or any other games of skill or chance for money or other items of value.

o. Student Delinquencies—Financial, Records, Property
   Failure to remit, return or submit financial obligations, property or records of the institute, within the time prescribed by the institute.

p. Law Violations and Off-Campus Violations of the Student Conduct Code Occurring Outside Institute-owned, or Controlled, or Related Premises

q. Violations of the Georgia Tech Motor Vehicle Regulations

r. Campus Disruption

   Violation of the Regents Statement of Disruptive Behavior, the full text of which is given in Section C.

B. Disciplinary Administration

1. Disciplinary Procedures.
   a. All acts of misconduct (excepting violations of motor vehicle regulations) on the part of students shall be reported to the dean of students, who is designated the principal administrator to enforce institute disciplinary measures as they pertain to student academic and nonacademic misconduct.
   b. The dean of students shall cause to be investigated alleged acts of student misconduct. The dean may appoint a staff member(s) to conduct an inquiry into alleged misconduct act(s) and the appointed member(s) shall recommend to the dean of students what further action, if any, might be initiated. When additional action is indicated, the dean of students shall no-
ify the accused student(s) in writing. Cases of academic misconduct are referred to the student honor committee through the hearing body chairman. Cases of nonacademic misconduct are referred to the graduate judiciary or undergraduate judiciary cabinet through the hearing body chairman.

When written notification is made by the dean of students to a student(s) for alleged academic misconduct or nonacademic misconduct, it shall contain a statement of the nature of the alleged or suspected misconduct, and state the section(s) of the conduct code the student(s) is alleged to have violated.

d. The dean of students or the dean’s authorized representative will normally confer with the accused student(s), and at this conference the student(s) may admit or deny the alleged violation, the student(s) may waive further hearing(s) and appeal(s) in writing and request that the dean of students take appropriate action, or he or she may request a hearing as specified in e, f or g below.

e. Cases of academic misconduct will normally be referred to the student honor committee, which shall hear and try cases involving academic misconduct on the part of any student(s).

f. Cases of serious nonacademic misconduct which may result in suspension of expulsion will normally be referred to the graduate judiciary or undergraduate judiciary cabinet, which shall hear and try these cases. (This does not preclude possible legal actions by appropriate law enforcement agencies in those cases of nonacademic misconduct in violation of federal, state or local law).

g. If the case does not involve possible suspension or expulsion, the dean of students ordinarily shall make full disposition of the case except that he or she shall not at the request of the accused, or for good cause may, refer any case of nonacademic misconduct to the graduate judiciary or undergraduate judiciary cabinet.

h. A student(s) accused of an act(s) of misconduct is encouraged to notify his or her parents or guardian of the charge(s). Parents or guardian will, if requested, be granted a conference with the dean of students prior to the hearing.

i. An accused student(s) will continue to attend classes and required institute functions until the hearing is held and a decision is rendered. Exceptions to this will be made when the student(s)’ presence may create a clear and present danger of materially interfering with the institute’s normal operations or the requirements of appropriate institute discipline. In such cases, the dean of students may impose temporary protective measures, including interim suspension, pending the hearing; such protective measures, if applied, will be without reasonably avoidable prejudice to the student(s).

2. Student Honor Committee.

a. The student honor committee shall consist of four members of the corps of instruction elected from the academic senate and two undergraduate students with at least junior standing elected by the student council and one graduate student elected by the graduate student senate. The chairman shall be elected annually by the committee from among the academic senate members. The secretary shall be appointed by the chairman.

b. The committee shall hear and try all cases referred to it involving alleged dishonesty in academic matters on the part of students. The decision in the case shall be transmitted to the office, or offices, responsible for recording it, for notifying the student officially and for implementing the action.

c. In its distributed minutes and in the annual report of its activities and findings, the committee shall preserve the anonymity of individuals by generalizing the issues involved and the actions taken.

3. Student Judiciary.

a. The graduate judiciary shall consist of a graduate student chairman and six graduate student justices. The graduate student justices and chairman shall be currently enrolled, full-time graduate students in good standing who are appointed by the graduate student body president and approved by the graduate student senate. The graduate judiciary shall normally hear all cases of graduate student nonacademic misconduct in which there is the possibility of suspension or expulsion of the accused student.

b. The undergraduate judiciary cabinet shall consist of an undergraduate student chairman and 10 undergraduate student justices. The undergraduate student justices and chairman shall be currently enrolled, full-time, undergraduate students in good standing who are appointed by the student body president and approved by the student council. The undergraduate judiciary cabinet shall normally hear all cases of undergraduate student nonacademic misconduct in which there is the possibility of suspension or expulsion of the accused student.

4. Procedural Rights of Accused

a. A student(s) accused of an act(s) of misconduct and summoned to a hearing before the student honor committee, graduate judiciary or judiciary cabinet shall have the right to:

(1.) be accompanied by an adviser of his or her choice,
(2.) remain silent with no inference of guilt drawn therefrom,
(3.) question the complainant,
(4.) present evidence in his or her behalf,
(5.) call pertinent witnesses in his or her behalf,
(6.) cross-examine witnesses.

b. In undergraduate judiciary cabinet hearings the accused may challenge and unseat as many as four student justices (the chairman cannot be struck; a quorum of six student justices and the chairman must remain) and appeal.

5. Hearing Procedures.

a. The chairman of the hearing body shall set the date, time and place of the hearing, shall notify the members of the hearing body and summon all principals in the case (defendants and witnesses).

b. In cases referred to the student honor committee, graduate judiciary or undergraduate judiciary cabinet, the chairman shall notify the accused student(s) in writing at least three days in advance of the scheduled hearing. The written notification should, if reasonably possible, be hand-delivered; if not reasonably possible, notification should be by registered mail to the student's local address. The written notification should specify:

(1.) The date, time and place of the hearing.
(2.) A statement of the nature of the alleged or suspected misconduct with which he or she is accused, with sufficient particularity to ensure opportunity to prepare for the hearing.
(3.) Names of witnesses scheduled to appear.

b. Decisions of the hearing body shall be by majority vote. A quorum for
the student honor committee shall consist of five members, three faculty members and two students. A quorum for the undergraduate judiciary cabinet shall consist of the chairman and six justices. A quorum for the graduate judiciary shall consist of the chairman and four justices.

d. Any member of the hearing body shall disqualified himself or herself if his or her personal involvement in the hearing is of such a nature as to prejudice the case.

e. The hearings of the student honor committee, graduate judiciary and undergraduate judiciary cabinet shall ordinarily be closed except for the accused and his or her adviser and those directly involved; exceptions may be made at the discretion of the chairman. The hearing body may exclude any person who may be reasonably expected to interfere materially with the hearing or who does interfere materially with the hearing. Hearing body deliberations are closed to all but the hearing body members.

f. The hearing body shall make a tape recording and/or summary transcription of the proceedings.

g. The hearing body shall provide a brief written summary of each case with recommendations for appropriate disciplinary action to the dean of students and to the student(s) involved.

h. The dean of students will review the case and recommendations and implement disciplinary action.


   a. For violations of institute rules and regulations or for acts of student misconduct, academic or nonacademic, the following disciplinary measures may be taken. (This list shall not be taken to be exhaustive and may be enlarged or modified to meet particular circumstances in any given case.)

   (1.) Expulsion—permanent severance of the student's relationship with the institute.

   (2.) Disciplinary suspension—temporary severance of the student's relationship with the institute for a specific period of time, though not less than one quarter.

   A student expelled or suspended shall leave the campus and not visit the campus during the period of suspension or expulsion, except when on official school business. To violate this stipulation would affect adversely the student's chances for readmission.

   (3.) Disciplinary probation—notice to the student that any further major disciplinary violation may result in suspension; disciplinary probation might also include either or both of the following: the setting of restriction, the issuing of a reprimand. A student on disciplinary probation is not in good standing, and shall not be permitted to hold any elective or appointive office in extracurricular activities, or participate in any contest, performance or activity to which the general public is invited.

   (4.) Reprimand

   Oral reprimand—an oral disapproval issued to the student.

   Letter reprimand—a written statement of disapproval to the student.

   (5.) Restrictions—exclusion from enjoying or participating in:

   (a.) Social activities

   (b.) Identification card privileges

   (6.) Fines

   (7.) Restitution—reimbursement for damage to or misappropriation of property; this may take the form of appropriate service or other compensation.

   (8.) Forced withdrawal—from the academic course within which the offense occurred without credit for the course.

   (9.) Change in grade—for the course in which the offense occurred.

7. Appeal Procedures.

   a. If an accused or an accuser is dissatisfied with the action taken by the dean of students, he or she may appeal the case in writing to the president of Georgia Tech within five days after the action about which there is a complaint. Such appeal shall recite all reasons for dissatisfaction with the previous decision.

   b. The president, within five days, shall refer the appeal to the student grievance and appeal committee. This committee shall review all facts and circumstances connected with the case and shall within five days make its findings and report thereon to the president. After consideration of the committee's report, the president shall within five days make a decision which shall be final so far as the institute is concerned.

   c. The student grievance and appeal committee shall consist of three members of the corps of instruction elected from the academic senate and two students with at least junior standing elected jointly by the student council and the graduate senate. The chairman shall be elected annually by the committee from among the elected academic senate members. The secretary shall be appointed by the chairman.

   d. The Board of Regents of the University System of Georgia is the final appellate authority for all cases involving students who have been suspended or expelled. Should the aggrieved person be dissatisfied with the decision of the president he or she may appeal the case in writing to the board of regents, without prejudice to his or her position, for a review of the decision. The application for review shall be submitted in writing to the executive secretary of the board within a period of 20 days, following the decision of the president. This application for review shall state the decision complained of and the redress desired. A review by the board is not a matter of right, but is within the sound discretion of the board. If the application for review is granted, the board, or a committee of the board, shall investigate the matter thoroughly and render its decision thereon within 60 days from the filing date of the application for review or from the date of any hearing which may be held thereon. The decision of the board shall be final and binding for all purposes.

