### TENTATIVE CALENDAR 1973-74*

#### Summer Quarter 1973
- **June 25**: Registration.
- **July 4**: Holiday.
- **Sept. 1**: End of term.

#### Fall Quarter 1973
- **Sept. 17**: Registration.
- **Nov. 22**: Begin Thanksgiving recess.
- **Nov. 25**: Last day of Thanksgiving recess.
- **Dec. 8**: End of term.
- **Dec. 9**: Begin Christmas recess.
- **Jan. 2**: Last day of Christmas recess.

#### Winter Quarter 1974
- **Jan. 3**: Registration.
- **Mar. 20**: End of term.
- **Mar. 21**: Begin Spring recess.
- **Mar. 26**: Last day of Spring recess.

#### Spring Quarter 1974
- **Mar. 27**: Registration.
- **June 8**: End of term.

#### Summer Quarter 1974
- **June 20**: Registration.
- **Aug. 31**: End of term.

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*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.
1. General Information
THE GEORGIA TECH HERITAGE

The Georgia Institute of Technology, founded in 1885, is a co-educational institution of higher learning located in the heart of 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 128 students, all but one from Georgia. This year over 8,000 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 by the same name, football, and hard-working students who approach work with zest and ingenuity. Georgia Tech alumni support, from graduates scattered throughout the world, is consistently among the strongest in the nation.

ACADEMIC OFFERINGS

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.

Undergraduate degrees are offered in the four broad areas of engineering, architecture, science, and management; specific degrees offered are listed in the Curricula and Degrees section. Certain of these curricula can be specifically tailored as preparation for later professional study in law, medicine or dentistry. Army, Air Force, and Navy ROTC are offered on a voluntary basis.

Some students wishing to obtain practical experience while helping finance their education should investigate Tech's co-operative program, which allows alternating quarters of schooling with quarters of work in industry. In five years the student is awarded a degree in his chosen field with a co-op designation. Those interested should write or call the Co-operative Division for necessary forms and a special catalog.

Other students may wish to obtain both a liberal arts education and a professional technological education; they can enter the dual degree program. Georgia Tech has agreements with over 60 liberal arts institutions in the nation to allow students three years of liberal arts study after which they transfer to Georgia Tech as juniors to complete the two final years of professional technological study. At the end of the five-year program, the students are awarded both a bachelor's degree from the liberal arts institution and a bachelor's degree in his chosen professional field at Tech. Those interested should call or write the College of Engineering for necessary forms and further information.

Outstanding high school students may qualify for the Joint Enrollment Program for High Schoolers (JEPHS), under which the student enters Tech after completing the eleventh grade. At the end of his freshman year at Tech, he is awarded his high school diploma. All courses taken at Tech also apply toward an institute degree.

Extracurricular activities that allow a student to broaden his education are described in the Student Handbook. Short-term travel/study programs are also available.

ACCREDITATION

The Georgia Institute of Technology is an accredited member of the Southern Association of Colleges and Schools. All of the four-year engineering curricula leading to bachelor's degrees in engineering and the five-year program leading to a master's degree in sanitary engineering are accredited by the Engineers' Council for Professional Development, the national engineering accrediting agency. The curriculum leading to the degree Master of Architecture is accredited by the National Architecture Accrediting Board. The curriculum leading to the B.S. 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.

DEFINITION OF LEGAL RESIDENCE

To be considered a legal resident of Georgia for the purpose of registering at an institution of the University System of Georgia, a student must establish the following facts to the satisfaction of the Residence Committee of that institution:

1. A student who is under 18 years of age at the time he seeks to register or re-register at the beginning of any quarter will be accepted as a resident student only upon a showing by him that his supporting parent or guardian has been legally domiciled in Georgia for a period of at least twelve months immediately preceding the date of registration or re-registration.

2. In the event that a legal resident of Georgia is appointed as guardian of a non-resident minor, such minor will not be permitted to register as a resident student until the expiration of one year from the date of appointment, and then only upon proper showing that such appointment was not made to avoid payment of the non-resident fee.

3. If a student is over 18 years of age, he may register as a resident student only upon showing that he has been domiciled in Georgia for at least twelve months prior to the registration date. Any period of time during which a person is enrolled as a student in any educational
institution in Georgia may not be counted as a part of the twelve months' domicile and residence herein required when it appears that the student came into the state and remained in the state for the primary purpose of attending a school.

4. A full-time faculty member of the University System, his or her spouse, and minor children may register on the payment of resident fees, even though such faculty member has not been a resident in Georgia for twelve months.

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

6. Military personnel and their dependents may become eligible to enroll in institutions of the University System as resident students provided they file with the institution in which they wish to enroll the following:
   (a) A statement from the appropriate military official showing that the applicant's "home of record" is the State of Georgia; and
   (b) Evidence that applicant is registered to vote in Georgia; or
   (c) Evidence that applicant, if under 18 years of age, is the child of parents who are registered to vote in Georgia; and
   (d) Evidence that applicant, or his supporting parent or guardian, filed a Georgia State income tax return during the preceding year.

7. Foreign students who attend institutions of the University System under 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. All aliens shall be classified as non-resident students; provided, however, that an alien who is living in this country under a visa permitting permanent residence or who has filed with the proper federal immigration authorities a Declaration of Intention to become a citizen of the United States shall have the same privilege of qualifying for resident status for fee purposes as has a citizen of the United States.

9. Teachers in the public schools of Georgia and their dependents may enroll as students in University System institutions on the payment of resident fees, when it appears that such teachers have resided in Georgia for nine months, that they were engaged in teaching during such nine months' period, and that they have been employed to teach in Georgia during the ensuing school year.

10. If a woman who is a resident of Georgia and who is a student in an institution of the University System marries a non-resident of the state, she may continue to attend the institution on payment of resident fees, provided that her enrollment is continuous.

11. If a woman who is a non-resident of Georgia marries a man who is a resident of Georgia, she will not be eligible to register as a resident student in a University System institution until she has been domiciled in the State of Georgia for a period of twelve months immediately preceding the date of registration.

12. Non-resident graduate students who hold assistantships that require at least one-third time service may register as students at the institution in which they are employed on payment of resident fees.

PLEASE NOTE: In order to avoid delay and inconvenience upon arrival for registration, if there is any question in your mind concerning your residence status, application for clarification should be made immediately or not later than one month prior to the registration date. Applications should be addressed to Residence Committee, Georgia Institute of Technology, Atlanta, Georgia 30332.

SPECIAL SUPPORTING FACILITIES

LIBRARY
The Price Gilbert Library's scientific, engineering and management collection includes 750,000 volumes, 600,000 microtext, and 175,000 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. In 1962 it was designated one of twelve Federal Scientific Report Centers, and its collection of such documents from governmental agencies now totals 500,000 titles. The library is a depository for government publications issued by the U.S. Government Printing Office and for maps issued by the U.S. Army Topographic Command. The government documents collection contains 225,000 publications and 100,000 maps.

Over 9,300 serials, including 5,000 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.

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. The library is also affiliated with the University of Georgia's Information Dissemination Center, which provides computer-based searches of published literature. Approximately 85 percent of the library's holdings are recorded on magnetic tape.
ENGINEERING EXPERIMENT STATION

The Georgia Tech Engineering Experiment Station, activated in 1934, operates a number of specialized facilities of importance to industrial and academic research. These include chemical and physical analytical laboratories, two electron microscopes, a central machine shop, and a photographic and reproduction laboratory. The research and development laboratories include some of the South's most advanced technological facilities in areas that include the biological, chemical, nuclear and physical sciences, electronics and microwave engineering, high temperatures and materials, mechanical design and development, and waste product utilization. The industrial extension service, which works with business and industry to further the economic and technological growth of Georgia, maintains offices in Albany, Augusta, Carrollton, Douglas, Macon, Rome and Savannah. Graduate students may be appointed as Graduate Research Assistants in the Engineering Experiment Station, and may participate in investigations that could provide the subject of a thesis.

FRANK H. NEELY NUCLEAR RESEARCH CENTER

The Frank H. Neely Nuclear Research Center provides Georgia Tech with outstanding research capability in fields of interest to nuclear engineering. Included are a heavy-water-moderated, five-megawatt research reactor, a low-power training reactor, a sub-critical assembly, PDP-8 data acquisition system, hot cells for handling highly radioactive materials remotely, a 12,000-curie cesium-137 radiation source, a one-million-volt Van de Graaff accelerator, and a californium-252 neutron source.

COMPUTER FACILITIES

The Office of Computing Services provides a wide range of computing services in instruction, research and administration. The center operates a Univac 1108 in the Shared Processor System configuration with batch, demand, and remote time-sharing facilities. A Calcomp Digital Plotter system and an Analog-to-Digital conversion system are also available. An IBM 360/30 computer is used for administrative support. Georgia Tech is a leading institution in a National Science Foundation sponsored experiment to implement a regional computer network.

The School of Information and Computer Sciences also operates a Burroughs B-5500, a multiprogramming and multiprocessing system with remote time sharing capabilities; two PDP computer systems; and an information processing laboratory.

The Applied Computer Research Division conducts computer-related research.

OAK RIDGE ASSOCIATED UNIVERSITIES

Georgia Tech is a member of the ORAU. Through this cooperative association, the school has at its disposal the facilities of the National Laboratories at Oak Ridge. When a master's or doctoral candidate has completed his resident work at Georgia Tech, it is possible for him to go to Oak Ridge to do his research problem and to prepare his thesis.

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.

BIOENGINEERING CENTER

The Bioengineering Center serves as a focal point in the application of the knowledge, techniques, and approaches of the physical and engineering sciences to the problems and research areas of the life sciences. The center assists individual schools and departments in developing relevant interdisciplinary study and research opportunities for qualified students. Cooperative programs with other units of the University System and with the Emory University School of Medicine provide additional opportunities for bioengineering education and research.

HEALTH SYSTEMS RESEARCH CENTER

The HSRC offers an interdisciplinary and interinstitutional program of health systems research, education, and service, applying the disciplines of industrial and systems engineering, operations research, and management science. The center coordinates health systems programs throughout the University System and cooperates with other academic and health organizations throughout Georgia in such programs as Systems Improvement Services to Georgia hospitals. Research programs are concerned mainly with developing systems for planning, designing, and managing health care facilities, manpower, and methods, and with techniques for evaluating current and proposed health care delivery systems. The center also provides educational seminars and courses, and provides data sources for health systems research. Courses and curricula of the Program in Health Systems, administered by HSRC through the College of Engineering, are described in the Curricula and Degrees section.

ENVIRONMENTAL RESOURCES CENTER

This multidisciplinary center coordinates the application of Tech's resources to programs involving science and technology, socio-economic systems, and the natural environment in an effort to anticipate and solve problems of ecology. The center administers federal traineeships in water resources planning and management, and administers and aids in developing research programs
related to the environment. It cooperates with academic schools and departments in the development of multidisciplinary curricula, and offers special courses and directed studies concerning environmental problems.

DEPARTMENT OF CONTINUING EDUCATION

This department conducts up to 200 educational programs annually designed to help professionals in technology keep pace with their field, advance in their profession, or retrain for a related field. The short-term courses are intensive in subject coverage. 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.

SOUTHERN TECHNICAL INSTITUTE

STI is a unit of the Georgia Tech Engineering College that is designed for the student who wishes to become an engineering technician, engineering technologist, or Fire Science Technician. Eleven two- and ten four-year technology programs leading to the associate or baccalaureate degree are offered at the Southern Technical Institute campus at Marietta, Georgia. These curricula are designed to provide the basic scientific training, the specialized technical “know-how,” and the supervisory and management training needed by the engineering technician. The courses are briefer, more intensive, and more specific in purpose than those of the professional engineering curricula, although they lie in the same fields of industry and engineering. Their aim is to prepare the individual for specific technical positions or lines of activity rather than for broad sectors of engineering practice. A catalog is available upon request.

STUDENT SERVICES

Complete information concerning all student activities, organizations, and general student information is contained in the Student Handbook, which is made available to all students on campus.

INFIRMARY

The modern 70-bed infirmary is fully staffed with medical doctors, registered nurses, and medical and psychological consultants. All students are provided this service for a $15.00 quarterly fee. Major medical insurance is optional at a nominal fee.

COUNSELING CENTER

A 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.

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.

STUDENT CENTER

The Student Center is the campus “living room.” The staff and facilities of this center plan and coordinate constant programs and activities for students, faculty, alumni, and their guests.

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.

ORIENTATION

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.

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.

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 400 students from 60 foreign countries assist in providing programs to promote intracultural understanding and adjustment.

FRATERNITIES

The Fraternity Affairs Office coordinates and administers the many activities and programs of the 30 social fraternities and sororities on the Tech Campus.
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 effect the student in some manner.

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 F.M. radio station.

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, but interviews can be arranged at any time with at least two weeks notice.

AFFILIATED ORGANIZATIONS

THE GEORGIA TECH ATHLETIC ASSOCIATION

This nonprofit corporation administers intercollegiate sports at Georgia Tech. The Board of Directors consists of seven faculty members, three alumni, and three students. The president of Tech is chairman 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 create adequate facilities for every student to take part in some athletic activity. Intercollegiate schedules are played in football, basketball, cross country, swimming, track, golf, tennis, baseball, gymnastics, and wrestling.