C. Regent's Statement on Disruptive Behavior

The following is the policy of the board of regents regarding disruptive behavior in any institution of the university system. The rights, responsibilities and prohibitions contained in this statement are incorporated as a part of these regulations.

The Board of Regents of the University System of Georgia reaffirms its policies to support fully, freedom of expression by each member of the academic community and to preserve and protect the rights and freedom of its faculty members and students to engage in debate, discussion, peaceful and nondisruptive protests and dissent. The following statement relates specifically to the problem described below. It does not change or in any way infringe upon the board's existing policies and practices in support of freedom of expression and action. Rather, it is considered necessary to combat the ultimate effect of irresponsible disruptive and obstructive ac-
tions by students and faculty which tend to destroy academic freedom and the institutional structures through which it operates.

In recent years a new and serious problem has appeared on many college and university campuses in the nation. Some students, faculty members and others have engaged in demonstrations, sit-ins and other activities that have clearly and deliberately interfered with the regular and orderly operation of the institution concerned. Typically, these actions have been the physical occupation of a building or campus area for a protracted period of time or the use or display of verbal or written obscenities involving indecent or disorderly conduct.

These actions have gone beyond all heretofore recognized bounds of meetings for discussion, persuasion or even protest in that: (1) acquiescence to demands of the demonstrators is the condition for dispersal and (2) the reasonable and written directions of institutional officials to disperse have been ignored. Such activities thus have become clearly recognizable as an action of force, operating outside all established channels on the campus, including that of intellectual debate and persuasion which are at the very heart of education.

The board of regents is deeply concerned by this new problem. Under the Constitution of the state of Georgia, under all applicable court rulings and in keeping with the tradition of higher education in the United States, the board is ultimately responsible for the orderly operation of all institutions of the university system and the preservation of academic freedom in these institutions. The board cannot and will not divest itself of this responsibility.

Of equal or even greater importance, such action of force as has been described above destroys the very essence of higher education. This essence is found in the unhampered freedom to study, investigate, write, speak and debate on any aspect or issue of life. This freedom, which reaches its full flowering on college and university campuses, is an essential part of American democracy, comparable to the jury system or the electoral process.

For these reasons and in order to respond directly and specifically to this new problem the board of regents stipulates that any student, faculty member, administrator or employee, acting individually or in concert with others, who clearly obstructs, disrupts or attempts to obstruct or disrupt any teaching, research, administrative, disciplinary, public service activity or any other activity authorized to be discharged or held on any campus of the University System of Georgia is considered by the board to have committed an act of gross irresponsibility and shall be subject to disciplinary procedures, possibly resulting in dismissal or termination of employment.

The board reaffirms its belief that all segments of the academic community are under a strong obligation and have a mutual responsibility to protect the campus community from disorderly, disruptive or obstructive actions which interfere with academic pursuits of teaching, learning and other campus activities.

The board of regents understands that this policy is consistent with resolutions adopted by the American Association of University Professors in April 1968, by the Association of American Colleges in January 1968 and by the executive committee of the Association for Higher Education in March 1968 condemning actions taken to disrupt the operations of institutions of higher education.

XII. Withdrawal From School

A. General

1. No student under 18 years of age will be allowed to withdraw from school before the official close of a quarter, unless he or she first presents, with his or her formal resignation, written permission to the effect from his or her parents or guardian. A student over 18 years of age may withdraw upon the submission of a formal resignation. A student who withdraws without notice is not entitled to an honorable dismissal.

2. A student withdrawing from school should obtain the proper forms from the Office of the Registrar and comply with the instructions therein.

3. Students who withdraw from school and receive all grades of W will not ordinarily be permitted to enroll the next succeeding quarter.

4. Students may withdraw from school during the first five weeks of the quarter without penalty. Withdrawals will not be permitted after the fifth week except in cases of demonstrated and verified hardship. Requests for readmission must be filed with the registrar at least 20 days before the registration date of the quarter for which readmission is requested.

B. Exceptions

This regulation does not apply to those instances where a student has completed attendance for an official school quarter and does not register for the succeeding quarter.

XIII. Student Motor Vehicles

Students desiring to operate motor vehicles on campus are subject to all rules set forth by the Georgia Tech motor vehicle regulations.

XIV. Medical Regulations

A. General

No student with a contagious disease may stay in a dormitory or fraternity house or attend class. Any illness with fever should be considered a contagious disease until checked by a physician. Every student is held individually responsible for reporting such illness immediately to the infirmary.

B. Health Information Record

Health information record and consent-for-treatment forms are mailed to students with the notice of their acceptance for enrollment. These forms are to be completed by the prospective student and his or her parents or guardians and mailed to the director of health in sufficient time to be received prior to the date of initial registrations. After review of the health information record, the school physicians shall determine the qualifications for physical training. Any student who desires special consideration because of mental or physical disability should have his or her physician write an explanatory letter to the director of health giving full details of the disability and any desired limitations on physical activity. This letter is to be attached to the
health information record. Any special examinations or reports needed to determine eligibility for enrollment or assignment are at the expense of the student, not the school.

C. Infirmary regulations

Students must conform to infirmary regulations, as posted in the infirmary, while confined as patients in the infirmary.

XV. Physical Education

All students entering Georgia Tech are required to satisfactorily complete three credit hours in physical education courses. It is expected that this requirement will be completed during the student’s freshman year. Unless medically disqualified, all students will be required to complete swimming (P.E. 1010) plus two additional courses. One of these must be selected from the remaining courses at the 1000 level and one must be selected from the 2000 level.

The health information record will determine any medical exemptions from physical education courses. All certificates of disability from personal physicians must be endorsed by the Student Health Services before they will be accepted by the department.

Students who are exempt for medical reasons from all physical education activity courses will be required to satisfactorily complete P.E. 1040 (Health Education) to complete their physical education requirement. Students who are medically exempt from a single 1000 level course including swimming must substitute an additional 1000 level course in its place.

Transfer students will be granted credit for comparable physical education courses completed at other institutions.

Students who are 25 years of age or older upon matriculation to the institute have the option of satisfying the physical education requirement for graduation by completing the regular physical education requirements or by satisfactorily completing P.E. 1040.

For a listing of present courses by categories as they would relate to the recommended requirements, see p. 21.

XVI. ROTC Regulations

A. General

1. Georgia Tech offers both the four-year and the two-year programs as provided for in the 1964 ROTC Vitalization Act.
2. The entire ROTC program at Georgia Tech is voluntary.

B. Basic course

1. Six hours of completed basic ROTC can be counted by the student toward his or her degree.
2. If the student elects to take basic ROTC but drops it before completing six credit hours he or she must make up the difference between the credit hours he or she has completed in ROTC and six hours.

C. Advanced course

Students who are selected for further training may enroll in the advanced course. The advanced course is a recognized elective in all schools at Georgia Tech to the extent that a maximum of nine hours of credit may be applied toward a degree.

XVII. General Student Activities

A. Participation

1. In order to be eligible for participation in extracurricular activities, a student must be enrolled in a degree program, not on probation and carrying a schedule of at least six credit hours. (In addition, he or she must meet any further requirements stipulated by the student activities committee.)
2. During the first week of each quarter, a schedule of public performances to be sponsored by each student organization must be submitted to the dean of students for approval by the student academic and financial affairs committee.
3. In each quarter the weekend before final examinations is closed to extracurricular activities.

B. Social functions

All student organizations must take written application to, and receive permission from, the Office of the Dean of Students to hold a social function. Such requests must be submitted one week before the date of the activity. This permission must be received before making any agreement in connection with the function.

C. Student organizations

1. Any group of undergraduate students desiring to form an organization on the campus of the Georgia Institute of Technology must submit a written statement of the purposes of the proposed organization, six copies of the constitution and a list of officers and members to the student council for its approval. If the student council approves these it shall forward them to the student activities committee, whose approval is also necessary. Academic senate approval will be granted by the acceptance of the minutes of the student activities committee. Subsequent revisions and amendments of the constitution must also be approved by the student council and the student activities committee.
2. A copy of the constitution of each student organization is to be filed with the Office of the Dean of Students. Periodic reports as requested by the Office of the Dean of Students are to be supplied. Failure to fulfill such requests will be cause for inactivation of the organization concerned.
3. All student organizations are subject to the social regulations of the Georgia Institute of Technology.
4. An annual review of each undergraduate student organization will be made by the student council and each graduate organization by the graduate student senate to determine its vitality and usefulness, its pursuit of its purposes, its observance of its constitution and the student rules and regu-
lations and its compliance with all other relevant school rules and regulations. The conclusions about each organization will be transmitted to the student activities committee with a recommendation to continue, to place on probation for one year or to inactivate the organization.

D. Fraternity rules
1. In order to be eligible for initiation, a person must be a bona fide student, not on probation, carrying a schedule of at least 12 hours.
2. The initiation of any individual must be registered with and approved by the dean of students prior to the initiation.
3. The individual must meet all Georgia Tech IFC requirements concerning initiation.
4. All fraternities are subject to the rules established by the Georgia Tech IFC.

E. Eligibility for class rings
A student may purchase a class ring during or after the second quarter of the school year if at that time, he has reached the second quarter of junior classification.

F. Athletic regulations
1. In order to be eligible for athletic competition, a student must be a bona fide student, not on probation, carrying a schedule of at least 12 credit hours, and making satisfactory progress towards a degree. (In addition he must meet any further requirements of the NCAA. See athletic director for rules.)
2. No student may be excused from regularly scheduled classes for athletic practice.
3. No student may participate in more than two sports in intercollegiate competition in any school year, except by permission of the dean of students. Being manager or assistant manager is counted as participation within the meaning of this rule.