THE GEORGIA TECH NATIONAL ALUMNI ASSOCIATION

The Alumni Association is a nonprofit corporation dedicated to serving Georgia Tech. Some of its objectives are: maintain an up-to-date record of each alumnus; publish the Georgia Tech Alumnus and Tech Topics; 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 alumni secretary acts as a central contact for alumni.

THE GEORGIA TECH FOUNDATION, INC.

This non-profit 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 undertake special programs, which cannot be financed by state funds, for the development of Georgia Tech; and to enable faculty members to improve their professional qualifications and standing by grants for such purposes as advanced degrees.

THE GEORGIA TECH RESEARCH INSTITUTE

This nonprofit corporation administers and seeks funds for research activity at Georgia Tech, both in the academic colleges and in the Engineering Experiment Station. It is the coordinating agency for patent applications and other matters related to the protection and use of technological discoveries made at Georgia Tech.

STUDENT RULES AND REGULATIONS

All students, both undergraduate and graduate, are expected to be thoroughly familiar with Part Six of this catalog, Student Rules and Regulations, and will be held responsible for all information it contains.
2. Information for Undergraduate Students
DEGREES
The Georgia Institute of Technology at present offers curricula leading to the following undergraduate degrees shown in the order of their establishment.

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

To graduates who have completed their courses under the cooperative plan, the degree is awarded with the designation "Cooperative Plan."

ACADEMIC REGULATIONS
Detailed information regarding the academic regulations of the institute is contained in Part Six of this catalog - Student Rules and Regulations. Questions concerning academic regulations should be directed to the general office of the students' major school or to the Office of the Registrar, Room 104, Administration Building.

EXAMINATION AND GRADE REPORTS
Final examinations are scheduled during the last week of each quarter and reports of the students' academic progress are issued after the close of the quarter.

CONSTITUTION AND HISTORY EXAMINATIONS
The Georgia law as amended March 4, 1953 requires that before graduation 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. 3001, or Hist. 3004.

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 received directly from the previous institution must be provided the Office of the Registrar by the student before the credit can be awarded.

SELECTIVE SERVICE
Current academic status will be furnished to the Selective Service System (local draft boards) upon written request by the student. A Selective Service information card is provided for this purpose. Once requested, however, subsequent changes in status are reported automatically until the authorization is retracted by the student. Any questions concerning student deferments should be directed to the Office of the Registrar, Room 104 Administration Building.

SCHOLASTIC AVERAGE
The scholastic average of an undergraduate student includes the grades of all courses scheduled after being admitted to the institute. Grades received on previous courses are not replaced by higher or lower grades received at some later date. All course grades are averaged in just as any new course scheduled. The graduate average includes the grades on all courses scheduled by the student after being admitted to the graduate division, plus the grades on all courses listed on the student's Approved Program of Study which have been earned at Georgia Tech prior to his admission to the graduate division. The scholastic average is computed by dividing the total number of quality points earned by the total number of credit hours scheduled.

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 Part Six, section XVI.
PHYSICAL TRAINING CREDIT

All degrees require three 1000-level courses of physical training including PT 1010. Individual schools must allow a minimum of three hours of physical training and may allow as many as six hours of physical training to be counted toward degree requirements. Students should check with their individual schools in order to determine the number of hours of physical training that may be counted toward their respective degrees. See Part Six, section XV.

GRADING SYSTEM

Detailed information regarding the grading system is contained in Part Six of this catalog. Student Rules and Regulations, Section IV.

HUM./S.S. REQUIREMENTS

A tabulation of the work required for degrees in the curricula offered by the Georgia Institute of Technology is given in Part Four of this catalog.

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

ENGINEERING COLLEGE

All students enrolled in curricula of the Engineering College must take at least 36 hours of humanities and social sciences distributed as follows:

At least 18 hours of humanities (including at least 3 hours of literature) selected from the following subjects:

- Modern Languages:
  - German: 3001, 3002, 3003, 4001, 4002, 4003, 4021, 4022, 4023, 4091, 4092, 4093.
  - Russian: 3001, 3002, 3003.
  - Spanish: 3001, 3002, 3003, 3006, 4001, 4002, 4003, 4004, 4007, 4008, 4009, 4010, 4091, 4092, 4093.
  - French: 3001, 3002, 3003, 4001, 4002, 4003, 4091, 4092, 4093.
  - Architecture: 3201, 3202, 3203, 4201, 4202, 4203, 4242, 4243, 4244, 4245, 4246.

At least 18 hours of social sciences (including at least 3 hours of history and 3 hours of American government) selected from the following subjects:

*Up to 9 hours of beginning modern language may be included, provided that 9 additional hours of 2000-level or higher course work in the same language are also completed.

GENERAL COLLEGE AND INDUSTRIAL MANAGEMENT COLLEGE

All students enrolled in curricula of either the General College or the Industrial Management College must take at least 36 hours of humanities and social sciences distributed as follows:

At least 18 hours of humanities (including at least 3 hours of literature) selected from the following subjects:

- Modern Languages:
  - German: 1001, 1002, 1003, 3001, 3002, 3003, 4001, 4002, 4003, 4004, 4007, 4008, 4009, 4010, 4091, 4092, 4093.
  - Russian: 1001, 1002, 1003, 3001, 3002, 3003.
  - Spanish: 1001, 1002, 1003, 3001, 3002, 3003, 3006, 4001, 4002, 4003, 4004, 4007, 4008, 4009, 4010, 4091, 4092, 4093.
  - French: 1001, 1002, 1003, 3001, 3002, 3003, 3004, 3005, 3006, 3007, 3008, 3009, 3010, 3011, 3012, 3013, 3017, 3018, 3020, 3022, 3024, 3025, 3028, 3040, 4025, 4075, 4925.
  - Philosophy and History of Science: 1126, 1127, 1128, 3100, 3102, 3103, 3104, 3105, 3107, 3108, 3115, 3116, 3117, 3118, 3119, 3120, 3121, 3122, 4108, 4110, 4115, 4116, 4948, 4949.
  - Political Science: 1251, 1253, 2270, 2271, 3200, 3203, 3204, 3205, 3210, 3215, 3216, 3217, 3265, 3266, 3270, 3275, 3276, 3280, 3281, 4210, 4211, 4950.
  - Sociology: 1376, 1377, 3306, 3310, 3330, 3334, 3335, 3338, 3339, 3875, 3876, 3877, 4306, 4308, 4750, 4999.
  - Modern Languages:
    - Psychology: 3300, 3303, 3304, 4400, 4402, 4410, 4423, 4750.
  - Socio-technology:
    - C.E.: 4143.

History: 1001, 1002, 3003, 3004, 3010, 3011, 3012, 3013, 3017, 3018, 3020, 3022, 3024, 3025, 3028, 3040, 4025, 4075, 4925.

General College and Industrial Management College / 17
At least 18 hours of social sciences (including at least 3 hours of history and 3 hours of American government) selected from the following subjects:

Social Science:
- History: 1001, 1002, 3003, 3004, 3010, 3011, 3012, 3013, 3017, 3018, 3020, 3022, 3024, 3025, 3028, 3040, 4025, 4075, 4925.
- Philosophy and History of Science: 1126, 1127, 1128, 3100, 3102, 3103, 3104, 3105, 3107, 3108, 3115, 3116, 3117, 3118, 3119, 3120, 3121, 3122, 4108, 4110, 4115, 4116, 4948, 4949.
- Political Science: 1251, 1253, 2270, 2271, 3200, 3203, 3204, 3205, 3210, 3215, 3216, 3217, 3265, 3266, 3270, 3275, 3276, 3280, 3281, 4210, 4211, 4950.
- Sociology: 1376, 1377, 3306, 3310, 3330, 3334, 3335, 3338, 3339, 3875, 3876, 3877, 4306, 4308, 4750, 4999.

Modern Languages:
- Psychology: 3300, 3304, 4400, 4402, 4410, 4423, 4750.

ADMISSIONS

Admission requirements for freshmen and transfer students are explained in detail in the Prospective Student Bulletin, which is available upon request from the Office of the Director of Admissions, Georgia Tech, Atlanta, Georgia 30332. Leaflets of condensed information especially designed for prospective freshmen and prospective transfer students are also available upon request.

Students accepted for admission have been, insofar as is possible, determined to possess a record of past academic achievement and tested scholastic aptitude sufficient for completing requirements for the desired degree. This assumes the student possesses the necessary motivation and willingness to expend the required time and effort to maintain a satisfactory academic record.

ACCEPTANCE DEPOSIT

All admitted students must make acceptance and dormitory deposits as required in the letter of admission.

HEALTH INFORMATION RECORD

Each admitted student will be required to submit a health information record form, which will be sent with the notice of acceptance. See section XIV-B of Part Seven, Student Rules and Regulations, for further directions.

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 Office of Registrar, and must be completed and returned at least 20 calendar days prior to the beginning of the quarter to which readmission is sought. Additional information is available in Part Six of this catalog, Student Rules and Regulations.

ADVANCED PLACEMENT AND HONORS PROGRAMS

Superior students entering Georgia Tech may receive college credit for courses completed in high school if their grades and scores on the advanced placement tests or the achievement tests of the College Entrance Examination Board (CEEB) indicate a satisfactory knowledge of college coursework. Advanced placement and credit are offered by the schools of Chemistry, Mathematics, and Physics; and departments of English, Modern Languages, and Social Sciences on the basis of Advanced Placement Test results of the CEEB Advanced Placement Program. Advanced sectioning is possible in the School of Chemistry, and an honors program is offered in the School of Mathematics. Participation in the advanced placement and honors programs is voluntary.

PRE-MED – PRE-DENTAL – PRE-LAW PROGRAMS

Pre-med, pre-dental, and pre-law programs are all offered at Georgia Tech. None of these are specified as degree programs as such; but if a student takes the proper courses from the various Tech curriculums, these objectives can certainly be met. A major may be declared in almost any engineering or science area for pre-medical or pre-dental and in almost any engineering or management area for pre-law. Commonly, if one wants to obtain a pre-med or pre-dental background, a major in biology is declared. The courses taken routinely in the first three years in biology include all of the courses listed in Medical School Admissions Requirements, USA and Canada, published by the Association of American Medical Colleges. Other quite logical majors for pre-med and pre-dental are chemistry, chemical engineering, electrical engineering, mechanical engineering, physics, and psychology.

AUDITORS

Any officially enrolled student who has obtained the approval of his advisor 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 publish-ed in the college calendar for each given 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 sit in on a course providing permission is obtained from the department concerned and the registrar.

ADMISSION OF WOMEN

By action of the Board of Regents on December 13, 1967, qualified women students were ruled eligible for admission in all programs of study offered at Georgia Tech. The requirements for admission and the regulations governing students apply alike to men and women, except that women students will not be required to schedule physical training but will take a health education course to make up the credit hours.

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 go in person to the nearest Veterans' Administration Office to make application. The Veterans' Administration will require such items as proof of discharge, marriage license, birth certificate, and other documentation needed to define an individual's eligibility. After the Veterans' Administration has evaluated these documents and your application, they will issue a certificate of eligibility. This certificate of eligibility will be processed by Georgia Tech on registration day for your first quarter of enrollment. After you have received this certificate of eligibility, any questions regarding procedures for enrolling should be directed to the director of Financial Aid, located in the Administration Building on the Georgia Tech campus.

The veteran planning to further his education 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.

Most veterans who served on active duty for more than 180 days, any part of which occurred after January 31, 1955, 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. Contact your local Veterans Administration office for complete details.

The local Atlanta Veterans Administration address is: 730 Peachtree Street, N.E., Atlanta, Georgia 30308.
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 desires to help, 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 students wishing to receive scholarships, loans, or any other type of monetary aid should contact this office for information and service.

International students may apply for scholarship aid, but because of limited funds and other restrictions should not normally expect assistance.

Transfer students will be considered for scholarships, loans, and work opportunities as other entering students and should adhere to the February 1 deadline if they wish assistance for any quarter of the year beginning with the subsequent fall quarter, since all scholarships for enrolled and transfer students are awarded during the summer.

Although the co-operative 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 co-operative plan and earns from $2,000 to $2,800 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 co-operative plan will not be denied consideration for other aid because of his enrollment. Students desiring other information on the co-operative program should write to the director of the Co-operative 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 family. Any financial aid is, therefore, awarded according to individual need and individual college costs. Financial aid includes scholarships, 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 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.

Applications for financial aid may be obtained by calling or writing: Director of Financial Aid, Georgia Institute of Technology, Atlanta, Georgia 30332, (404) 894-4160. Requests for further information on any programs 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 in Schools of 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 Adams Estate.

Each student so honored receives, in addition to the engraved silver medal, a certificate citing his accomplishment in architectural studies; the runner-up also may be awarded the certificate if the head of the School so requests.

The Alpha Rho Chi Medal
The Medal of Alpha Rho Chi, national professional architectural fraternity, is given annually upon recommendation of the faculty of the School of Architecture, to that graduating student who has shown an ability for leadership, performed willing service for his School, and gives promise of real professional merit through his attitude and personality.