XVIII. Exceptions
Where appeals are not otherwise specified in this document, exceptions to the regulations may be made by the appropriate faculty committee upon petition by the student and recommendation of the student's school or the department concerned. (See also Sec. VI Par. G.) Blanket exceptions for groups of students which have the effect of amending these regulations shall be referred to the academic senate for approval.

All regulations adopted before this time are hereby superseded.
George A. Christenberry, acting vice chancellor
Henry G. Neal, executive secretary
Jerry M. Williamson, vice chancellor-Academic Development
Frank C. Dunham, vice chancellor-Facilities
Shealy E. McCoy, vice chancellor-Fiscal Affairs
Harry B. O'Rear, vice chancellor-Health Affairs
Haskin R. Pounds, vice chancellor-Planning
Mario J. Goglia, vice chancellor-Research
Howard Jordan, Jr., vice chancellor-Services
Robert M. Joiner, assistant vice chancellor-Communications
Mary Ann Hickman, assistant vice chancellor-Personnel
Thomas F. McDonald, director, Testing and Admissions

Institutional Administration

Office of the President
Joseph Mayo Pettit, Ph.D., president
Richard Fuller, Jr., Ph.D., executive assistant to the president

Office of the Vice-president for Academic Affairs
James R. Stevenson, Ph.D., acting vice-president, Academic Affairs
Walter L. Bloom, M.D., associate vice-president, Academic Affairs
E. Jo Baker, Ph.D., assistant to the vice-president, Academic Affairs

Office of the Vice-president for Research
Thomas E. Stelson, D.Sc., vice-president, Research
Albert P. Sheppard, Ph.D., associate vice-president, Research
Edward E. Renfro III, M.A., director, Contract Administration

Office of the Vice-president for Business and Finance
Gene M. Nordby, M.S., Ph.D., vice-president, Business and Finance
Frank H. Huff, B.B.A., C.P.A., comptroller
C. Evan Crosby, B.S., budget director
Clyde D. Robbins, Ph.D., director, Office of Campus Planning
Charles R. Johnson, B.M.E., director, Physical Plant
Howard J. Fretwell, B.B.A., director, Personnel
Roger E. Wehrle, B.S., director, Auxiliary Enterprises
George Mitchell, B.A., director, Bookstore
F. C. Auman, M.A., director, Campus Safety
Kathleen Stanwyck, manager, Financial Data Processing
John H. Gibson, assistant to the vice-president, Employee Relations

Office of the Vice-president for Development and Public Relations
P. Warren Heemann, M.A., vice-president, Development and Public Relations

John P. Culver, M.A., assistant vice-president for Public Relations
Eleanor C. Cain, A.B., assistant to the vice-president for development and public relations and acting executive secretary, Georgia Tech Foundation, Inc.

Office of the Vice-president for Planning
Clyde D. Robbins, Ph.D., vice-president, Planning
Paul Weber, Ph.D., special assistant to the vice-president for planning and vice-president for planning emeritus
David O. Savini, B.Arch. campus architect
Paul vander Horst, B.L.A., campus landscape architect
Thomas R. Kirby, B.S., facilities planner
J. R. Anthony, director, Real Estate

College of Architecture
William L. Fash, M.Arch., dean
Joseph N. Smith, B.Arch., assistant dean for Instruction
John A. Templer, Ph.D., assistant dean for Research

College of Engineering
William M. Sangster, Ph.D., dean
Charles R. Vail, Ph.D., associate dean
J. R. Williams, Ph.D., associate dean
Carolyn C. Chesnutt, M.S., assistant to the dean
Coleen A. Donahue, M.S., assistant to the dean
Paul Reynolds, Jr., M.S., assistant to the dean

College of Industrial Management
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C. P. Reed, Jr., M.S., director, Computing Services
Gary G. Watson, M.S., associate director, Application System Design
Jerry W. Head, B.S., associate director, Application System Programming
S. Paine Lenoir, M.S., associate director, Computer Operations
Frank Gleason, M.S., assistant to the director

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E. Graham Roberts, Ph.D., director, the libraries
Arthur T. Kittle, D.L.S., associate director

Division of Graduate Studies
James J. Bynum, Ph.D., acting dean, Graduate Studies
Helen E. Grenga, Ph.D., associate dean

Department of Continuing Education
Robert S. Herndon, M.Ed., acting director
George H. Adams, M.A., associate director

Georgia Tech Research Institute
Joseph M. Pettit, Ph.D., president
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Melvin W. Carter, Ph.D., director, Interdisciplinary Programs and director, Bioengineering Center
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Health Systems Research Center
Harold E. Smallley, Ph.D., director

Department of Campus Safety
G. L. Petherick, B.A., associate director
E. Carl Baxter, B.S., chief of police

Office of Radiological Safety
R. M. Boyd, B.S., radiological safety officer

Georgia Tech Athletic Association
Douglas W. Weaver, J.D., athletic director
John McKenna, B.A., associate athletic director

Academic Faculty
As of March 1, 1979
After each name is listed the highest earned degree and its source. The academic rank is followed by the individual's major assignment. Profes-
sional registration is indicated with the state(s) of registration as follows: P.E. = Professional Engineer, L.S. = Land Surveyor, R.A. = Registered Architect, L.A. = Landscape Architect, P.G. = Professional Geologist.

Mohamed A. Abdou, Ph.D.
University of Wisconsin
Associate Professor, Nuclear Engineering

Aristides F. Abri, D.C.S.
University of Havana
Professor, Industrial Management

Philip Adler, Jr., Ph.D.
Ohio State University
Professor, Industrial Management

Israel Aharoni, Ph.D.
Hefei University
Visiting Assistant Professor, Mathematics

Feroz Ahmed, M.L.S.
University of Western Ontario
Research Scientist II, Information and Computer Science

R. Martin Ahrens, Ph.D.
Washington University
Professor, Physics

Cecil O. Allford, Ph.D.
Mississippi State University
Associate Professor, Electrical Engineering

Sabo Ali, Ph.D.
Peshawar University
Research Scientist II, Textile Engineering

Douglas C. Allen, M.L.A.
Harvard University
L.A. (Kentucky)
Assistant Professor, Architecture

Fred C. Allwine, D.B.A.
Indiana University at Bloomington
Professor, Industrial Management

William F. Ames, M.S.
University of Wisconsin
R.A. (Georgia)
Professor, Mathematics

Gary L. Anderson, Ph.D.
Indiana University at Bloomington
Assistant Professor, Biology

Jerry M. Anderson, Ph.D.
Stanford University
Associate Professor, Engineering Science and Mechanics

Alfred D. Andrew, Ph.D.
Stanford University
Assistant Professor, Mathematics

Mustafa M. Aral, Ph.D.
Georgia Institute of Technology
Visiting Associate Professor, Civil Engineering

Peter H. Aranson, Ph.D.
University of Rochester
Associate Professor, Industrial Management

John C. Archea, B.Arch.
University of Cincinnati
Lecturer, Architecture

Alan R. Armstrong, Ph.D.
Cornell University
Assistant Professor, English

Troy M. Artusy, Ph.D.
Stanford University
Assistant Professor, Electrical Engineering

E. C. Ashby, Ph.D.
University of Notre Dame
Regents' Professor, Chemistry

Larry P. Atkinson, Ph.D.
Dalhousie University, Nova Scotia
Adjunct Associate Professor, Geophysical Sciences

Stayanadham Atluri.
Massachusetts Institute of Technology
Professor, Engineering Science and Mechanics

Albert N. Badre, Ph.D.
University of Michigan
Assistant Professor, Information and Computer Science

Stanley C. Bailey, Ph.D.
Stanford University
P.E. (Georgia)
Associate Professor, Aerospace Engineering

Scott S. Baird III, M.S.
Georgia Institute of Technology
Research Engineer II, Mechanical Engineering

William E. Baird, Jr., Ph.D.
Georgia Institute of Technology
Research Scientist II, Electrical Engineering

E. Jo Baker, Ph.D.
Emory University
Professor and Assistant to the Vice-President for Academic Affairs

William F. Bale, Ph.D.
University of Rochester
Professor, Biology

Alan H. Balfour, M.F.A.
Princeton University
R.A. (Great Britain)
Associate Professor, Architecture

Jerry Banks, Ph.D.
Oklahoma State University
Associate Professor, Industrial and Systems Engineering

E. Kent Barefield, Ph.D.
Ohio State University
Associate Professor, Chemistry

Richard D. Barksdale, Ph.D.
Purdue University
P.E. (Ga., Fla., S.C., N.C., Ala., Tenn.)
Professor, Civil Engineering

Samuel C. Barnett, Ph.D.
Georgia Institute of Technology
P.E. (Georgia)
Professor, Mechanical Engineering

Thomas P. Barnwell III, Ph.D.
Massachusetts Institute of Technology
Associate Professor, Electrical Engineering

Emmanuel N. Barron, Ph.D.
Northwestern University
Assistant Professor, Mathematics

Glenn R. Bateman, Jr., Ph.D.
Princeton University
Visiting Associate Professor, Nuclear Engineering

Valorie Batorewicz, M.Ed.
Yale University
Visiting Lecturer, Architecture

Ronald H. Bayor, Ph.D.
University of Pennsylvania
Associate Professor, Social Sciences

Mokhtar Sadek Bazaara, Ph.D.
Georgia Institute of Technology
Professor, Industrial and Systems Engineering

Jane P. Bean, M.S.
Georgetown University
Lecturer, Modern Languages

Bill D. Beavers, M.S.
Florida State University
Associate Professor, Physical Education and Recreation

Kevin C. Beck, Ph.D.
Harvard University
Associate Professor, Geophysical Sciences

Arthur Franklin Beckum, Jr., M.F.A.
Princeton University
Professor, Architecture

Johan G. F. Belinfante, Ph.D.
Princeton University
Associate Professor, Mathematics

Arthur C. Benke, Ph.D.
University of Georgia
Professor, Biology

James F. Benzle, Ph.D.
University of Illinois
P.E. (Alabama)
Professor, Ceramic Engineering

Marc A. Berger, Ph.D.
Carnegie-Mellon University
Assistant Professor, Mathematics

Donald G. Berghaus, Ph.D.
Case Western Reserve University
P.E. (New York)
Associate Professor, Engineering Science and Mechanics

Michael C. Bernard, Ph.D.
Purdue University
Associate Professor, Engineering Science and Mechanics

John T. Berry, Ph.D.
University of Birmingham, England
Whirlpool Professor, Mechanical Engineering

J. Aaron Bertrand, Ph.D.
Tulane University
Professor and Director, Chemistry

Helmut Britz, Ph.D.
University of Vienna
Associate Professor, Physics

W. Carl Biven, Ph.D.
St. Louis University
Professor, Industrial Management

William Z. Black, Ph.D.
Purdue University
P.E. (Georgia)
Professor, Mechanical Engineering

Cynthia L. Blanton, Ph.D.
Princeton University
Assistant Professor, English

Jackson O. Blanton, Ph.D.
Oregon State University
Adjunct Associate Professor, Geophysical Sciences

Edith H. Blicksilver, M.A.
Smith College
Assistant Professor, English
John H. Clark, B.A.
Michigan State University
Lecturer, Modern Languages

Susan B. Clark, M.Ln.
Emory University
Librarian-Instructor

Frank J. Clarke, Ph.D.
Emory University
Associate Professor, Architecture

Joseph D. Clement, Ph.D.
University of Wisconsin
Professor, Nuclear Engineering

Joe K. Cochran, Jr., Ph.D.
Ohio State University
Associate Professor Ceramic Engineering

Susan I. Cohen, Ph.D.
Northwestern University
Assistant Professor, Industrial Management

Gregory Colson, M.A.
Kent State University
Assistant Professor and Head, Music

Gene T. Colwell, Ph.D.
University of Tennessee
P.E. (Georgia)
Professor, Mechanical Engineering

Edward J. Conlon, Ph.D.
Carnegie-Mellon University
Assistant Professor, Industrial Management

Neill W. Connah, M.F.A.
Tulane University
Associate Professor, Architecture

Arnall T. Connel, M.C.P.
Georgia Institute of Technology
Professor, Architecture

J. Alvin Connelly, Ph.D.
University of Tennessee
P.E. (Georgia)
Associate Professor, Electrical Engineering

Terrence Connolly, Ph.D.
Northwestern University
Associate Professor, Industrial and Systems Engineering

Ellen D. Conway, B.A.
Georgia State University
Lecturer, Modern Languages

Fred L. Cook, Ph.D.
Georgia Institute of Technology
Assistant Professor, Textile Engineering

Wister J. Cook, Ph.D.
Auburn University
Assistant Professor, English

Andrew Jackson Cooper III, Ph.D.
Princeton University
Associate Professor, Industrial Management

Richard J. Corbin, Ph.D.
Tulane University
Assistant Professor, English

Melvin Corley, Ph.D.
University of Texas, Austin
P.E. (Georgia, Louisiana)
Assistant Professor, Mechanical Engineering

Gregory M. Corso, Ph.D.
New Mexico State University
Assistant Professor, Psychology

James Courtney, Jr., Ph.D.
University of Texas, Austin
Assistant Professor, Industrial Management

Donald O. Covault, Ph.D.
Purdue University
P.E. (Georgia)
Professor, Civil Engineering

Thomas F. Craft, Ph.D.
Georgia Institute of Technology
Senior Research Scientist, Nuclear Engineering

James I. Craig, Ph.D.
Stanford University
Associate Professor, Aerospace Engineering

Robert M. Craig, Ph.D.
Cornell University
Associate Professor, Architecture

Vernon D. Crawford, Ph.D.
University of Virginia
Professor and Vice-president for Academic Affairs

John W. Crenshaw, Ph.D.
University of Florida
Professor and Director, Biology

Phillip L. Crews, Ph.D.
Texas A & M University
Assistant Professor, Information and Computer Science

Wendall H. Cross, Ph.D.
Georgia Institute of Technology
Research Scientist II, Civil Engineering

Paul J. Crutzen, D.Sc.
University of Stockholm
Adjunct Professor, Geophysical Sciences

James P. Culpepper, M.Ed.
Mississippi State University
Assistant Professor, Physical Education and Recreation

John Cecil Currie, Ph.D.
Louisiana State University
Professor, Mathematics

Richard Dagenhart, M.Arch. and M.C.P.
University of Pennsylvania
Associate Professor, Architecture

Anton M. Dainty, Ph.D.
Dalhousie University
Associate Professor, Geophysical Sciences

Sherman F. Dallas, Ph.D.
Indiana University
Professor, Industrial Management

Carolyn B. Dallalvalle, A.B.
University of North Carolina
Librarian-Associate Professor

Douglas J. Dairymple, D.B.A.
Michigan State University
Visiting Professor, Industrial Management

Brady R. Daniel, B.A.E.
Georgia Institute of Technology
Senior Research Engineer, Aerospace Engineering

James N. Davidson, Ph.D.
University of Michigan
P.E. (Georgia)
Associate Professor, Nuclear Engineering

Douglas D. Davis, Ph.D.
University of Florida
Professor, Geophysical Sciences

L. Harlan Davis, Ph.D.
University of Wisconsin
Associate Professor, Industrial Management and Director of Interinstitutional Programs in International Affairs

Monte V. Davis, Ph.D.
Oregon State University
P.E. (Arizona)
Professor and Director, Nuclear Research Center, Nuclear Engineering

Wayne B. Davis, M.S.
Georgia Institute of Technology
Colonel, U.S. Army
Professor and Head, Army ROTC

Gerald J. Day, D.B.A.
Indiana University
Associate Professor and Associate Dean, Industrial Management

Thomas N. Debo, Ph.D.
Georgia Institute of Technology
Assistant Professor, Architecture

Atif S. Debs, Ph.D.
Massachusetts Institute of Technology
Associate Professor, Electrical Engineering

Carlos E. deCubas, M.S.
National Institute of Physical Education, Havana
Assistant Professor, Physical Education and Recreation

Richard A. DeMillo, Ph.D.
Georgia Institute of Technology
Associate Professor, Information and Computer Science

Stephen G. Demko, Ph.D.
Kent State University
Associate Professor, Mathematics

Roger D. Dennett, M.S.
Purdue University
Research Engineer II, Geophysical Sciences

Ann J. Derhovitz, M.S.
University of Pennsylvania
Research Scientist I, Biology

Pratien V. Desai, Ph.D.
Tulane University
Associate Professor, Mechanical Engineering

Rebecca Dettra, B.A.
University of Southern Mississippi
Lecturer, English

Howard M. Deutsch, Ph.D.
Georgia Institute of Technology
Research Scientist II, Chemistry

Stuart J. Deutsch, Ph.D.
University of Wisconsin
Professor, Industrial and Systems Engineering

Stephen L. Dickerson, Sc.D.
Massachusetts Institute of Technology
Professor, Mechanical Engineering

James A. Diez, Ph.D.
University of Connecticut
Assistant Professor, Biology

James B. Dodd, M.S.L.S.
University of Illinois
Librarian-Associate Professor
Lionel D. Gillespie, B.S.
Art Center College of Design
Assistant Professor, Architecture

Glenn Gilman, Ph.D.
University of Chicago
Regents' Professor, Industrial Management

Jagannath Giri, Ph.D.
Georgia Institute of Technology
Research Engineer II, Engineering Science and Mechanics

Ethel W. Githii, M.A.
Columbia University
Assistant Professor, English

John J. Goda, Jr., M.S.
University of Massachusetts
Assistant Professor, Information and Computer Science

James L. Gole, Ph.D.
Rice University
Associate Professor, Chemistry

Daniel P. Golightly, M.D.
Meharry Medical College
Adjunct Associate Professor, Health Systems

Jamie J. Goode, Ph.D.
University of North Carolina
Associate Professor, Mathematics

Barry Greenwood, Ph.D.
Stanford University
P.E. (Georgia)

Assistant Professor, Civil Engineering

Sidney L. Gordon, Ph.D.
Columbia University
Professor, Chemistry

Charles W. Gorton, Ph.D.
Purdue University
P.E. (Georgia)
Professor, Chemical Engineering

James Gough, Jr., Ph.D.
Harvard University
Professor, Information and Computer Science

John C. Gould, M.R.P.
University of North Carolina
Professor, Architecture

Joseph P. Gould, Ph.D.
University of Michigan
Assistant Professor, Civil Engineering

Edgar D. Grady, Ph.D.
University of Illinois
Principal Research Scientist, Biology

Gerald W. Grams, Ph.D.
Massachusetts Institute of Technology
Professor, Chemical Sciences

U. S. Grant, Jr., M.S.
U.S. Navy Postgraduate School
Assistant Professor, Navy ROTC

Robert J. Graves, Ph.D.
State University of New York, Buffalo
Professor, Industrial and Systems Engineering

Robin B. Gray, Ph.D.
Princeton University
Regents' Professor and Associate Director, Aerospace Engineering

David B. Green
Research Engineer I, Civil Engineering

Robert E. Green, D.B.A.
Indiana University
Professor, Industrial Management

William L. Green, Ph.D.
University of Pennsylvania
Assistant Professor, Mathematics

Robert Greenberg, M.S.
Florida State University
Major, U.S. Air Force
Assistant Professor, Air Force ROTC

Rufus R. Greene, B.Arch.
Georgia Institute of Technology
P.A. (Georgia)

Associate Professor, Architecture

George W. Greenwood, M.S.I.E.
Georgia Institute of Technology
Adjunct Lecturer, Industrial and Systems Engineering