The Honor Society of Phi Kappa Phi
Among the prizes offered for scholarship by the Georgia Institute of Technology is membership in the honor society, Phi Kappa Phi, to which a limited number of seniors representing all departments are elected annually. Phi Kappa Phi is a national organization with chapters in many of the leading universities and colleges.

The local chapter of Phi Kappa Phi awards annually a scholarship cup to that member of the senior class who, on the basis of all work taken in this institution, ranks scholastically as one of the first two students in the class.

Tau Beta Pi
Tau Beta Pi is a national honorary engineering fraternity with chapters in most of the leading engineering schools of the country. The Alpha Chapter of Georgia offers membership to approximately twenty-five engineering students of each graduating class who can qualify according to the standards of scholarship, character, loyalty, personality, leadership, and school activities. The fact that Tau Beta Pi is the second oldest honorary fraternity in the country and numbers among its members many of our leading engineers makes membership in the society a coveted honor.

The local chapter of Tau Beta Pi awards annually a scholarship cup to an outstanding engineering senior who ranks among the first five of his class, on the basis of all scholastic work taken in this institution.

Phi Eta Sigma
Phi Eta Sigma is a freshman honor society in which any male student is eligible for membership who has made an average of at least 3.5 on the work of the first term of the freshman year. The society awards a scholarship cup to the freshman who makes the highest average for the first term.

Chi Epsilon Award
The Chi Epsilon Award is given annually by the Georgia Tech Chapter. The recipient is chosen from the five highest members, based on scholarship, of the senior class. The final choice of the recipient is made from the five candidates on the basis of leadership, sociability, practicality and scholarship.

The winner receives a certificate and his name is placed on an honor roll in the Civil Engineering Building.

Textile Scholarship Medals
The Georgia Textile Manufacturers Association awards a watch annually to a member of the senior textile class, based on scholarship throughout his course and for original effort in the work of the Textile Department during his senior year. The American Association of Textile Technologists makes an award annually in the form of a suitable plaque to a member of the graduating class of the School of Textile Engineering. The award is based on scholarship and other personal qualities which indicate an outstanding student.

Briarean Scholarship Cup
The Briarean Society of the Georgia Institute of Technology presents annually a scholarship cup to a senior member of the society whose scholastic average for a period of four and one-half years entitles him to rank as one of the highest three members of the class.

Fraternity Scholarship Cup
The Interfraternity Council awards quarterly a scholastic cup to the chapter of that organization which makes the highest scholastic average.

Alpha Chi Sigma Prize
The professional chemical fraternity, Alpha Chi Sigma, annually presents a handbook to the junior who has made the best record in the chemistry or chemical engineering course.

Eta Kappa Nu
The Eta Kappa Nu Association, national electrical fraternity, awards annually an electrical engineering handbook to the regular sophomore Electrical Engineering student (on the basis of four quarters) or to the co-op pre-junior electrical engineering student (on the basis of four quarters) having the highest scholastic average.

Delta Kappa Phi
The Delta Kappa Phi Plaque is awarded annually to the graduating senior selected as the outstanding graduate in the textile department. A certificate is presented at the annual Honors Day exercises. Delta Kappa Phi is the oldest national honorary textile fraternity in the country.

Pi Tau Sigma
Pi Tau Sigma, national mechanical engineering fraternity, elects to membership outstanding mechanical engineering students in the junior and senior years.

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 Oglethorpe 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 membership to the senior in the College of Industrial Management who ranks first in his class on the basis of all scholastic work taken at Georgia Tech.

Gordon Gambill Memorial Endowment Award
An annual award of an appropriate book to the athlete with the highest academic
grade each year at the sophomore, junior, or senior level from the following 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 fifty-dollar bond to the student in his 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 yearly 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 scholastically, and 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, award is presented to the Industrial Engineering junior who is most outstanding in scholastic attainment and who has demonstrated such personal qualities as leadership, character, and breadth of interest. The presentation is made annually at the Honors Day exercises.

Army R.O.T.C. 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 Habersham Chapter of D.A.R. presents annually a medal to the ROTC senior who attains the highest rating in Military Science.

The Third Army Certificate of Meritorious Achievement is awarded annually to the ROTC senior on the basis of leadership development throughout his 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 annually awards medals to an Army ROTC junior and senior for excellence in scholastic achievement.

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

The Professor of Military Science Awards are presented annually to the ROTC 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 outstanding senior in the Flying category.

The Sons of American Revolution presents an award to outstanding freshmen.

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 awards to outstanding cadets in AS 4000, AS 3000, and AS 2000.

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

The Air Force Association annually presents a medal to the AFROTC senior who attains the highest rating for proficiency in leadership and scholarship.

The General Dynamics Award is presented annually to the outstanding sophomore 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 recognize the most improved cadet in each Aerospace Studies class.

Naval R.O.T.C. 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 10 engineering medals for the outstanding engineering NROTC seniors and 10 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 Navy 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 Navy Officer's sword to the senior NROTC student 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 senior 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 male 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 Boggus 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 recommended by the civil engineering faculty.
3. 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 Division of Graduate Studies and Research.

The goals of the division are: to establish an educational environment that will encourage and assist students to fully develop their capabilities both as professionals and as human beings; and 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 creative skills required for the design and 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:

- Aerospace Engineering
- Ceramic Engineering
- Chemical Engineering
- Chemistry
- Civil Engineering and Sanitary Engineering
- Economics
- Electrical Engineering
- Engineering Science and Mechanics
- Geophysical Science
- Industrial and Systems Engineering
- Industrial Management
- Information and Computer Science
- Mathematics
- Mechanical Engineering
- Nuclear Engineering
- Physics
- Psychology
- Textile Engineering and Science

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
- Industrial and Systems Engineering
- Industrial Management
- Information and Computer Science
- Mathematics
- Mechanical Engineering
- Metallurgy

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.

City Planning also offers joint programs with School of Civil Engineering, the School 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.

Interdisciplinary and Special Programs

All graduate degrees are offered through the 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.

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 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.

Many high schools are introducing courses dealing with engineering concepts to provide their students with a more realistic understanding of modern technology and its implications for contemporary society. The course designed
Environmental Protection 2-2.

Types of Admission

Cleries either in content or quality. Must be supplemented by additional work or demonstrated ability to be performed at a specified degree from an approved institution whose previous work, because of deficiencies either in content or quality, must be supplemented by additional work or demonstrated ability to be performed at a specified level.

Policies and Regulations

The Graduate Council is responsible for establishing policy for the graduate program. With the approval of the Academic Senate, it 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 and in the Graduate Student Handbook distributed by the graduate division. 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 he may be enrolled is 18. A full-time student must be enrolled for 12 hours. The special regulations concerning the number of hours of enrollment for students who hold assistantships or fellowships or who work on a full- or part-time basis are on file in each school and the division office.

Admissions Information

All correspondence concerning admission to graduate study should be directed to the appropriate school. Necessary admission forms may be obtained from the appropriate school or from the Division of Graduate Studies and Research. These forms, together with letters of recommendation and official transcripts of previous academic work, should be on file at the Institute at least four weeks before the beginning of the term for which the applicant plans to register.

Types of Admission

Full graduate standing will be accorded those applicants holding a bachelor'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, 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 to the Division of Graduate Studies and Research 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 to them.

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 university may be admitted as 'transient graduate students' after filing an application and verification of 'good standing' status. The work undertaken will not be applicable toward a Georgia Tech degree.

The Georgia Institute of Technology reserves the right to deny entrance to any applicant without showing cause.

Readmission

A student who interrupts the continuity of his graduate program by not registering for one quarter (summer quarter excepted) must seek readmission by filing with the registrar a completed Request for Readmission form at least twenty-one days prior to the beginning of the quarter in which readmission is sought. Request forms are available from the registrar's office.

Reactivation of Application

Students who have been admitted for graduate study at Tech but 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 no later than 20 days before the registration date for the new quarter.

Undergraduate Students

Exceptionally well qualified undergraduate students may in their senior year schedule graduate courses in the 600 numbered series provided they have the permission of the director of their school.

Credit toward the master's degree for work by undergraduates will be allowed 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 desires graduate credit.

2. Credit for the course was not applied toward an undergraduate degree.
STAFF MEMBERS

No staff member beyond the rank of instructor will be permitted to work for a master's degree in the school in which he serves.

No new staff member with the rank of assistant professor will be permitted to work for a doctor's degree in the school in which he serves.

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, Psychology, and Industrial and Systems Engineering (Operations Research program only) are required to submit GRE scores. Applicants to the School of 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 division. Students applying to the College of Industrial Management are required to supply Admission Test for Graduate Study in Business (ATGSB) 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 can be obtained 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 ATGSB test may be obtained by writing the Educational Testing Service, Box 966, Princeton, N.J., 08540.

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 Division of Graduate Studies and Research 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 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 Friends of the Middle East (AFME) in Tehran, Iran; Amman, Jordan; Beirut, Lebanon; Tangier, Morocco; and Cairo, Egypt; and 4) the American-Korean Foundation in Seoul, Korea.


REGISTRATION

Official registration dates will be found on the calendar pages of this bulletin. New graduate students must report first to their school at 8:00 a.m. on registration day, where further instructions regarding registration procedures will be made available.

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

The division conducts an orientation for new graduate students in the fall quarter just before registration.

TUITION AND FEES

NOTICE: 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 1973-74 academic session:

<table>
<thead>
<tr>
<th></th>
<th>Matriculation Fee Per Quarter</th>
<th>Tuition Fee Per Quarter</th>
<th>Student Activity Fee Per Quarter</th>
<th>Medical Fee Per Quarter</th>
<th>Total Fees Per Quarter</th>
<th>Total Fees Per Academic Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents of Georgia</td>
<td>$145.00</td>
<td>$18.00</td>
<td>$15.00</td>
<td>$178.00</td>
<td>$534.00</td>
<td></td>
</tr>
<tr>
<td>Nonresidents of Georgia</td>
<td>$145.00</td>
<td>$295.00</td>
<td>$18.00</td>
<td>$15.00</td>
<td>$473.00</td>
<td>$1419.00</td>
</tr>
</tbody>
</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 $12.00 per credit hour in satisfaction of the matriculation fee and $33.00 for the student activity and medical fees unless the student is carrying less than 6 credit hours. For these students only the matriculation fee is charged. All other graduate students will have an additional tuition fee of $25.00 per credit hour. The minimum number of hours a student may enroll for is three.

Graduate students who have completed the residence requirements for the
Continuous matriculation will be maintained by the student if he is officially registered for at least one quarter per calendar year during the period of six years following his original admission.

If a student has completed all of his course work and is planning to submit a thesis in partial fulfillment of the requirements for a master's degree, he should register for research hours consistent with a realistic appraisal of the amount of work yet to be done on the thesis and the amount of faculty involvement required. The student is not entitled to receive thesis guidance during any quarter in which he is not registered.

A minimum of one full academic year or its equivalent in residence at the Georgia Institute of Technology is required for the master's degree. This residence need not be gained in consecutive terms, but the entire program toward the degree must be completed within a period of not more than six consecutive calendar years.

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.

ACADEMIC REQUIREMENTS

Thirty-three quarter hours of approved work in courses beyond the bachelor's degree, plus a thesis, are required for the master's degree. With the consent and approval of the director of the school in which the student is registered, 17 additional quarter hours of work in courses at the 6000-7000 level, of which 9 hours are in the student's major field, may be submitted in lieu of a thesis.

A student must earn a graduate grade average of at least 2.7 and satisfy other requirements of his school before he may be certified for a master's degree. Grade points are given for all courses in which grades are reported. 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 graduate average includes the grades on all courses scheduled by the student after being admitted to the graduate division, plus the grades on all courses listed on the student's Approved Program of Study which have been earned at Georgia Tech prior to his admission to graduate study.

At least 18 quarter hours of work in courses, not including a thesis (or courses submitted in lieu of a thesis), must be taken in the student's major field. Required undergraduate courses in the student's major field may not normally be used for graduate credit. At least 18 quarter hours of the student's program must be in courses numbered from 6000 to 7999, not including those courses which may be submitted in lieu of a thesis. No graduate credit will be given for any course not approved by the school, Graduate Council, and Academic Senate.

*The term "major field" as used in these regulations indicates a basic field of knowledge rather than a department of specialization.
The student, in conference with his faculty advisor, must prepare his program of study for the master's degree for submission to the director of the school in which he is enrolled by the end of the fifth week of the second quarter of enrollment. The program must receive the approval of the director of the school and the dean of the Division of Graduate Studies and Research. Departures or changes from this program must be approved by the school director and graduate dean.

TRANSFER OF CREDIT

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

a. Transfer credit 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.

b. A maximum of nine quarter hours can be petitioned for under the guidelines set forth by the Graduate Council. Exceptions to this maximum must be brought before the Council or the Executive Committee of the Council except as noted below.

c. 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, provided such courses (1) are not offered at Georgia Tech, (2) are approved in writing in advance by the student's advisor and school director, and (3) are passed with a grade of C or better. Requirement (2) is satisfied when the courses appear on the student's "Proposed Program of Study."

d. The processing steps that must be followed in all cases are:

1. The student must confer with his graduate advisor 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 M.S. student. A Ph.D. student would normally not be seeking transfer of credit.

2. If the courses are appropriate, he 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 this 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 is not the school director, the school director should cosign it. The transfer credit form should then be sent directly to the graduate division.

3. Finally, the student must write a petition to the dean of the graduate division indicating his wishes relative to the courses. On this petition there must be a place for recommended action by the student's school director. The transfer credit forms do not eliminate the need for the letter petition. The transfer credit forms serve as documentation for the contents of petition.

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 seventeen 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 good literary 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 to plan, conduct, and report an organized and systematic study of importance.

The Manual for Graduate Theses, available from the Division of Graduate Studies and Research, explains the requirements for the thesis.

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.

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. The petition for Admission to Candidacy (forms available in 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. He must show that he will have satisfactorily completed course requirements for the master's degree in accordance with the following table:

<table>
<thead>
<tr>
<th>Course and Scholarship Requirements for the Master's Degree</th>
<th>Minimum Hours in Major Field</th>
<th>Minimum Hours at 6000-7000 Level</th>
<th>Total Required Credit Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>With thesis</td>
<td>18</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>Without thesis*</td>
<td>27</td>
<td>35</td>
<td>50</td>
</tr>
</tbody>
</table>

*Must have approval of School Director.
2. He must have completed, or be scheduled to complete during the quarter, any required non-credit prerequisite work outlined at the time of his matriculation.
3. He must have an overall grade point average of at least 2.7 and satisfy the requirements of his school.
4. He must have completed satisfactorily any language requirement imposed.
5. He must have passed any qualifying or comprehensive examinations required by the department in which he is registered.
6. He must have filed with the Division of Graduate Studies and Research an approved thesis topic and have made satisfactory progress on his thesis if it is a part of his program.

REQUIREMENTS FOR AWARD OF THE DEGREE

The Graduate Council may recommend to the Academic Senate the awarding of the master's degree to the candidate who complies with the following requirements:

1. Has an overall grade point average of at least 2.7 and has satisfied the requirements of his school.
2. Receives final acceptance of his thesis from the division and deposits three unbound copies with the library.
3. Supplies the division with a publishable abstract of his thesis, up to 300 words, the accuracy of which has been certified by the thesis advisor.
4. Presents an Approved Program of Study (complete within a period of not more than six consecutive calendar years) to the dean of the Division of Graduate Studies and Research in accordance with the deadline set forth in the Institute calendar for the quarter.
5. Passes any general examinations, oral or written, required by his school.
6. Is, at the time, a registered student.

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 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 power of original thought, talent for research, and ability to organize and present his findings.

MATRICULATION REQUIREMENTS

Ordinarily a student will be admitted to the Division of Graduate Studies and Research for the purpose of studying for the doctorate only if he has graduated in the upper quarter of his 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 requirements for entrance to the division with the purpose of working towards the doctorate 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 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 dean of the Division of Graduate Studies and Research as well as the director of the school concerned.

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 his research is to be carried out, each student will be required to demonstrate a mastery of some other, smaller body of knowledge within or, preferably, outside his school. This area of study is referred to as a minor field. The purpose of the minor is to encourage a wider interest on the part of the student and to provide a broader basis for the evaluation of his 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 guidance committee. The proposed minor must be approved by the dean of the Division of Graduate Studies and Research prior to its completion. After the minor is satisfactorily completed, this fact should be transmitted to the graduate division 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.

LANGUAGES

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

1. 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. Enroll in one of the following sequences of courses and earn an average grade of C or better:
   b. Ger. 4075-4076-4077 Intensive Readings in German.
   e. Ling. 4075-4076-4077 Languages for Science and Technology.

3. 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. Present evidence of 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 division the satisfactory completion of the above foreign language requirements for each candidate. If the student wishes to satisfy the language requirement using alternative (1) or (4), he 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.

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 for their objective the testing of the student's knowledge of the general field in which he is to receive his degree, as well as the specialized portion of this field in which his 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 in order to provide himself with an adequate background 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 will be given by and are the responsibility of the school in which the student is to receive his 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 for these examinations by a guidance committee appointed by the director of the school. The duties of the committee shall include (1) evaluation (by personal consultation) of the background and interests of each entering stu-
dent, (2) aiding the student in planning his course work, taking into account his special circumstances, and (3) consultation with the student from time to time for purposes of evaluating and aiding his progress.

   The student will be expected to take examinations in all courses in which he is regularly enrolled. His grades in these courses will be reported in the usual manner to the Office of 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 school and the dean of the Division of Graduate Studies and Research a formal statement naming his thesis advisor and setting forth the topic he has selected for his research, the purpose of the investigation, and the steps by which he 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.

   The requirements for the degree must be completed within five (5) years from the end of the quarter in which the candidate passes his comprehensive (qualifying) examinations.

THE DISSERTATION

Prior to his admission to candidacy the candidate will present for the approval of the director of his school and the dean of the Division of Graduate Studies and Research a formal statement naming his dissertation advisor and setting forth the topic he has selected for investigation, the objectives he hopes to gain, and the steps by which he 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 the Division of Graduate Studies and Research. All dissertations are microfilmed and deposited with the University Microfilms Service. A charge of $25.00 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 appointed by the dean of the Division of Graduate Studies and Research. The student must be registered during the quarter in which the final examination is given and in the quarter in which he 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 case of a failure on the final oral examination the result will be reported to the dean of the Division of Graduate Studies and Research and the director of the candidate's school. On 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 the dean of the Division of Graduate Studies and Research.

Additional requirements for the doctorate may be added by the schools at their discretion.

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.

INSTITUTE AWARDS

The following awards are available to graduate students:

Graduate Research Assistantships

These awards are ordinarily offered students on a one-third or half-time basis. However, awards of a greater or lesser amount may be offered according to the needs of the respective school, departments, and centers, or divisions of the Engineering Experiment Station.

Graduate Teaching Assistantships

These awards are ordinarily offered on a one-third or half-time basis. However, awards of a greater or lesser amount may be offered according to the needs of the respective schools and departments.

Part-Time Instructorships (Non-faculty)

Graduate students qualified to teach or assist in teaching at college level who wish to obtain experience and advance themselves in the field of science and engineering education may be appointed part-time instructors. Their duties will consist of part-time teaching under the direction of experienced engineering and science educators. These positions do not carry academic rank. Stipends for the nine-month academic year will be in proportion to the teaching load.

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.

Atlantic Steel Company

A fellowship in chemical engineering, civil engineering, or mechanical engineering in the amount of $1500.

Automotive Safety Foundation

A fellowship in highway engineering; tuition and matriculation fees, plus $1800. Awarded on basis of national competition.

Burlington Industries Fellowship

A fellowship in the amount of $5,000 awarded to the School of Textile Engineering be used to provide the fellow's stipend, tuition, and research equipment and supplies.

Burroughs Corporation

Two scholarships of $2,000 each to assist students whose goals are related to a career in industry.

Celanese Fellowship

A fellowship in textiles; tuition and matriculation fees, plus $1,600; total grant $2,500.

E. I. DuPont de Nemours & Company, Inc.

A $6,000 grant to the Textile School. 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.

Eastman Kodak Fellowship

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.

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.

Ford Foundation Fellowship
Fellowship and loan for doctoral studies in engineering. These awards are a combination of fellowship and teaching or 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.

General Electric Foundation
A $5,000 grant to the School of Mechanical Engineering

Kaiser Financial Aid Grant
A grant of $4,600 to the School of Chemical Engineering, $3,600 to the recipient and $1,000 to the school.

Loula D. Lasker Fellowship Trust
Graduate Fellowships in city planning. Awarded on a basis of national competition.

Richard King Mellon Charitable Trusts
Fellowships for graduate work in city planning. Preference is given to men and women who are working in the field of city planning and who recognize a need for further graduate training.

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

Robert J. Painter Memorial Fellowship
A fellowship to be awarded to an outstanding applicant entering his final year of full-time graduate work leading to a doctor's degree in a field contributing to the science and knowledge of materials. $5,000 to the fellow and $1,500 to the institution. This grant will be awarded by June 1.

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

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

Sandoz Foundation Inc.
A grant of $5,000 awarded to the School of Textile Engineering to be used as a fellowship and supporting funds for tuition, equipment, and faculty supervision.

Schlumberger Fellowship
Two fellowships in electrical engineering; tuition and fees, plus $3,000 stipend; total grant $5,500.

Shell Companies Foundation
A fellowship for graduate study in civil engineering; $2,000 stipend academic year, $2,500 calendar year (married students $2,600 and $3,200 respectively) plus tuition and matriculation fees; $1,000 to the School of Civil Engineering.

Standard Oil Company of California
A fellowship in chemical engineering; tuition and matriculation fees, plus $2,000 to the student if single or $2,600 if student has one or more dependents; $1,000 unrestricted grant to the school.

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

T. Earle Stribling Memorial Textile Fellowship Fund
A fellowship in textiles; tuition and matriculation fees, plus $1,500.

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 twelve-month period.

United States Steel Foundation Fellowship
A fellowship in physics; tuition and matriculation fees, plus $1,500 ($1,800 if married); $1,500 to School of Physics.
Union Camp Fellowship
A $5,000 fellowship in chemistry and chemical engineering; tuition and matriculation fees, plus a minimum of $250 a month to the student for a period of at least nine months, the remaining money to be used for department needs.

Urban Studies Fellowship
$9,000 for the purpose of supporting two city planning and urban studies fellows; $3,000 to each fellow and $3,000 to the school for a cost of education allowance.

Whirlpool Corporation
Three graduate fellowships in engineering; $2,400 stipend, plus tuition and fees.

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

Federal Fellowships and Traineeships
The institute awards a number of fellowships and traineeships through participation in programs sponsored by agencies of the federal government. These include: National Defense Education Act Graduate Fellowship Program—Title IV; National Science Foundation Fellowship Program; National Science Foundation Summer Teaching Assistantship Program; National Science Foundation Traineeship Program; Atomic Energy Commission Programs; and Fellowship and Traineeship Programs under the U. S. Public Health Service.

In addition, traineeships associated with specific training programs are available as follows: Water Resources Planning and management through the Environmental Resources Center; Solid waste training program through the School of Civil Engineering; Radiation Health Specialist Training Program through the School of Nuclear Engineering; Environmental Health through the School of Civil Engineering; and Air Quality Control through the School of Chemical Engineering.

TUITION WAIVERS
Nonresident graduate students who hold assistantships or work for the institute in a professional capacity on at least a one-third-time basis may register on payment of resident fees. In addition, there are available a limited number of tuition waivers for award to qualified out-of-state students upon recommendation of the school director. Preference will be given to those students taking 12 hours or more of courses for credit. Full-time students sponsored by WSF, AFGRAD, LASPAU, and certain IIE students may carry top priority if Georgia Tech has given an institutional commitment to the group or agency. Since there are usually many more people recommended than the 40 waivers will support, grade point averages will be used in determining the final allocation of awards by the dean of the Division of Graduate Studies and Research.

LOCAL INDUSTRY WORK-STUDY PROGRAMS
Many industries located in and around Atlanta offer opportunities to pursue graduate degrees as an integral part of their employee training programs. In such a plan, the student may work and study on a reduced work week schedule that is compatible with school, 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 dean of the Division of Graduate Studies and Research. 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. Approval of the thesis topic is in the prerogative of the dean of the Division of Graduate Studies and Research.

VETERAN'S PROGRAM
Most veterans who served on active duty for more than 180 days, any part of which occurred after January 31, 1955, are eligible for financial support to attend college.

Generally, sons and daughters between 18 and 26 years old of deceased veterans and those of living veterans who have disabilities which are considered to be permanent, whose death or disability was a result of service in the armed forces, are eligible for financial benefits under the veterans program to attend college.

If a prospective student has never before received any benefits for education from the Veterans Administration, he will need to go to their office and fill out the necessary forms. It is important that the student carry with him: file number “C” number; discharge papers; and legal proof of any dependents, such as marriage license, birth certificates.

Once the basic application and legal papers have been forwarded to the V.A., they will be processed and the student will be sent a certificate of eligibility. This item should be given to the Georgia Institute of Technology on registration day for handling.

The Georgia Institute of Technology has assigned the responsibility of the veterans program to the Financial Aid Office, located in the Administration Building on the Tech campus. After a student has completed registration for his
first quarter at Georgia Tech, he should submit his certificate of eligibility to that office for processing. Generally, the first check is received not later than six weeks after the certificate has been submitted to the institution. Once payments have begun, they should continue on a regular basis for the period of approval.

Any questions or comments may be directed to the Financial Aid Office at Georgia Tech.
ENGINEERING COLLEGE
SCHOOL OF AEROSPACE ENGINEERING
(Daniel Guggenheim School of Aeronautics)
(Established in 1930)


GENERAL INFORMATION
The School of Aerospace Engineering prepares students at the B.S., M.S. and Ph.D. 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 of 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.

GRADUATE PROGRAMS
The graduate programs at both the M.S. and Ph.D. 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, servo-aeroelastic instabilities and control, static aeroelastic instabilities and loading, unsteady aerodynamics—V/STOL and conventional aircraft, vibrational characteristics of vehicles.

Environmental Dynamics—air pollution simulation and meteorology, atmospheric simulation in the wind tunnel, ocean dynamics, planetary atmospheres, upper atmospheric reactions on aerospace vehicles, upper atmospheric winds and modelling.