Tatjana Gregory
Assistant Professor, Modern Languages

Helen E. Grenga, Ph.D.
University of Virginia
Professor, Chemical Engineering

Harry L. Griffin, Jr., L.L.B.
Duke University
Lecturer, Civil Engineering

Mary E. Gring, M.A.
Middlebury College
Assistant Professor, Architecture

Stanley J. Grossman, Ph.D.
Brown University
Visiting Associate Professor, Mathematics

Erling Grovenstein, Jr., Ph.D.
Massachusetts Institute of Technology
Regents' Professor, Chemistry

Homer V. Grubb, Ph.D.
Georgia Institute of Technology
Professor, Mechanical Engineering

William J. Hadden, Jr., Ph.D.
Northwestern University
Assistant Professor, Mechanical Engineering

James M. Hall, Ph.D.
Purdue University
Research Scientist II, Chemistry

Dwight H. Hall, Ph.D.
Purdue University
Associate Professor, Biology

Timothy A. Hall, Ph.D.
University of Oklahoma
Assistant Professor, Social Sciences

Daniel W. Halpin, Ph.D.
University of Illinois
Associate Professor, Civil Engineering

Roger A. Hambridge, Ph.D.
University of California at Los Angeles
Assistant Professor, English

Joseph L. Hammond, Jr., Ph.D.
Georgia Institute of Technology
Professor, Electrical Engineering

Sathyanarayana V. Hanagud, Ph.D.
Stanford University
Professor, Aerospace Engineering

John C. Handley, Ph.D.
Georgia Institute of Technology
P.E. (Georgia)

Senior Research Engineer, Aerospace Engineering

James L. Harding, Ph.D.
Texas A & M University
Assistant Professor, Geophysical Sciences

Don S. Harmer, Ph.D.
University of California at Los Angeles
Professor, Nuclear Engineering

Jill B. Harmer, B.A.
Indiana University
Lecturer, Modern Languages

John J. Harper, M.S.
Georgia Institute of Technology
P.E. (Georgia)
Professor, Aerospace Engineering
Jean I. Kelley, M.S.
Pennsylvania State University
Research Scientist I, Geophysical Sciences

John A. Kelly, M.Arch.
University of Illinois
R.A. (Georgia) Professor, Architecture

Patrick Kelly, Ph.D.
Emory University
Professor and Associate Dean, College of Sciences and Liberal Studies

Nisbet S. Kendrick, M.S.
Emory University
Associate Professor, Physics

Robert P. Kertz, Ph.D.
Northwestern University
Associate Professor, Mathematics

Samuel C. Ketchin, Ph.D.
Emory University
Professor, English

Slothe P. Kezios, Ph.D.
Illinois Institute of Technology
P.E. (Illinois) Professor and Director, Mechanical Engineering

Chia Szu Kiang, Ph.D.
Georgia Institute of Technology
Professor and Associate Director, Geophysical Sciences

Richard King, M.S.
Illinois Institute of Technology
P.E., L.S. (Connecticut) Professor, Civil Engineering

Wilton W. King, Ph.D.
Virginia Polytechnic Institute
P.E. (Georgia) Professor and Associate Director, Engineering Science and Mechanics

Jean Kirkland, M.Ln.
Emory University
Librarian-Associate Professor

Robert S. Kirkland, B.S.
University of Oklahoma
Senior Research Engineer, Nuclear Engineering

Darlene Kishbaugh, M.S.
Pennsylvania State University
Research Scientist 1, Health Systems

Arthur T. Kittle, D.L.S.
Columbia University
Librarian-Professor and Associate Director, Libraries

Jack Kleiner, S.J.D.
New York Law School
Associate Professor, Industrial Management

James A. Knight, Jr., Ph.D.
Pennsylvania State University
Professor, Engineering Experiment Station

Arthur J. Koblasz, Ph.D.
California Institute of Technology
Assistant Professor, Engineering Science and Mechanics

Ludmila Konopasek, M.S.
University of Manchester
Research Engineer II, Chemical Engineering

Milos V. Konopasek, Ph.D.
University of Manchester
Associate Professor, Textile Engineering

Melvin Kranzberg, Ph.D.
Harvard University
Callaway Professor, Social Sciences

Richard K. Kunz, Ph.D.
Georgia Institute of Technology
Assistant Professor, Engineering Science and Mechanics

James S. Lai, Ph.D.
Brown University
P.E. (Georgia) Associate Professor, Civil Engineering

Uzi Landman, D.Sc.
Technion Israel
Associate Professor, Physics

Karl T. Langenbruch, Ph.D.
University of Hamburg
Associate Professor, Modern Languages

Frederick H. Langhorst, Ph.D.
Emory University
Assistant Professor, Modern Languages

Randall L. Lanning, M.A.
Central Missouri State University
Captain, U.S. Air Force

Lewis F. Lanter, M.Arch.
Columbia University
P.A. (Georgia) Associate Professor, Architecture

James A. Largay III, Ph.D.
Cornell University
Associate Professor, Industrial Management

Alan V. Larson, Ph.D.
University of Illinois
Professor, Mechanical Engineering

Marlin V. Law, M.S.
Georgia Institute of Technology
Assistant Professor, Industrial Management

William M. Leach, Ph.D.
Georgia Institute of Technology
Associate Professor, Electrical Engineering

Charles R. Leacy, M.A.
Emory University
Librarian-Associate Professor

Richard J. LeBlanc, Ph.D.
University of Wisconsin
Assistant Professor, Information and Computer Science

Gary M. Leff, Ph.D.
Georgia State University
Assistant Professor, Industrial Management

Keith O. Legg, Ph.D.
University of York, England
Research Scientist II, Physics

Robert N. Lehrer, Ph.D.
Purdue University
P.E. (Georgia) Professor, Industrial and Systems Engineering

Jane A. Leonard, M.A.
Georgia State University
Lecturer, Modern Languages

Barbara G. Levi, Ph.D.
Stanford University
Lecturer, Physics

Ferdinand K. Levy, Ph.D.
Carnegie-Mellon University
Professor, College of Industrial Management

H. Clay Lewis, Sc.D.
Carnegie Institute of Technology
Professor, Chemical Engineering

Maria E. Lewis, M.A.
West Georgia College
Lecturer, Modern Languages

Albert A. Libaistra, Ph.D.
Georgia Institute of Technology
Research Scientist II, Chemical Engineering

John Paul Line, M.S.
University of Michigan
Associate Professor, Mathematics
Douglas C. Montgomery, Ph.D.  
Virginia Polytechnic Institute  
Professor, Industrial and Systems Engineering

Elliott W. Montroll, Ph.D.  
University of Pittsburgh  
Adjunct Professor, Physics

Willis E. Moody, Jr., Ph.D.  
North Carolina State University  
P.E. (Georgia)  
Professor, Ceramic Engineering

L. Hugh Moore, Ph.D.  
Emory University  
Professor, English

Mack A. Moore, Ph.D.  
University of Wisconsin  
Professor, Industrial Management

Thomas F. Moran, Ph.D.  
University of Notre Dame  
Professor, Chemistry

Cheryl E. Morgan, M.Arch.  
University of Illinois  
Assistant Professor, Architecture

Karl Z. Morgan, Ph.D.  
Duke University  
Neely Professor, Nuclear Engineering

William F. Moss, Ph.D.  
University of Delaware  
Assistant Professor, Mathematics

Pieter Muije, Ph.D.  
Washington State University  
P.E. (Georgia)  
Associate Professor, Chemical Engineering

Stanley A. Mulaik, Ph.D.  
University of Utah  
Associate Professor, Psychology

William B. Mullen, Ph.D.  
Columbia University  
Professor, English

Albert L. Mullikin, Ph.D.  
University of Wisconsin  
Associate Professor, Mathematics

Karl M. Murphy, Ph.D.  
Harvard University  
Professor and Head, English

John D. Muzzy, Ph.D.  
Rensselaer Polytechnic Institute  
Associate Professor, Chemical Engineering

Justin A. Myrick, Ph.D.  
University of Missouri, Columbia  
Associate Professor, Health Systems

David C. Nachman, Ph.D.  
Northwestern University  
Associate Professor, Industrial Management

Michihiko Nakagaki, Ph.D.  
University of Washington  
Research Engineer II, Engineering Science and Mechanics

Helen H. Naugle, Ph.D.  
University of Alabama  
Professor, English

Douglas H. Neale, Ph.D.  
Georgia Institute of Technology  
Senior Research Engineer, Aerospace Engineering

John D. Neff, Ph.D.  
University of Florida  
Professor, Mathematics

Henry M. Neumann, Ph.D.  
University of California  
Professor, Chemistry

Robert J. Nichols, M.Arch.  
Harvard University  
R.A. (Ill., Tex., Miss., Ga.)  
Associate Professor, Architecture

Hoylene H. Noble, M.Ed.  
Georgia State University  
Instructor, Physical Education and Recreation

Gene M. Nordby, Ph.D.  
University of Minnesota  
P.E. (Colo., Ariz., Okla.)  
Professor and Vice-president for Business and Finance

John D. Norgard, Ph.D.  
California Institute of Technology  
P.E. (Georgia)  
Associate Professor, Electrical Engineering

Kofi O. Niti, Ph.D.  
Yale University  
Visiting Assistant Professor, Industrial Management

Michael K. H. Nuddling, M.A.  
Northwestern University  
Lecturer, Modern Languages

H. Neal Nunally, Ph.D.  
Georgia Institute of Technology  
P.E. (Georgia)  
Associate Professor, Electrical Engineering

Gerald E. O'Brien, B.S.  
Southern Technical Institute  
Research Scientist I, Chemistry

Matthew C. O'Brien, Ph.D.  
University of Maryland  
Associate Professor, English