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, V/STOL aircraft.

Propulsion—combustion instability, external burning, propulsion system noise, solid rocket propellant research, supersonic combustion.

Structures—buckling and postbuckling of structures, 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, use of acoustic emission methods.

Urban and Societal Engineering—air pollution, biomechanics, fire research, noise pollution.

### 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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<tbody>
<tr>
<td>E.Gr. 1170</td>
<td>Visual Communication Engr. Design I</td>
<td>2-3-3</td>
<td>2-3-3</td>
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<tr>
<td>Chem. 1101-2</td>
<td>Engineering Elective</td>
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<tr>
<td>Hum./S.S./M.L.</td>
<td>Inorganic Chemistry</td>
<td>4-3-5</td>
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<td></td>
<td>Humanities/Social sciences/Modern Language</td>
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### Junior Year

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### Senior Year

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<td>A.E. 4200</td>
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<td>Jet Propulsion</td>
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<td>A.E. 4350-1</td>
<td>Aerospace Engineering Design Project I, II</td>
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<td>A.E. 4500</td>
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<td>16-3-17</td>
<td>15-6-17</td>
<td>14-6-16</td>
</tr>
</tbody>
</table>

1. See "information for Undergraduate Students" for engineering electives.

2. Eighteen credit hours in humanities and 18 credit hours in social sciences are required for graduation. To satisfy these requirements, humanities and social sciences courses must be selected from the Engineering College 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 must be scheduled the first quarter the student is enrolled.

4. The student may elect any two of the physical training courses listed under Department of Physical Training courses.

5. Free electives. Not more than 9 credit hours of advanced ROTC may be applied toward the requirements for a degree.
SCHOOL OF ARCHITECTURE
(Established in 1908)
Including the Departments of Architecture, Building Construction, Industrial Design, and City Planning.


*On leave

GENERAL INFORMATION
The School 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.

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. For those students who matriculated before 1972-73 the Bachelor of Architecture is still available, but wherever possible they are encouraged to elect graduation under the new six-year program in Architecture listed below, which will be mandatory for all entering students.

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 these 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 school 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 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. Architects 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 School of Architecture has embraced as many disciplines in design and planning as possible, not only to train its students in specialized fields but to liberalize and expand the training in architecture 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; accreditation will apply exclusively to the professional degree, Master of Architecture, awarded after two years of graduate study.

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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<tbody>
<tr>
<td>Arch. 1001-02-03</td>
<td>Design Fundamentals</td>
<td>1-12-5</td>
<td>1-12-5</td>
<td>1-12-5</td>
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<tr>
<td>Arch. 1201-02-03</td>
<td>Architectural History</td>
<td>3-0-3</td>
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<tr>
<td>Math. 1307-08-09</td>
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<td>12-16-17</td>
<td>12-16-17</td>
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</table>
## Social Sciences:
Architecture History Sequence
Additional, Electives
### Humanities:
Requirements of the Engineering School will include 18 credit hours, for the student to plan toward specialization in the graduate program. Humanities: 9 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 architecture history sequence will satisfy the remaining humanities requirements.

### General Electives: 39 credit hours may be structured to best further the student's professional goals, but must include at least 6 credit hours of advanced History and 6 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.

### Graduate Programs in Architecture

The regular two-year graduate program in Architecture awards the professional degree, Master of Architecture, on completion of the credit hours listed below. Admission is obtained through the Graduate Division with approval of the School of Architecture; prerequisites are completion of the undergraduate Bachelor of Science curriculum at Georgia Tech or its equivalent in another School of Architecture, plus an acceptable performance record. Concentrations are available in design, structures, urban design, health facilities, and housing, and electives in the program will be employed to reinforce the student's option. A thesis is optional.

### BUILDING CONSTRUCTION

As one of the major industries in the country, construction has need of many men who are trained in the field of materials, manufacturing, sales, general contracting, and management. The Building Construction Department was established to supply graduates who, with the architect and engineer, help to coordinate all building projects. The course includes building design and a survey of history, specializes in the technical studies of structures, materials, finance, and management problems. The degree, Bachelor of Science in Building Construction, is awarded upon the completion of four years of study.

Two options available to the student are management and construction. The management option prepares the student to enter one of the fastest growing professions: construction manager. The management of the building construc-

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### Sophomore 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>Arch. 2001-02-03</td>
<td>Architectural Design</td>
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<td>1-12-5</td>
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<td>Building Anatomy</td>
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### Junior Year

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<tr>
<td>Arch. 3321-22-23</td>
<td>Structures &amp; Materials</td>
<td>4-3-5</td>
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<td>Urban Planning Facilities</td>
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### Senior Year

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¹Electives

A total of 66 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 Engineering College in the humanities and social sciences, additional professional requirements of the School of Architecture, and will allow a degree of latitude for the student to plan toward specialization in the graduate program.

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

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### Quarter Hours Credit

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<th>With Thesis</th>
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tion - from land acquisition, planning and financing to design, construction and management - is being written into more and more government and private construction contracts. The construction option prepares the student for the more traditional role of the professional contractor who, with application of “value engineering,” achieves the production of a building facility according to the architect’s and engineer’s design. This course prepares the student for a wide variety of building facilities or systems, or to specialize in a particular area of materials production or construction inspection.

### Freshman Year

<table>
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### Sophomore Year

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### Junior Year

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<tr>
<td>Arch. 3321-22-23</td>
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<td>4-3-5</td>
<td>4-3-5</td>
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### Senior Year

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<th>Course No.</th>
<th>Subject</th>
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<th>2nd Q.</th>
<th>3rd Q.</th>
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<td>Facilities Planning;</td>
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1NOTE: A total of 74 hours of electives are included in the curriculum in Building Construction and, with the advice of faculty counselors, they should be programmed to include the categories below; these categories will also satisfy the core curriculum requirements of the College of Engineering in the humanities and social sciences, will satisfy additional professional requirements of the curriculum and a degree of latitude for the student to pursue individual interests.

Humanities: 9 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 humanities requirements.

Social Sciences: 18 credit hours

General Electives: Of the remaining 47 hours, 21 hours must be selected from the list approved professional electives in the option chosen by the student. Military training is an option requirement 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.

### INDUSTRIAL DESIGN

Industrial design is a broad field of study concerned with the form, function, and appearance of the diverse products manufactured for home, industrial, and recreational uses. The designer’s role is a complex one. He must have the ability to define problems; to conceptualize and implement solutions by utilizing a vast
range of materials, industrial machines, and modern marketing techniques. Most important is the satisfaction of human needs for convenience, safety, and aesthetic values. The curriculum in industrial design prepares the student through basic professional studies and general education to receive the degree Bachelor of Industrial Design on the completion of four years of study.

**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>Arch. 1001-02-03</td>
<td>Design Fundamentals</td>
<td>1-12-5</td>
<td>1-12-5</td>
<td>1-12-5</td>
</tr>
<tr>
<td>I.D. 1261-62-63</td>
<td>History of Design</td>
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</tr>
<tr>
<td>Math. 1307-08-09</td>
<td>Mathematics</td>
<td>5-0-5</td>
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<td>5-0-5</td>
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<tr>
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<td>Physical Training</td>
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**Sophomore Year**

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**Junior Year**

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<td>Micro-Economics</td>
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¹Electives
A total of 66 credit hours of electives are included in the curriculum for industrial design and with the advice of faculty counselors they should include the categories below. These categories will satisfy the core curriculum requirements of the College of Engineering in the humanities and social sciences; additional professional requirements of the Department of Industrial Design, and allow for a degree of latitude so the student can develop an area of personal interest and concentration.

**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**


With the approval of his faculty advisor, a student may substitute 25 credit hours in a field of specialization instead of the thesis provided he has ap-
appropriate undergraduate preparation. At least six credit hours must be in independent study.

Joint degrees
Joint degrees are offered in city planning and transportation engineering (M.S. Civil Engineering), urban design (Master of Architecture), and civic design (Master of Landscape Architecture, University of Georgia).

Master of Science (undesignated) degree
Interdisciplinary programs are available for those students who desire an in-depth understanding of a particular segment of the field of urban and regional planning. Acceptance into these programs is limited to those applicants whose training or experience is in a discipline or professional field clearly related to urban and regional planning.

---

SCHOOL OF CERAMIC ENGINEERING
(Established 1924)

Director—Joseph L. Pentecost; Professors—Lane Mitchell (Emeritus), A. T. Chapman, Willis E. Moody; Associate Professor—W. C. Hansard (Emeritus), James F. Benzel; Assistant Professor—Joe K. Cochran, Jr.; Special Lecturer—R. A. Young.

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 are continuously developing which 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 electro-optical 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 material 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 degree 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.

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
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<td>or</td>
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Freshman Year (Cont.)

<table>
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<td>E.S.M. 3301</td>
<td>Mechanics of Deformable Bodies</td>
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<td>Geol. 2500</td>
<td>General Geology</td>
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<td>Geol. 3400</td>
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Totals 17-9-20 15-9-18 14-9-17

Sophomore Year

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<td>Ceramic Data Handling</td>
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<td>Cer.E. 2080</td>
<td>Ceramic Survey</td>
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<td>Applied Mechanics</td>
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<td>Math. 2307</td>
<td>Calculus IV</td>
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<td>Math. 2308</td>
<td>Calculus and Linear Algebra</td>
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<td>Phys. 2122-23</td>
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Totals 15-3-16 15-3-16 13-3-14

Junior Year

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<td>Cer.E. 3005</td>
<td>Phase Equilibria for Ceramists</td>
<td>3-0-3</td>
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<td>Processing and Forming</td>
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</table>

1See "Information for Undergraduate Students" for engineering electives.
2These free elective courses may be taken at any time during a student's course of study.
However, these six credit hours may be satisfied by selecting basic ROTC. If basic ROTC is elected by the student, then it must be scheduled beginning the first quarter the student is enrolled. 

NOTE: The following Cer. E. electives are recommended:

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<th>Hours</th>
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<td>Cer. E. 4051</td>
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<td>2-3-3</td>
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<td>Cer. E. 4060</td>
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<td>C.E. 2753</td>
<td>Elementary Surveying</td>
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Other suggested elective areas are geology, chemistry, physics, industrial engineering, industrial management, mathematics, psychology, or English. Check quarterly schedule of course offerings to determine if offered. Ordinarily a request for a course by eight or more students will be honored. Also, check prerequisites required.

SCHOOL OF CHEMICAL ENGINEERING
(Established in 1901)

Director—G. L. Bridger; Associate Director and Regent’s Professor—Clyde Orr, Jr.; Regents’ Professor—W. T. Ziegler; Professors—Frederick Bellinger (Emeritus), George A. Fowles (Adjunct), C. W. Gorton, H. V. Grubb, H. C. Lewis, H. C. Ward, Paul Weber (Emeritus); Associate Professors—John H. Burson, Ill., Jude T. Sommerfeld; Assistant Professors—M. J. Matteson, J. D. Muzzy, J. J. Smrekar, Associate Director and Professor of Metallurgy—R. F. Hochman; Professors—N. N. Engel (Emeritus), E. A. Starke, Jr., R. E. Underwood; Associate Professors—H. Grenga, B. G. LeFevre, Pieter Muije, S. Spooner.

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, and dye industries. 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 doctor’s degrees.

By judicious choice of free and technical electives, a student may include in his curriculum an area of concentration in which he may have a special interest. Typical areas of concentration are chemical metallurgy, physical metallurgy; plastics engineering, biomedical engineering, environmental engineering, simulation science, and instrument technology. Detailed descriptions for each of these areas are available from the Ch.E. office.
### Freshman Year

<table>
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<tr>
<th>Course No.</th>
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<td>2-3-3 or 2-3-3</td>
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<td>Chem 1111-12</td>
<td>General Chemistry</td>
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### Sophomore Year

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<td>Ch.E. 2209</td>
<td>Computers in Chemical Engineering</td>
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<td>Ch.E. 3304</td>
<td>Transport Phenomena</td>
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### Senior Year

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</tbody>
</table>

See “Information for Undergraduate Students.”

1 Advanced level chemistry for chemical engineering majors. However, Chem. 1101-1102 will be accepted for students transferring to chemical engineering from other curricula.

2 Other humanities courses listed in the Undergraduate section will be accepted for students transferring to chemical engineering from other curricula.

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, then ROTC must be scheduled beginning the first quarter the student is enrolled.

4 Language is recommended for students considering graduate work.
Senior Year (Cont.)

<table>
<thead>
<tr>
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<tr>
<td>Electives</td>
<td>3-0-3</td>
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<tr>
<td>Totals</td>
<td>17-3-18</td>
<td>14-6-16</td>
<td>13-6-15</td>
<td></td>
</tr>
</tbody>
</table>

*From approved list.

NOTE: The chemical engineering curriculum contains a total of 51 hours of electives, comprising 15 hours of free electives, 9 hours of technical electives, and 27 hours of electives in humanities, social sciences, and modern languages. Students electing to take ROTC must use 6 hours of free electives for basic ROTC and 9 hours of free electives for advanced ROTC. The 27 hours of electives in humanities, social sciences, and modern languages must be chosen from the list of courses in the Undergraduate section in accordance with the distribution there specified. The technical electives must be chosen from the list of approved technical electives available from the Ch.E. office.

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 simultaneous award of the degrees Master of Science in Civil Engineering or Master of Science (undesignated; major in transportation engineering) and Master of City Planning.

PROGRAM IN ENGINEERING GRAPHICS
Engineering design graphics is a multi-faceted descriptive title uniting creative design with its avenue of expression, graphics.

While creativity is an art rather than a science, it is an art that can be learned and applied. When applied to engineering design it becomes an orderly, step-by-step, structured, decision-making process, actually more related to inventiveness than to research. Success in this relatively new addition to engineering curricula is predicated upon continued practice, therefore this iterative growth process is prescribed early in the student’s career.

The goals of this program are to kindle in the student an awareness of the professional role he is ultimately to play in the area of design; to afford him live opportunities to participate creatively; and to provide instruction in the most flawless communication medium known to man.

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 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, operation, 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.

### Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
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<th>3rd Q.</th>
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<tr>
<td>Chem. 1101-2</td>
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<td>or 2-3-3</td>
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<td></td>
<td>and Engr. Design I</td>
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<td>Sciences/Modern Languages</td>
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### Sophomore Year

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<td>Sciences/Modern Languages</td>
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<td>Calculus IV</td>
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<tr>
<td>Math. 2308</td>
<td>Calculus &amp; Linear Algebra</td>
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<tr>
<td>Math 1309 or 3308 or 3215</td>
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<td>Physics 2122-23</td>
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<td>Mech. of Deformable Bodies</td>
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<td>C.E. 2254</td>
<td>Plane Surveying</td>
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<td>C.E. 2502</td>
<td>Digital Computers</td>
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<td>C.E. 3309</td>
<td>Materials of Construction</td>
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<tr>
<td>C.E. 3216</td>
<td>Structural Analysis I</td>
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<td>C.E. 3053-54</td>
<td>Fluid Mechanics, I, II</td>
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<td>Sciences/Modern Language</td>
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<td>Geol. 2500</td>
<td>Physical Geology</td>
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<td>Engineering Economy</td>
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<td>I.Sy.E. 4725 or I.Sy.E. 4726</td>
<td>Engineering Economic Analysis in the Public Sector</td>
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<td>M.E. 3720</td>
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<td>C.E. 4204</td>
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<td>Electives⁴</td>
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Senior Year

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<td>Fluid Mechanics Laboratory</td>
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<td>C.E. 4214</td>
<td>Concrete Structural Components</td>
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<td>C.E. 4304</td>
<td>Transportation Engineering I</td>
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<td>C.E. 4103-13</td>
<td>Sanitary Engineering I, II</td>
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<td>C.E. 4353</td>
<td>Hydrology</td>
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<tr>
<td>C.E. 4154</td>
<td>Behavior of Soil and Rock</td>
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<tr>
<td>E.E. 3740</td>
<td>Electrical Instrumentation Laboratory</td>
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<td>E.E. 3700</td>
<td>Elements of Electric Circuits and Instruments</td>
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<tr>
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<td>15-6-17</td>
<td>15-6-17</td>
<td>18-3-19</td>
</tr>
</tbody>
</table>

1. See "Information for Undergraduate Students."
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 must be scheduled the first quarter the student is enrolled.
3. See Physical Training section of "Curricula and Degrees."
4. Nine hours of free electives at the 3000 level or higher must be taken if advanced ROTC is not taken.
5. 8 C.E. Electives. Each C.E. Senior must choose four of the following courses: C.E. 4003, 4053, 4123, 4133, 4143, 4163, 4213, 4223, 4233, 4253, 4263, 4273, 4283, 4313, 4363, 4373, 4393 or 4774.

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 adviser and director.
3. Up to 6 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 6 and 12 hours of C.E. 8756. No more than 17 hours of C.E. 7000, or no 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 those undergraduate courses (for no credit toward the M.S.) required by their adviser and the director. The undesignated Master of Science degree is 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, engineering, environmental engineering, fluid mechanics, hydraulics, hydrology, sanitary engineering, soil mechanics, structures, transportation, and water resources planning and management. Latitude in the selection of courses in an M.S. program is encouraged, provided that the resulting program leads to a definable goal.

The Master of Science in Sanitary Engineering has been continuously accredited since 1962, as a first degree in engineering, by the Engineers' Council for Professional Development.

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 Ph.D. students spend approximately two years in course work beyond the bachelor's degree before beginning their research activities.
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, persistence and patience; and 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. Many electives have been organized into "tracks" such as bioelectronics, computer engineering, energy engineering, instrumentation and controls, and urban engineering.

The student may also design a program, with the counsel and guidance of faculty adviser, around other interests.

The graduate programs leading to the M.S. and Ph.D. 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: Bioelectronics, communications, computer systems, control systems, electric power, electromagnetics, instrumentation, network and system theory, modern optics, and physical electronics. 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.

Freshman Year

<table>
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<tr>
<th>Course No.</th>
<th>Subject</th>
<th>1st Q.</th>
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<td>Hum./S.S./M.L.</td>
<td>Electives²</td>
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<tr>
<td>E.Gr. 1170</td>
<td>Visual Communication</td>
<td>2-3-3</td>
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<td>Math. 1307-8-9</td>
<td>Calculus I, II, III</td>
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<td>Physics 2121</td>
<td>Particle Dynamics</td>
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<td>General Chemistry</td>
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Sophomore Year

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<td>Math. 2307</td>
<td>Calculus IV</td>
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<td>Math. 2308</td>
<td>Calculus and Linear Algebra</td>
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<td>Math. 3308</td>
<td>Ordinary Differential Equations</td>
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<td>Physics 2122</td>
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<td>Optics and Modern Physics</td>
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<td>Circuits and Systems</td>
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¹Electives: The electrical engineering curriculum contains 57 hours of electives, in addition to 36 hours of specified humanities/social sciences/modern language electives. The 57 hours of electives must include a minimum of:
- 3 hours of freshman engineering electives.
- 12 hours of technical electives, subject to school approval, outside the major field, including one of the following five thermodynamics options: (1) M.E. 3720 (2) M.E. 3726 (3) M.E. 3322 and M.E. 3323 (4) Physics 3141 (5) A course or courses approved by School of Electrical Engineering.
- 21 hours of electives in electrical engineering, subject to school approval. Thus, 21 credit hours of entirely free electives are included in the curriculum. These free electives may be taken at any time during a student's course of study. Up to six (6) hours of basic ROTC and a maximum of nine (9) 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 freshman English is strongly recommended. Additional Hum./S.S./M.L. electives and their required distribution are given in "Information for Undergraduate Students."

²All students who are physically qualified will be required to take physical training courses P.T. 1010 (swimming) and any other two courses from P.T. 1020, 1040, 1050. Students with an exemption from all or any one of P.T. 1010, 1020, or 1050 will be required to take P.T. 1040. A maximum of six hours credit in P.T. courses (three required hours and three free-elective hours) may be applied toward degree requirements.

### Senior Year

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¹Electives: The electrical engineering curriculum contains 57 hours of electives, in addition to 36 hours of specified humanities/social sciences/modern language electives. The 57 hours of electives must include a minimum of:
- 3 hours of freshman engineering electives.
- 12 hours of technical electives, subject to school approval, outside the major field, including one of the following five thermodynamics options: (1) M.E. 3720 (2) M.E. 3726 (3) M.E. 3322 and M.E. 3323 (4) Physics 3141 (5) A course or courses approved by School of Electrical Engineering.

²Three credit hours each of literature, history, and political science must be included. One year freshman English is strongly recommended. Additional Hum./S.S./M.L. electives and their required distribution are given in "Information for Undergraduate Students."

NOTE: All students must demonstrate knowledge of the history and constitutions of the United States and Georgia, either by passing appropriate examinations or by completion of certain courses offered by the Department of Social Sciences.
SCHOOL OF ENGINEERING SCIENCE AND MECHANICS
(Established 1959)


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 83 hours of elective credit, including 23 hours of free electives, 24 hours of technical electives, and 36 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, technicallyrelated 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 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, 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 ESM 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 of the School of Engineering Science and Mechanics holds degrees in most of the recognized branches of engineering, as well as mathematics and physics. Housed in two buildings ESM has excellent classroom, office, and shop facilities and modern, newly-equipped laboratories. Various grants, assistantships, and fellowships are available to students of outstanding merit.

Freshman Year

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Sophomore Year

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### Junior Year

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<td>ESM 4210</td>
<td>Mechanical Vibrations</td>
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<td>ESM 3501</td>
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PROGRAM IN HEALTH SYSTEMS
(Established in 1972, Option in 1958)

Director and Regents' Professor—Harold E. Smalley; Associate Director and Professor—H. A. Joseph Emerzian; Professor—John R. Watt; Associate Professors—J. Norman Berry (Adjunct), Raphael B. Levine (Adjunct), James B. Mathews, F. Levering Neely (Adjunct); Assistant Professors—Richard M. Bramblett, John W. Coyle, James F. Smith.

GENERAL INFORMATION
Health Systems is a new career field. As one of the allied health professions, it works to improve health care services while controlling costs. It uses the systems approach, applies scientific methods, and works with people to create real improvements.

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, but 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 Program in Health Systems is an academic division of the College of Engineering administered by the faculty of the Health Systems Research Center. The program offers undergraduate and graduate health systems courses, and administers programs of study for students enrolled in the B.S. curriculum in health systems.

The program is a direct outgrowth of faculty involvement in the field since 1952 and of a health-related academic program begun at Georgia Tech in 1958; its faculty pioneered the field and is recognized worldwide as leaders in health systems education, research, and community outreach service.

CURRICULUM
The career-oriented curriculum was designed to prepare students for entry into the profession of health systems, and it provides an academically sound base for lifelong learning. Even though it is technical and analytical, the course of study places considerable emphasis upon interpersonal, organizational, and societal relationships. Although it is directed toward the health field, the curriculum provides students with valuable knowledge and marketable skills needed in many different fields. Successful completion of this curriculum leads to the Bachelor of Science degree.

The program offers several unique features. It provides considerable flexibility that students from various fields can transfer into it without losing credit already earned; it contains sufficient electives to accommodate various specialty interests; and it contains a senior year practicum or externship that enables students to be involved in actual health systems work while still in college.

Modified versions of the health systems curriculum are available under the Dual Degree (3-2) Program.

This course of study also forms an excellent pre-medical or pre-dental program. Carefully chosen electives allow the entrance requirements of most medical and dental schools to be completed within the 196 quarter-hours required for the B.S. degree.

Freshman Year

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Sophomore Year

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### Senior Year (Practicum Option)

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1 See "Information for Undergraduate Students" for Engineering College-approved humanities and social science electives.
2 Three hours of P.T. are required; men take P.T. 1010 plus two P.T. electives, and women take P.T. 1040.
3 These free elective courses may be taken at any time during the course of study. If ROTC is elected by the student these 6 credit hours may be applied for basic ROTC, which must be scheduled beginning the first quarter the student is enrolled.
4 These courses will apply toward satisfaction of the social science requirements stated in "Information for Undergraduate Students."
5 Suggestions to aid the student in his free choice will be provided by the HSRC faculty; however, the student should plan his electives with a view toward satisfying the humanities and social science requirements given in "Information for Undergraduate Students."
6 The student may choose any course with the H.S. prefix or a substitute course approved by the HSRC faculty.
7 These 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 HSRC faculty.
These 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 HSRC faculty.

It is suggested that students in this option schedule the externship in the first or second quarter of the senior year.

Under the Practicum Option, students work one-third time for three quarters on real problems assigned to them in local institutions.

Under the Externship Option, students work full-time for one quarter on real problems assigned to them at affiliated institutions or agencies, some outside Atlanta.
VISITING SCHOLAR/PRACTITIONER OFFERINGS

Upon occasion, the school brings to campus selected individuals of unique accomplishment for course offerings built around their special area 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 in Operations Research, and Doctor of Philosophy.

The MSIE program is available for students holding the BIE degree and for other engineers who satisfy requisites covering the principal subject matter of the current BIE curriculum. The MSOR program is available for students holding the BS in engineering, mathematics or science. Requisites include work in probability, statistics, linear algebra, advanced calculus, and optimization. The requisite requirements may be satisfied after enrollment; however, such course work may not be applied to satisfy degree requirements.

The undesignated MS is intended for those students who desire to follow programs in applied statistics, systems engineering, human activity systems, or other special programs.

For each of the above masters programs, a student has two options: either thirty-three quarters hours of course work and a thesis, or fifty quarter hours of course work and a written comprehensive examination.

The Ph.D. 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.

Traineeship support is available for selected students in the Environmental Resources Center, in the Health Systems Research Center, and through the programs of the National Science Foundation. Assistantship support is also available.

THE BIE CURRICULUM

Freshman Year

<table>
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<th>Course No.</th>
<th>Subject</th>
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<td>Introduction to Literature</td>
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<td>Chem 1101-2</td>
<td>Inorganic Chemistry</td>
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### Freshman Year (Cont.)

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### Sophomore Year

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THE BEES CURRICULUM

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Sophomore Year

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Junior Year

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Senior Year

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Senior Year (Cont.)

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*The requirement for science may be satisfied by Chem. 1101-2 or by other natural and/or life science courses approved by the student's department for a total of 10 credits.