Roderick F. O'Connor, Ph.D.  
Vanderbilt University  
Professor, Industrial Management

L. Howard Olson, Ph.D.  
University of Manchester  
P.E. (Georgia)  
Associate Professor, Textile Engineering

Daniel E. O'Neil, Ph.D.  
Massachusetts Institute of Technology  
Assistant Professor, Industrial Management

Clyde Orr, Jr., Ph.D.  
Georgia Institute of Technology  
P.E. (Georgia)  
Regents' Professor, Chemical Engineering

James M. Osborn, Ph.D.  
University of Michigan  
Associate Professor, Mathematics

Donald O. O'Shea, Ph.D.  
Johns Hopkins University  
Associate Professor, Physics

Thomas E. Papageorge, M.S.  
Georgia Institute of Technology  
Assistant Professor, Architecture

Daniel S. Papp, Ph.D.  
University of Miami  
Associate Professor, Social Sciences

Demetrius T. Paris, Ph.D.  
Georgia Institute of Technology  
Professor and Director, Electrical Engineering

R. Gary Parker, Ph.D.  
Kansas State University  
Associate Professor, Industrial and Systems Engineering

Fred K. Parrish, Ph.D.  
Emory University  
Senior Research Scientist, Biology

Leonard J. Parsons, Ph.D.  
Purdue University  
Professor, Industrial Management

Peter S. Parsons, Ph.D.  
North Carolina State University  
P.E. (Georgia)  
Associate Professor, Civil Engineering

Stephen L. Passman, Ph.D.  
Georgia Institute of Technology  
Associate Professor, Engineering Science and Mechanics
E. T. Patonis, Jr., Ph.D.
Georgia Institute of Technology
Professor, Physics

Edward M. Patterson, Jr., Ph.D.
Georgia Institute of Technology
Research Scientist II, Geophysical Sciences

Elliott A. Pavlos, M.C.P.
University of Pennsylvania
Professor, Architecture

C. Lee Payne, B.S.
University of Cincinnati
Associate Professor, Architecture

M. Carr Payne, Jr., Ph.D.
University of North Carolina
Assistant Professor, Aerospace and Mechanical Engineering

John B. Peatman, Ph.D.
Case Western Reserve University
Assistant Professor, Mathematics

John B. Peatman, Ph.D.
Case Western Reserve University
Professor, Psychology

Joseph L. Pentecost, Ph.D.
University of Illinois
P.E. (Georgia, Virginia)
Professor and Director, Ceramic Engineering

Marni A. Perlstadt, Ph.D.
University of California, Berkeley
Visiting Assistant Professor, Mathematics

Joseph M. Pettit, Ph.D.
Stanford University
Professor and President

Ray H. Pettit, Ph.D.
University of Florida
Professor, Electrical Engineering

Philips E. Pfeifer, Ph.D.
Georgia Institute of Technology
Research Engineer II, Industrial Engineering

Kevin T. Phelps, Ph.D.
Auburn University
Assistant Professor, Mathematics

Thomas D. Phillips, A.B.
Emory University
Assistant Professor, Social Sciences

John Pienpenbrink, Ph.D.
University of California at Los Angeles
Assistant Professor, Mathematics

Allan D. Pierce, Ph.D.
Massachusetts Institute of Technology
Regents' Professor, Mechanical Engineering

G. Alvin Pierce, Ph.D.
Ohio State University
P.E. (Ohio)
Professor, Aerospace Engineering

Robert A. Pieretti, Ph.D.
University of Washington
Professor, Chemistry

Julian V. Pittman, B.S.
Georgia Southern College
Research Scientist II, Health Systems

E. Juanita Pitts, M.A.
University of Alabama
Assistant Professor, Mathematics

Gary W. Poehelein, Ph.D.
Purdue University
Professor and Director, Chemical Engineering

Frederick G. Pohland, Ph.D.
Purdue University
P.E. (Georgia)
Professor, Civil Engineering

Russell Pohlemus, M.S.
East Texas State University
Instructor, Physical Education and Recreation

C. O. Pollard, Jr., Ph.D.
Florida State University
Assistant Professor, Geophysical Sciences

Alan L. Porter, Ph.D.
University of California at Los Angeles
Associate Professor, Industrial and Systems Engineering

John W. Poston, Ph.D.
Georgia Institute of Technology
Associate Professor, Nuclear Engineering

Eugene A. Powell, Ph.D.
Georgia Institute of Technology
Assistant Professor, Aerospace Engineering

James C. Powers, Ph.D.
Massachusetts Institute of Technology
Professor, Chemistry

Edward W. Price, B.A.
University of California at Los Angeles
Professor, Aerospace Engineering

Ruby J. Price, M.Ln.
Emory University
Librarian-Inspector

Mark A. Prichard
Research Engineer II, Civil Engineering

David D. Pruitt, B.S.
U.S. Naval Academy
Lieutenant, U.S. Navy
Assistant Professor, Navy ROTC

Sara M. Putzell, Ph.D.
Emory University
Assistant Professor, English

Patrick M. Quinlan, Ph.D.
California Institute of Technology
Adjunct Professor, Civil Engineering

S. Ramalingam, Ph.D.
University of Illinois at Urbana
Professor, Mechanical Engineering

George H. Ramsey, D.P.L.G.
Ecole Nationale Superieure des Beaux-Arts Paris
R.A. (France)
Professor, Architecture

Ronald L. Rardin, Ph.D.
Georgia Institute of Technology
Associate Professor, Industrial and Systems Engineering

Hugh D. Ratliff, Ph.D.
Johns Hopkins University
P.E. (Fla.)
Professor, Industrial and Systems Engineering

Milton E. Raville, Ph.D.
University of Wisconsin
P.E. (Kansas)
Professor and Director, Engineering Science and Mechanics

Date C. Ray, Ph.D.
University of Michigan
Professor, Electrical Engineering

David H. Ray, Ph.D.
Stanford University
Assistant Professor, Social Sciences

Nancy C. Ray, M.L.S.
Florida State University
Librarian-Assistant Professor

Alfred L. Recouley, Ph.D.
University of North Carolina
Assistant Professor, English

Germaine M. Reed, Ph.D.
Louisiana State University
Associate Professor, Social Sciences

James A. Reddy, Ed.D.
George Peabody College
Professor and Head, Physical Education and Recreation

Lawrence W. Rehfeld, Ph.D.
Stanford University
Professor, Aerospace Engineering

Robert P. Reno, Ph.D.
Michigan State University
Assistant Professor, English

George M. Rentzepis, Ph.D.
Rensselaer Polytechnic Institute
Associate Professor, Engineering Science and Mechanics

J. de Casseres Reshower, Certificate
Clarence White School of Photography
Lecturer, Architecture

J. H. Reuter, Ph.D.
University of Wurzburg
Associate Professor, Geophysical Sciences

William T. Rhodes, Ph.D.
Stanford University
Associate Professor, Electrical Engineering

Martin W. Ribarsky, Ph.D.
University of Cincinnati
Research Scientist II, Physics

Charles V. Riche, Jr., Ph.D.
University of Washington
Associate Professor, Psychology

Edmun B. Richmond, Ed.D.
University of Georgia
Assistant Professor, Modern Languages

Leland S. Riggs, M.S.
University of Oklahoma
Instructor, Civil Engineering

Gary F. Riley, Ph.D.
University of Nebraska
Lecturer, Chemistry

Edward J. Rinalducci, Ph.D.
University of Rochester
Visiting Professor, Psychology

John G. Rinker, Ph.D.
Georgia Institute of Technology
Research Engineer I, Chemical Engineering

H. Randall Roark, M.Arch. and M.C.P.
University of Pennsylvania
R.A. (Georgia, Alabama)
Associate Professor, Architecture

Clyde D. Robins, Ph.D.
Georgia State University
Assistant Professor and Vice-president for Planning
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<tr>
<th>Name</th>
<th>Position</th>
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</tr>
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<tr>
<td>Edward Graham Roberts</td>
<td>Assistant Professor, Chemistry</td>
<td>University of Tennessee</td>
<td>Chemistry</td>
</tr>
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<td>Philip J. Roberts</td>
<td>Assistant Professor, Electrical Engineering</td>
<td>University of Technology</td>
<td>Electrical Engineering</td>
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<td>Assistant Professor, Mathematical Sciences</td>
<td>University of Florida</td>
<td>Mathematical Sciences</td>
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<td>Assistant Professor, Architecture</td>
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<td>Associate Professor, Civil Engineering</td>
<td>University of Illinois</td>
<td>Civil Engineering</td>
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<td>Lecturer, Modern Languages</td>
<td>University of Florida</td>
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<td>Associate Professor and Registrar</td>
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<td>Registrar and Systems Engineer</td>
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<td>Assistant Professor, Aerospace Engineering</td>
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<td>Aerospace Engineering</td>
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<td>Professor, Chemistry</td>
<td>New York University</td>
<td>Chemistry</td>
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<td>Catherine B. Ross</td>
<td>Associate Professor, Mathematics</td>
<td>Cornell University</td>
<td>Mathematics</td>
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<td>University Professor, Social Sciences</td>
<td>University of California at Berkeley</td>
<td>Social Sciences</td>
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<td>Associate Professor, Chemistry</td>
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<td>Emory University Professor</td>
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<td>Rice University Professor</td>
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<td>John S. Russell</td>
<td>Johns Hopkins University Assistant Professor, English</td>
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<td>Purdue University Professor</td>
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<td>Professor, Industrial and Systems Engineering</td>
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<td>Rino A. Salvo</td>
<td>University Professor, Research Scientist II, Physics</td>
<td>Harvard University</td>
<td>Associate Professor, Industrial and Systems Engineering</td>
</tr>
<tr>
<td>Andrea Sander</td>
<td>Hunter College Lecturer, Modern Languages</td>
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<td>Professor, Nuclear Engineering</td>
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<td>Carnegie Institute of Technology Professor, Psychology</td>
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<td>Georgia Institute of Technology Research Scientist II, Chemical Engineering</td>
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<td>State University of Iowa Research Scientist III, Chemical Engineering</td>
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<td>F. Michael Saunders</td>
<td>University of Illinois Assistant Professor, Civil Engineering</td>
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<td>Nelson F. Sayford</td>
<td>Georgia Institute of Technology Research Scientist I, Health Systems</td>
<td>University of Washington</td>
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<tr>
<td>William E. Sayle</td>
<td>University of Washington P.E. Georgia, Washington</td>
<td>University of California at Berkeley</td>
<td>Associate Professor, Electrical Engineering</td>
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<td>Ronald W. Schafer</td>
<td>Massachusetts Institute of Technology Professor, Electrical Engineering</td>
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<td>Associate Professor, Electrical Engineering</td>
</tr>
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<td>Alfred Schneider</td>
<td>Polytechnic Institute of New York Professor, Nuclear Engineering</td>
<td>University of Illinois</td>
<td>Nuclear Engineering</td>
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<td>Frederick W. Schultz</td>
<td>University of Illinois P.E. Georgia</td>
<td>University of Illinois</td>
<td>Associate Professor and Associate Dean, College of Engineering</td>
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<td>Indiana University Adjunct Professor, Biology</td>
<td>University of Illinois</td>
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<td>Esta K. Seaton</td>
<td>University of Minnesota Associate Professor, English</td>
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<td>English</td>
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<td>University of Illinois Assistant Professor, Architecture</td>
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<td>Architecture</td>
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<td>University of Pennsylvania R.A. Georgia</td>
<td>University of Illinois</td>
<td>Assistant Professor, Architecture</td>
</tr>
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<td>Robert P. Sharp</td>
<td>Georgia Institute of Technology Research Engineer II, Aerospace Engineering</td>
<td>University of Delaware</td>
<td>Aerospace Engineering</td>
</tr>
<tr>
<td>Samuel V. Shelton</td>
<td>Georgia Institute of Technology Research Scientist II, Physics</td>
<td>University of Florida</td>
<td>Social Science and Engineering</td>
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<tr>
<td>William W. Frank E. Roper, Jr.</td>
<td>Associate Professor, Mechanical Engineering</td>
<td>University of Maryland</td>
<td>Mechanical Engineering</td>
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<td>Michael E. Stilesinger</td>
<td>University of Virginia Associate Professor, Chemistry</td>
<td>University of Virginia</td>
<td>Chemistry</td>
</tr>
<tr>
<td>Robert W. Shreeses</td>
<td>University of Illinois Associate Professor, Engineering Science and Mechanics</td>
<td>University of Illinois</td>
<td>Engineering Science and Mechanics</td>
</tr>
<tr>
<td>Philip J. Siegmann</td>
<td>Ohio State University Associate Professor, Information and Computer Science</td>
<td>University of Illinois</td>
<td>Information and Computer Science</td>
</tr>
<tr>
<td>George J. Simitses</td>
<td>Stanford University Professor, Engineering Science and Mechanics</td>
<td>University of California at Berkeley</td>
<td>Aerospace Engineering</td>
</tr>
<tr>
<td>Daniel Sipper</td>
<td>Georgia Institute of Technology Visiting Associate Professor, Industrial and Systems Engineering</td>
<td>University of Illinois</td>
<td>Visiting Associate Professor, Industrial and Systems Engineering</td>
</tr>
</tbody>
</table>
Raymond P. Vito, Ph.D. 
Cornell University 
Assistant Professor, Engineering Science and Mechanics 

Harrison M. Wadsworth, Jr., Ph.D. 
Western Reserve University 
P.E. (Ohio) 
Assistant Professor, Industrial and Systems Engineering 

Edward B. Wagstaff, Ph.D. 
Carnegie-Mellon University 
Assistant Professor, Electrical Engineering 

Barbara J. Walker, M.L.S. 
Atlanta University 
Librarian-Assistant Professor 

Jack R. Walker, Ph.D. 
Oklahoma State University 
Lecturer, Industrial and Systems Engineering 

James V. Walker, Ph.D. 
University of North Carolina 
Professor, Mathematics 

William H. Walker, Jr., M.S. 
Emory University 
Instructor, Biology 

Gordon T. Wallace, Ph.D. 
University of Rhode Island 
Adjunct Associate Professor, Geophysical Sciences 

James R. Wallace, Sc.D. 
Massachusetts Institute of Technology 
P.E. (Georgia) 
Assistant Professor, Civil Engineering 

John M. Wallace, Jr., M.S. 
Georgia Institute of Technology 
Associate Professor, Electrical Engineering 

Nancy W. Walls, Ph.D. 
University of Michigan 
Associate Professor, Biology 

Helan S. Waizer, M.S. 
University State Teachers' College, Geneva, New York 
Librarian-Assistant Professor 

J. M. Wampier, Ph.D. 
Columbia University 
Associate Professor, Geophysical Sciences 

James Ting-Shun Wang, Ph.D. 
Purdue University 
Professor, Engineering Science and Mechanics 

Bradley W. Ward, M.S. 
Mississippi State University 
Research Engineer I, Civil Engineering 

Cecile W. Ward, M.A.T. 
Georgia State University 
Lecturer, Modern Languages 

Henderson C. Ward, Ph.D. 
Georgia Institute of Technology 
Professor, Chemical Engineering 

Roger M. Wartell, Ph.D. 
University of Rochester 
Associate Professor, Physics 

Thomas L. Weatherly, Ph.D. 
Ohio State University 
Professor, Physics 

Charles E. Weaver, Ph.D. 
Pennsylvania State University 
Professor and Director, Geophysical Sciences 

Lynn E. Weaver, Ph.D. 
Purdue University 
P.E. (Oklahoma) 
Professor and Director, Nuclear Engineering 

Roger P. Webb, Ph.D. 
Georgia Institute of Technology 
P.E. (Georgia) 
Professor, Electrical Engineering 

LaNor J. Weems, M.S.C.E. 
Georgia Institute of Technology 
Professor, Civil Engineering 

Jay A. Weinstein, Ph.D. 
University of Illinois 
Associate Professor, Social Sciences 

Gerald A. Wempner, Ph.D. 
University of Illinois 
Professor, Engineering Science and Mechanics 

Nicholas J. Weyland, Ph.D. 
University of Notre Dame 
Assistant Professor, Mathematics 

Earl R. Wheby, M.S.I.M. 
Georgia Institute of Technology 
Associate Professor, Civil Engineering 

John A. White, Jr., Ph.D. 
Ohio State University 
P.E. (Virginia) 
Professor, Industrial and Systems Engineering 

Mark G. White, Ph.D. 
Rice University 
Assistant Professor, Chemical Engineering 

Thomas M. White, Jr., Ph.D. 
Georgia Institute of Technology 
Professor, Electrical Engineering 

Roy A. Wiggins, Jr., M.D. 
Emory University 
Adjunct Professor, Chemical Engineering 

Willard E. Wight, Ph.D. 
Emory University 
Professor, Social Sciences 

Arthur W. Wilhelm, M.A. 
Emory University 
Lecturer, Modern Languages 

Michael K. Wilkinson, Ph.D. 
Massachusetts Institute of Technology 
Adjunct Professor, Physics 

I. Edwin Wilks, M.S. 
Illinois Institute of Technology 
Associate Professor, Civil Engineering 

Kenneth E. Wilf, Ph.D. 
University of Texas, Austin 
Assistant Professor, Civil Engineering 

Richard M. Williamson, Ph.D. 
University of Florida 
Adjunct Assistant Professor, Physics 

Fred E. Williams, Ph.D. 
Purdue University 
Associate Professor, Industrial Management 

J. Quilton Williams, Ph.D. 
Duke University 
Professor, Physics 

J. Richard Williams, Ph.D. 
Georgia Institute of Technology 
Professor and Associate Dean, College of Engineering 

John E. Williams, D.Arch. 
University of Michigan 
R.A. (Michigan) 
Associate Professor, Architecture 

Wendell M. Williams, Ph.D. 
Ohio State University 
P.E. (Ohio) 
Assistant Professor, Mechanical Engineering 

Marilin L. Williamson, M.Ln. 
Emory University 
Librarian-Assistant Professor 

William J. Willkie, B.A. 
University of New Mexico 
Lieutenant, U.S. Navy 
Assistant Professor, Navy ROTC
Richard Wilson, A.A.Dipl.
Architectural Assn., School of Architecture, London
R.A. (Georgia)
Professor, Architecture

Charles E. Windish, M.A.
Florida State University
Lecturer, Modern Languages

Herbert L. Windom, Ph.D.
Scripts Oceanographic Institute
Associate Professor, Geophysical Science

Jean D. Wineman, D.Arch.
University of Michigan
Assistant Professor, Architecture

Ward O. Winer, Ph.D.
University of Michigan
P.E. (Georgia)
Professor, Mechanical Engineering

Gerrit Wolf, Ph.D.
Cornell University
Professor, Industrial Management

Robert Edward Wood, Ph.D.
University of Virginia
Assistant Professor, English

LeRoy A. Woodward, M.S.
University of Michigan
Associate Professor, Physics

W. E. Wooll, M.A.
Emory University
Associate Professor, Physics

Paul H. Wright, Ph.D.
Georgia Institute of Technology
P.E. (Georgia)
Professor, Civil Engineering

Robert L. Wright, M.Arch.
University of Illinois
Associate Professor, Architecture

James C. Wu, Ph.D.
University of Illinois
Professor, Aerospace Engineering

Roy O. Wyatt, Jr., M.A.
University of Alabama
Assistant Professor, Modern Languages