*An appropriate computer course, or demonstrated ability to effectively use the computers on campus, may be substituted for this requirement. Substitution must be approved by the School of Industrial and Systems Engineering.

*Three 1000 level physical training courses are required during the freshman year. For further details refer to the physical training section. A maximum of six credit hours of P.T. courses may be used for degree credit.

*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 must be scheduled beginning the first quarter the student is enrolled.

*The major selection should provide the student with additional background relative to the application area of most interest to him, and will likely be involved in his project work. Major selections should be discussed with the student's advisor, and must be approved by him. The resources of all educational organizations in the Atlanta area should be considered, particularly the offerings of Georgia State University.

*The sociology or political science selections may be satisfied by courses in sociology, political science, or any behavioral sciences which are acceptable to and approved by the student's advisor. Offerings of Georgia State University may be used to satisfy this requirement.

*Those additional courses in economics must be included in each student's program. These courses may be taken as part of the student's "major selection" or as electives in the sophomore and senior year. (If previously completed as part of the student's "major selection", these hours may be used as free electives in the senior year). A detailed list of approved economic electives is available from the Office of the School of Industrial and Systems Engineering.

*The project work is intended as an integrative experience for the student dealing with socio-economic problems related to the student's major selection. Project work usually involves dealing with a live situation and field activity for gathering data, problem definition, and direct interaction with those individuals involved within the problem setting. It also usually requires pilot implementation of project results and recommendations. Detailed information concerning the requirements of the project work is available from the office of the School of Industrial and Systems Engineering.

*See "Information for Undergraduate Students" for humanities elective to satisfy the Engineering College requirement.
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 basic degree in mechanical engineering while minoring 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 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 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, high temperature design, lubrication, magnetogasdynamics and plasma, materials processing, materials science and engineering, mechanisms (synthesis and analysis), nuclear power, power and 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, physical sciences, and biological sciences.

MULTIDISCIPLINARY PROGRAMS
The school participates in each of the multidisciplinary programs of the Engineering College: computer engineering, bioengineering, energy engineering, plastics engineering, urban engineering, environmental engineering, and educational engineering.

SCHOOL FACILITIES
The School of Mechanical Engineering has many types of specialized instruments and equipment associated with laboratories for the study of two-phase flow, lubrication and rheology, material processing, fire hazard and combustion, magnetogasdynamics, energetics, fluidics and fluid power control, heat transfer, vibration and thermal stress, automatic and digital control, and other areas. The school is housed in a four-building classroom-research complex. Part of this complex is a classroom-seminar conference building with modern facilities serving the institute. The main research building of the school houses a remote terminal linked to the main campus research and teaching computer, as well as analog computers and electronic calculators with programming capabilities. The school research activity is served by its own machine and instrumentation shops with a full-time supporting staff of technicians.

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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Sophomore Year

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### Senior Year

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1. See "Information for Undergraduate Students" 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 6 credit hours may be applied for basic ROTC, which must be scheduled beginning the first quarter the student is enrolled.
3. Nine hours of technical electives chosen from of M.E. Interest Area Courses. Courses other than these may be selected from mathematics, physics, chemistry, biology, another field of engineering, or graduate courses. A student who wishes to take courses not in M.E. must so notify the director of his choice and obtain approval at advance registration for the first quarter of his senior year.

A student completing his junior year with a grade average of 2.5 or higher may elect one technical elective from the Special Problem courses M.E. 4901 through 4912. (The particular course selected depending on the number of hours of credit needed. This student will follow a course of individual study under the guidance of a faculty member with the approval of the school director. Nine hours of electives may be replaced by advanced ROTC.

4. For selection of acceptable courses see list of electives allowed by the Engineering College in "Information for Undergraduate Students."
SCHOOL OF NUCLEAR ENGINEERING
(Established in 1962)

Director—L. E. Weaver; Neely Professor—K. Z. Morgan; Professor—M. W. Carter
J. D. Clement, M. V. Davis, G. G. Eichholz, D. S. Harmer, C. J. Roberts; Associate
Professors—F. W. Chambers, Jr., R. J. Kallfelz, R. A. Karam, J. H. Rust; Assistant

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, to 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.

UNDERGRADUATE PROGRAM

The curriculum leading to the degree Bachelor of Nuclear Engineering is structured to meet the needs of both the student who contemplates employment 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 interest 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; nuclear power management; nuclear methods development; and reactor operations.

Freshman Year (Cont.)

<table>
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Sophomore Year

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Junior Year

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¹ Hum./S.S./M.L.:
² Free Electives:
³ Course number for E.E. and Ch.E.

Course No. | Subject | 1st Q. | 2nd Q. | 3rd Q. |
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Senior Year

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1For selection of Engineering College-approved elective courses and requirements see "Information for Undergraduate Students."
4Free elective courses may be taken at any time during the course of study. If ROTC is elected by the student, 6 credit hours may be applied for basic ROTC and a maximum of 9 credit hours for advanced ROTC.
*Other courses may be substituted for these required courses. Substitutions are available from the general office of the School of Nuclear Engineering.
1The electives will be selected by the student after consultation with his adviser. At least 7 credit hours must be in the area of engineering science and at least 10 credit hours in the areas of design, synthesis and system.

GRADUATE PROGRAM

The School of Nuclear Engineering administers programs leading to the degrees Master of Science in Nuclear Engineering, Master of Science, Master of Applied Nuclear Science, and Doctor of Philosophy, the particular degree depending upon the course of study.

The program at the master's level provides eleven areas of emphasis: reactor engineering; reactor operations; nuclear fuels engineering; energy systems engineering; computer applications; nuclear power management; radiation technology; environmental engineering; applied health physics; radiological health physics; 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 B.S. degree in engineering will take the M.S.N.E. degree while students with a B.S. degree in science will enroll for the M.S. degree. Students completing studies in one of the three remaining areas will receive the M.A.N.S. degree. Those students in computer applications, radiation technology, and environmental engineering may elect to receive the M.A.N.S degree, contingent upon their plan of study.

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

The Ph.D. 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.

FACILITIES

The facilities available on the Georgia Tech campus for instruction and research in nuclear engineering include the following: a 5 megawatt research reactor, a low-power training reactor, a subcritical assembly, a 100,000 curie cobalt 60 source, several small digital computers, a UNIVAC 1108 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. In addition, the faculty members are well respected in their chosen specialties and are concerned with the total development of the student.
SCHOOL OF TEXTILE ENGINEERING  
(Established in 1899)  

Director—W. Denney Freeston, Jr.; Callaway Professor—John L. Lundberg; 
Professor—Walter C. Carter; Associate Professors—Winston C. Boteler, David R. 
Gentry, Ralph C. Latham, James W. McCarty, Wayne C. Tinch; Assistant 
Professor—L. Howard Olson, Rick A. Porter, Amad H. Tayebi.

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 many 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 esthetic 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, 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 exceed the number graduated.

CURRICULA

Three study programs are available leading to the degrees Bachelor of Textile Engineering, Bachelor of Science in Textile Chemistry, and Bachelor of Science in Textiles. Each degree may be pursued in a regular four-year program 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 mathematics, chemistry and physics; in the junior and senior years on materials 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 conventional laboratory sessions, textile students participate in a student operated and managed business venture. The students design, develop, produce and market novelty textile products. Every participant is exposed to all facets of the business environment.

Since most of the coursework in textiles 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.

TEXTILES MINOR

Students with other majors often enter the textile industry; to enhance their careers the School of Textile Engineering has developed selected course offerings that could constitute an unofficial minor in textiles. Listings of recommended course sequences for minors in Textiles are available in the School of Textile Engineering office.

GRADUATE PROGRAM

The School of Textile Engineering has a rapidly expanding 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 pursues 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, energetics, 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 laboratory facility. The building contains equipment illustrating most major types of textile processing. Well-equipped laboratories 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, fiber-reinforced composite testing, 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

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¹Twelve hours of electives must be chosen from a list recommended by the department. Six must be Hum./S.S./M.L. electives. Text 4301 can be substituted for Text 4204.

### PROGRAM FOR THE B.S. IN TEXTILES DEGREE

#### Freshman Year

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#### Sophomore Year

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Totals 13-12-17 14-3-15 14-6-16

¹Twelve hours of electives must be chosen from a list recommended by the department. Nine must be Hum./S.S./M.L. electives.
²English 2004 or 2007 may be substituted for English 2003.

### Program for B.S. in Textile Chemistry

#### Freshman Year

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### Sophomore Year

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Totals 15-9-18 14-9-17 13-6-15

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School of Textile Engineering / 117
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<tr>
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<td>Textile Manufacturing Processes IV, V</td>
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<tr>
<td>Text. 3484</td>
<td>Problems in Textile Management II</td>
<td></td>
<td></td>
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¹Fifteen hours of electives must be chosen from a list recommended by the department. Nine hours must be Hum./S.S./M.L. electives.

### Senior Year

<table>
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<th>Course No.</th>
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<td>Problems in Textile Management III</td>
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<td>Text 4481</td>
<td>Advanced Problems in Textile Management</td>
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<td>Text 4482</td>
<td>Product Innovation</td>
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¹Chem. 4211 or 4212 may substitute for Text. 4310.

Text. 4301 | Chem. & Chemical Processing of Fibers and Textiles II | 3-3-4 |        |        |
Text. 4503 | Science of Color |        | 3-0-3 |        |
Text. 4201-2 | Mechanics of Fibrous Structures I, II | 3-0-3 |        | 3-0-3 |

School of Textile Engineering / 119
### Junior Year

<table>
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<tr>
<th>Course No.</th>
<th>Subject</th>
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<td>Physical Chemistry</td>
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<td>Chem. 3481</td>
<td>Physical Chemistry Laboratory</td>
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<td>Engl. 2002-3</td>
<td>Survey of the Humanities</td>
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<td>Biol. 4413</td>
<td>Air and Water Pollution</td>
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<td>Text 4200</td>
<td>Fiber Science</td>
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<td>Text 4300</td>
<td>Chem. &amp; Chemical Processing of Fibers and Textiles I</td>
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<td>Text 3480-1</td>
<td>Textile Manufacturing Processes IV, V</td>
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<td>Text 3484</td>
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<td>12-9-15</td>
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¹Fifteen hours of electives must be chosen from a list recommended by the department. Nine hours must be Hum./S.S./M.L. electives.

### Senior Year

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<th>Course No.</th>
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<td>Text 4100</td>
<td>Textile Management Decision Making</td>
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<td>Text 4310²</td>
<td>Textile Instrumental Analysis</td>
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<td>Text 4503</td>
<td>Science of Color</td>
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<td>Text 4201-2</td>
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¹Fifteen hours of electives must be chosen from a list recommended by the department. Nine hours must be Hum./S.S./M.L. electives.

²C.E. 4103 or 4113 may substitute for Biol. 4413

³Chem. 4211 or 4212 may substitute for Text. 4310.
MULTIDISCIPLINARY PROGRAMS IN ENGINEERING

Five multidisciplinary educational programs provide unusual opportunities for specialized study in engineering at Georgia Tech. Six additional programs under development already provide diversified opportunities in research, coursework and seminars. These programs are designed for students to pursue the regular degrees while studying in one of the multidisciplinary areas. The multidisciplinary program is coordinated with normal degree requirements as to required and elective hours for the degree.

In addition to the established programs described in following sections, the following programs are under development: mineral engineering, environmental engineering, energy engineering, transportation engineering, structures engineering, and bioengineering. Additional information on these programs is available from the College of Engineering; please specify your particular interest and educational level.

ACOUSTICS ENGINEERING

The acoustics engineering program provides an opportunity to obtain coursework and research experience in the broad discipline of acoustics. The courses are offered in many schools of the institute, and are coordinated by the Acoustics Engineering Committee. The student may specialize in a particular acoustics area such as aerodynamic noise, or he may select a broad program such as environmental noise management. Either M.S. or Ph.D. students may enter the program.

The participating schools are Aerospace Engineering, Civil Engineering, Architecture, Electrical Engineering, Engineering Science and Mechanics, Mechanical Engineering, and Psychology. Courses are offered in theoretical acoustics, aerodynamic noise, architectural acoustics, audio engineering, environmental noise management, industrial noise, and psychoacoustics. Related courses exist in the areas of vibration control and seismology. The number of courses taken depends only upon the student's interest and the depth he desires in any particular area.

Current research opportunities exist in the fields of machinery noise, combustion noise, aerodynamic noise, helicopter noise, atmospheric acoustics, propagation through multiphase media, environmental site design for low noise, near field-far field relationships, subjective response to noise, and the effects of noise on human performance.

COMPUTER ENGINEERING

The computer engineering program is a master's degree program designed to provide engineers of all disciplines with the basic tools for computer applications in data acquisition, monitoring, control, simulation, and problem solving as an integral part of their engineering capability.

The program is divided into two tracks. Track I is for the student interested in using computers as components in the design of on-line systems. The inclusion of this track is stimulated by the vastly reduced cost of mini-computer main frames. The coursework emphasizes interface design, real-time programming, and systems design for control applications.

Track II is for the student interested in using the computer as a design and problem-solving tool in an off-line environment. The emphasis in this track is on methods of using large and small computer systems in an efficient manner to solve engineering problems.