L. David Wyly, Jr., Ph.D.
Yale University
Regents' Professor, Physics

Dorothy C. Yancy, Ph.D.
Atlanta University
Assistant Professor, Social Sciences

Edward K. Yeargers, Ph.D.
Michigan State University
Associate Professor, Biology

C. Michael York, Ph.D.
University of Maryland
Associate Professor, Psychology

Donovan B. Young, Ph.D.
University of Texas, Austin
P.E. (Georgia)
Associate Professor, Industrial and Systems Engineering

James D. Young, Ph.D.
Rice University
Professor, English

R. A. Young, Ph.D.
Polytechnic Institute of Brooklyn
Professor, Physics

Robert J. Young, B.Arch. and M.C.E.
University of Illinois
R.A. (Louisiana) and P.E. (Georgia)
Associate Professor, Architecture

Nai-Teng Yu, Ph.D.
Massachusetts Institute of Technology
Associate Professor, Chemistry

Louis J. Zahn, Ph.D.
University of North Carolina
Professor and Head, Modern Languages

Leon H. Zalkow, Ph.D.
Georgia Institute of Technology
Professor, Chemistry

Doron Zeilberger, Ph.D.
Weizmann Institute of Science
Visiting Assistant Professor, Mathematics

Michael D. Zeiler, Ph.D.
New School for Social Research
Adjunct Lecturer, Psychology

Stephen M. Zemyan, Ph.D.
University of Maryland
Visiting Assistant Professor, Mathematics

Craig M. Zimring, Ph.D.
University of Massachusetts
Instructor, Architecture

Ben T. Zinn, Ph.D.
Princeton University
Regents' Professor, Aerospace Engineering

Pranas Zunde, Ph.D.
Georgia Institute of Technology
Professor, Information and Computer Science

Emeriti

Tom F. Almon, M.A.
Peabody College
Professor Emeritus, English

James Hal Armstrong, Ph.D.
Iowa State University, Ames
Associate Professor Emeritus, Engineering Science and Mechanics

Ewell I. Barnes, B.S.
Berry College
Vice-president for Business and Finance

James E. Boyd, Ph.D.
Yale University
Professor Emeritus, Physics and Director Emeritus, Engineering Experiment Station

Hin Bredendieck, Diploma
Bauhaus, Dessau, Germany
Professor Emeritus, Industrial Design

Maurice R. Brewster, M.B.A.
Northwestern University
Professor Emeritus, Industrial Management

Bryan L. Brown, M.S.M.E.
Yale University
Professor Emeritus, Engineering Science and Mechanics

Anne P. Bugg, B.A.
Emory University
Librarian-Associate Professor Emeritus

Harold Bush-Brown, M.Arch.
Harvard University
Professor Emeritus, Architecture

Joseph A. Campoamor, M.A.
Burgos University
Professor Emeritus, Modern Languages

William L. Carmichael, M.S.
Georgia Institute of Technology
Registrar and Director of Admissions Emeritus

Marion Robert Carstens, Ph.D.
State University of Iowa
Professor Emeritus, Civil Engineering

David B. Comer III, Ph.D.
Duke University
Professor Emeritus and Head Emeritus, English

Dorothy Crosland, Certificate in Library Science
Emory University
Director Emeritus, Library

Hubert E. Dennison, A.B.
University of Tennessee
Professor Emeritus, Industrial Management

Herman A. Dickert, Sc.D.
Newberry College
Professor Emeritus, Textile Engineering

Donnell W. Dutton, M.S.
Georgia Institute of Technology
Professor Emeritus, Aerospace Engineering

Paul T. Eaton, Ph.D.
Aachen Techn. Hochs., University of Frankfurt
Professor Emeritus, Industrial and Systems Engineering

Henry Leitner Edwards, Ph.D.
University of North Carolina
Professor Emeritus, Chemistry

John Gran Eichler, M.C.E.
Syracuse University
Professor Emeritus, Civil Engineering

Niels N. Engel, Dr.Ing.
Max Planck Institute fur Eisenfor schung
Professor Emeritus, Chemical Engineering

Walter P. Ewalt, M.A.
University of Michigan
Professor Emeritus, Physics

R. K. Flege, M.S.
Massachusetts Institute of Technology
Professor Emeritus, Textile Engineering

John L. Fulmer, Ph.D.
University of Virginia
Regents' Professor Emeritus, Economics

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Emory University
Professor Emeritus, Social Sciences

James H. Grady, B.Arch.
Ohio State University
Professor Emeritus, Architecture

George C. Griffin, M.S.
Georgia Institute of Technology
Dean of Students Emeritus

Frank F. Groseclose, M.S.
Virginia Polytechnic Institute
Professor Emeritus and Director Emeritus, Industrial Engineering

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Duke University
Professor Emeritus English

A. Frank Hamrick, M.A.
Wake Forest University
Associate Professor Emeritus, English
William Carey Hansard, B.S.  
Georgia Institute of Technology  
Associate Professor Emeritus, Ceramic Engineering

Julian H. Harris, B.S. Arch.  
Georgia Institute of Technology  
Professor Emeritus, Architecture

Edwin Davies Harrison Ph.D.  
Purdue University  
President Emeritus

Paul M. Heffernan, M.Arch.  
Harvard University  
Professor Emeritus, Architecture and Director Emeritus, College of Architecture

George Hendricks, Ph.D.  
Columbia University  
Professor Emeritus, Social Sciences

Francis Marion Hill, M.S.E.  
University of Michigan  
Professor Emeritus, Engineering Science and Mechanics

F. Kenneth Hurd, Ph.D.  
University of California  
Professor Emeritus, Electrical Engineering

William Ben Johns, Jr., Ph.D.  
Purdue University  
Professor Emeritus, Mechanical Engineering

R. Kenneth Jacobs, Ph.D.  
University of Michigan  
Professor Emeritus and Head Emeritus, Engineering Graphics

William Ben Johns, Jr., M.S.  
Georgia Institute of Technology  
Professor Emeritus, Engineering Mechanics

Thomas W. Kethley, M.S.  
Emory University  
Professor Emeritus, Biology

Carl E. Kindsvater, M.S.  
State University of Iowa  
Regents Professor Emeritus and Director Emeritus, Environmental Resources Center

James H. Lucas, M.S.  
Georgia Institute of Technology  
Professor Emeritus, Civil Engineering

James W. McCarty, M.S.  
Georgia Institute of Technology  
Associate Professor Emeritus, Textile Engineering

Howard L. McKinley, M.S.  
Georgia Institute of Technology  
Professor Emeritus, Electrical Engineering

Howard K. Menhinick, M.L.A.C.P.  
Harvard University  
Regents Professor Emeritus, City Planning

Lane Mitchell, Ph.D.  
Pennsylvania State University  
Professor Emeritus and Director Emeritus, Ceramic Engineering

Joseph E. Moore, Ph.D.  
Peabody College  
Regents Professor Emeritus Psychology

Phil B. Narmor, Ph.D.  
University of Michigan  
Regents Professor Emeritus, Engineering Mechanics

Frank O. Nottingham, Jr., Ph.D.  
Purdue University  
Professor Emeritus, Electrical Engineering

Rudnor Joseph Paquette, M.S.  
Michigan College of Mining and Technology  
Professor Emeritus, Civil Engineering

William J. Proctor, M.A.  
Vanderbilt University  
Professor Emeritus, Engineering Management

Edward Theron Prosser, M.A.  
Ohio Wesleyan University  
Professor Emeritus, Physics

Glenn W. Rainey, M.A.  
Emory University  
Professor Emeritus, English

William Monroe Spencer, Ph.D.  
University of Virginia  
Professor Emeritus and Director Emeritus, Chemistry

Ralph R. Spillman, M.A.  
University of North Carolina  
Professor Emeritus, English

William R. Spruill, M.A.  
Georgia State University  
Associate Professor Emeritus, English

Austin L. Starrett, A.M.  
Harvard University  
Professor Emeritus, Mathematics

Robert E. Stiemke, M.S.  
University of Wisconsin  
Professor Emeritus, Civil Engineering

Charles E. Stoneking, Ph.D.  
Kansas State College  
Professor Emeritus, Engineering Science and Mechanics

James L. Taylor, Ph.D.  
University of North Carolina  
Professor Emeritus and Director Emeritus, Textile Engineering

Joseph P. Vidosic, Ph.D.  
Purdue University  
Regents Professor Emeritus, Mechanical Engineering

Andrew J. Walker, Ph.D.  
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Columbia University
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Georgia Institute of Technology
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Washington University
Senior Research Scientist
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University of Florida
P.E.(Florida)
Senior Research Engineer
Nicholas S. Gibson, M.A.
Georgia State University
Research Scientist II
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University of Arizona
Senior Research Engineer

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Georgia Institute of Technology
Research Scientist I

Douglas W. Robertson, M.S.
Georgia Institute of Technology
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Clyde G. Roby, Jr., B.S.
Virginia Polytechnic Institute
Senior Research Scientist I

Don E. Rogers, M.S.
Polytechnic Institute of Brooklyn
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Emory University
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Georgia Institute of Technology
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Robert G. Shackelford, M.S.
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Georgia Institute of Technology
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Orman A. Simpson, Jr., M.S.
Georgia Institute of Technology
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Georgia Institute of Technology
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Stanton B. Smith, Ph.D.
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Georgia Institute of Technology
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Georgia Institute of Technology
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David W. Wade, M.B.A.
Georgia State University
P.E.(Georgia)
Research Engineer II

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Georgia Institute of Technology
Research Engineer II

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Georgia Institute of Technology
Research Engineer I

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Georgia Institute of Technology
Research Engineer II

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Georgia Institute of Technology
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Georgia Institute of Technology
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Georgia Institute of Technology
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Georgia Institute of Technology
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Georgia Institute of Technology
Research Scientist II

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Georgia Institute of Technology
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University of Georgia
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Georgia Institute of Technology
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Georgia Institute of Technology
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