Coursework in both tracks consists of 15 quarter hours. The schools currently participating in the program are Aerospace Engineering, Civil Engineering, Chemical Engineering, Electrical Engineering, Industrial and Systems Engineering, Mechanical Engineering, and Nuclear Engineering.

EDUCATIONAL ENGINEERING

Educational engineering is a multidisciplinary program to educate engineers in the application of analytical concepts and experimental expertise to the creative solutions of problems in education. As a result, the educational engineer is trained to quantitatively plan, design and operate complex educational systems. He becomes capable of applying the skills and knowledge gained in engineering coursework to the structure of the educational system. The training of a student in both education and engineering creates an intellectual bridge to improved methodology for educational planning and operation.

This program emphasizes engineering design, systems science, system dynamics and control, systematic planning, financial management, and the learning developing process of human beings. The approach is typically multidisciplinary because the area of application requires competence in different specialized branches of knowledge.

The educational system is vast and complex; therefore, the curriculum in educational engineering is designed to be flexible enough to accommodate a student's individual area of interest. The student is able to branch into a specialty area after having completed a series of core courses in psychology and in industrial and systems engineering. Fundamental technology and control concepts are joined with behavioral concepts to focus on learning and the educational system.

The educational engineering program has grown from natural concern for applying technology to areas of relevance to society as a whole. The allocation of human resources to education has always been a substantial part of the American heritage, and their proper use has always been important. But the current complexities of educational institutions suggests that a systematic technological approach to educational problems would provide significant benefits for society. The educational engineer can be the means of effecting such benefits.
The schools presently participating in the educational engineering program are: Civil Engineering, Electrical Engineering, Engineering Science and Mechanics, Industrial and Systems Engineering, Mechanical Engineering, and Textile Engineering.

PLASTICS ENGINEERING
The plastics industry has been growing at an annual rate of 15 percent for two decades. In response to the engineering man power needs of this dynamic industry, courses, research, and design projects pertaining to plastics engineering are available to students in all engineering disciplines.

Course selection is based on the particular needs and interests of each student. Introductory courses include: polymer science and engineering I and II; polymer science and engineering lab; polymerization process analysis; plastics industry manufacturing policies; and fiber spinning, drawing and texturing. Advanced courses include: polymer structure and physical properties I and II; preparation and reactions of polymers; energetics; kinetics; polymer degradation; surface and solution properties of polymers; and non-Newtonian fluids.

Research and design projects can be selected in the areas of plastic materials, fabrication, applications, marketing, and economics to emphasize plastics engineering. Financial support can usually be obtained for thesis work on plastics.

The normal requirements of the major discipline must be satisfied to complete a B.S., M.S. or Ph.D. Plastics courses and projects can be readily incorporated within the major engineering programs.

URBAN ENGINEERING
Urban engineering is a multidisciplinary program offered by many schools of engineering at Georgia Tech. Urban engineering is the integrated application of engineering science and technology to problems of urban society.

It is thus concerned with the technological aspects of governmental agency and private industry functions such as education, housing, human resources development, natural resource management, public health, public safety, transportation, utilities, waste disposal, and water supply.

The urban engineer provides technical and managerial expertise in the decision processes involved and implements the decisions once made. He must be knowledgeable in economics, systems analysis, urban government, organization, and politics as well as in technology. He must be able to bridge the communications gap for people in the urban arena who are not technologically oriented.

The urban engineering curricula in the participating schools allow students to prepare themselves for technologically oriented careers sensitive to the needs of an urban society. The participating schools are Aerospace Engineering, Architecture, Civil Engineering, Chemical Engineering, Engineering Science and Mechanics, Industrial and Systems Engineering and Mechanical Engineering.

Department of Air Force Aerospace Studies / 123

GENERAL COLLEGE
DEPARTMENT OF AIR FORCE AEROSPACE STUDIES
(Established in 1950)

Professor of Air Force Aerospace Studies—Colonel Henry G. Hostetter; Assistant Professor—Major Thomas A. Barrett, Jr., Lt. Col. William A. Olson, Captain Dallas D. Morgan, Captain William J. McKechney.

GENERAL INFORMATION
Air Force Reserve Officer Training Corps. (AFROTC) program is divided into two phases. The first two years constitute the General Military Course (GMC) and the last two years the Professional Officer Course (POC).

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 GMC incur no military obligation. Students must compete for entry into the POC, which is normally taken during the last two years of college. Selection is based upon the results of an Air Force medical examination, the scores achieved on the Air Force Officer Qualifying Test, and an interview by a board of Air Force officers. Cadets normally attend a four-week field training session conducted at a regularly established Air Force base between their sophomore and junior years. Co-op students normally attend field training after graduation. Students accepted for the POC become members of the Air Force Reserve and receive a $100 per month tax-free subsistence allowance.

TWO-YEAR PROGRAM:
The two-year and the last two years of the four-year program are identical in academic content. The basic requirement for entry into this program 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 POC 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 baccalaureate 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 B.S. degree providing for specialization in a given area such as physiology, or for combined studies in biology and mechanics or in biology and electronics. The latter combinations lead to the B.S. 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, developmental biology, ecology, microbiology, population genetics, and radiation cytogenetics. Areas of particular strength include microbiology, physiology and radiation biology.

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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<td>4-3-5</td>
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<tr>
<td>Engl. 1001-2-3</td>
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Freshman Year (Cont.)

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Sophomore Year

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<td>4-3-5</td>
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</table>

NOTE: Under Quarters, 3-3-4 means 3 hours class, 3 hours lab., 4 hours credit.

¹Choice of: (1) two quarters of one of the following: American history, political science, philosophy and history of science, or sociology; and the third quarter selected from one of the three remaining areas; or (2) three quarters of Modern Languages in either German, French, or Spanish. Three quarters of either Modern Languages or Social Science are required.

²These 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 must be scheduled beginning the first quarter the student is enrolled. For further details see page xx.

Junior and Senior Years

The minimum total number of credit hours required for a bachelor's degree in biology is 200. In addition to the required courses of the freshman and sophomore years, the following courses are required of all candidates for the degree:

<table>
<thead>
<tr>
<th>Subject</th>
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<th>4 hrs.</th>
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<th>5 hrs.</th>
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<td>Introductory Physics (4-3-5 each)</td>
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<td>Biology 3310</td>
<td>General Microbiology (3-6-5)</td>
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<td>Biology 3334</td>
<td>Genetics (3-3-4)</td>
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<td>Biology 4431</td>
<td>Cytology (3-6-5)</td>
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</table>
Of the 51 hours of electives indicated above, 28 hours must be departmentally approved courses in biology, chemistry, mathematics, physics or engineering. These technical electives must be chosen in conference with a faculty adviser to provide a meaningful, interrelated group ancillary to a specific field of interest. The other 23 hours are free electives. Not more than 9 hours of free electives in the junior and senior years may be advanced ROTC.

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 62 quarter hours of elective work. A student must have had the prerequisites for any course he 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, 3383, 3411, 3412, 3413, 3481, and 3491.

The great number of free elective hours in the chemistry curriculum permits concentrated studies in pre-medical and pre-dental requirements, minor options in geochemistry, and T-4 certification in association with Georgia State University. Free electives may also include studies in written and oral communication, business, information and computer science, biochemistry, and environmental chemistry.

The School of Chemistry also offers graduate programs for both the M.S. and Ph.D. degrees in the fields of analytical, inorganic, nuclear, organic, and physical chemistry. In addition courses are offered and considerable research is oriented toward biochemistry.

Active research fields include biophysical chemistry; brillouin spectra; carbonation chemistry; 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>
<th>Subject</th>
<th>1st Q.</th>
<th>2nd Q.</th>
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<td>Chem. 2113</td>
<td>Chemistry Principles</td>
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<td>Math. 1307-8-9</td>
<td>Calculus</td>
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<th>2nd Q.</th>
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<tr>
<td>Chem. 3311-2-3</td>
<td>Organic Chemistry</td>
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<td>Math. 2308</td>
<td>Calculus and Linear Algebra</td>
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### Junior Year

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<td>Chem. 3481</td>
<td>Physical Chemistry Lab.</td>
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<td>Chem. 4411</td>
<td>Physical Chemistry</td>
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<td>Chem. 4111-2</td>
<td>Inorganic Chemistry</td>
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<td>Chem. 4211</td>
<td>Instrumental Analysis I</td>
<td>3-6-5</td>
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<tr>
<td>Engl. 2001-2-3</td>
<td>survey of the Humanities</td>
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<td></td>
<td>15-6-17</td>
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</tbody>
</table>

*The School of Chemistry recommends that German be taken in the freshman year. However, social science may be taken in the freshman year and German taken later.

^2These 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 must be scheduled the first quarter the student is enrolled. For further details, see each ROTC section of the catalog.

^3Electives, free: Of the total free electives in the Chemistry curriculum, at least eighteen hours of Social Sciences, selected from the General College listing in "Information for Undergraduate Students," must be taken.

^4May be taken in the junior year.

^5A total of 10 quarter hours in elective chemistry courses are required of which a minimum of 4 hours and a maximum of 6 hours must be from laboratory electives. These laboratory electives may consist of:
   a. Two laboratory courses, 0-6-2 each.
   b. One laboratory course, 0-6-2, and Chem. 4901, 4902, OR c. Chem. 4901, 4902, 4903
   Options b and c must have the approval of the department.
   Chemistry electives may consist of those chemistry courses numbered 4xxx, 6xxx, or 7xxx with the exception of Chem. 4701 and Chem. 4741.

Registration for courses 6xxx and above must have departmental and graduate division approval.
DEPARTMENT OF ENGLISH


GENERAL INFORMATION

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

The department also 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.

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—English 1033, 2031-32-33—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 exempted from certain freshman-sophomore courses. A number of students in the Engineering College whose curricula do not require English 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.

SCHOOL OF GEOPHYSICAL SCIENCES

(Established in 1970)

Director and Professor—Charles E. Weaver; Professor—David W. Menzel (Adjunct); Associate Professors—Kevin C. Beck, L. Timothy Long, Charles O. Pollard, Jr., J. Helmut Reuter, J. Marion Wampler, Herbert L. Windom; Assistant Professors—James L. Harding (Adjunct), Robert P. Lowell, G. Lafayette Maynard; Supporting Faculty—R. A. Young.

GENERAL INFORMATION

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

Persons with a B.S. degree in geology, 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, marine geology, and environmental geology. Interdisciplinary studies can be carried out in such areas as crystallography (crystal physics), geohydrology, engineering geology, nuclear science and engineering, organic geochemistry, and space geophysics.

Research and study in oceanography is 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 and mathematics; therefore, the undergraduate program in geophysical sciences has been developed within B.S. programs of other Georgia Tech schools.

A geochemistry option is available in the B.S. curriculum in chemistry, a geophysics option in the B.S. curriculum in physics. These options involve substitution of courses in geology for some of the directed and free electives in these curricula.

Undergraduate students in other majors may develop a substantial background in geology by completing the requirements for a "minor" in geophysical sciences within the elective structure of their own degree program.
Such a minor would be important, for example, to a student in civil engineering who is interested in engineering geology.

Students who find they have a strong interest in geology may elect to pursue an undesigned B.S. degree under the direction of the School of Geophysical Sciences faculty. The curriculum for such a student would be similar to an existing designated B.S. program (as in chemistry, physics, or civil engineering), but would allow greater latitude in selection of courses. Detailed listings of the courses to be scheduled in the geochemistry and geophysics options, and in the geophysical sciences "minor", are available in the School of Geophysical Sciences office.

M.S. IN GEOPHYSICAL SCIENCES

Graduate study will be tailored to the background and interests of each M.S. candidate. A student frequently will be admitted without sufficient background in the sciences or mathematics to pursue some of the graduate courses important to his interests; therefore, some remedial work without graduate credit may be required.

A special "field study requirement" must be met before admission to candidacy for the M.S. in Geophysical Sciences. This requirement may be met by completion of a field course of at least two weeks duration, or by other field work deemed by the school to be satisfactory.

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 Ph.D. degree. A wide range of individual programs is available, owing to the multidisciplinary nature of the geophysical sciences. A special "field study requirement," more extensive than that required for the M.S., must be met before admission to candidacy for the Ph.D.

SCHOOL OF INFORMATION AND COMPUTER SCIENCE

Established in 1963

Director—Vladimir Slamecka; Professors—Lucio Chiaraviglio, James Gough, Jr., Gordon Pask (Visiting), Edward G. Roberts, Vladimir Slamecka, James W. Sweeney (Visiting), Miroslav Valach, Thomas G. Windeknecht, Pranas Zunde; Associate Professors—Robert B. Cooper, Philip J. Siegmann; Assistant Professors—John J. Goda, Jr., William I. Grosky, Michael D. Kelly, David E. Rogers, Robert M. Siegmann (Adjunct); Instructors—Charles R. Pearson, Robert I. Winner; Special Lecturer—John M. Gwynn, Jr.

GENERAL INFORMATION

The goal of the information, computer and systems sciences 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 the largest graduate department of the institute, and is among the largest computer science schools in the United States. It offers the B.S., M.S., and Ph.D. degrees in computer, information and systems sciences 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.

ICS students have free access to the school's extensive computer laboratory, which includes three computer systems (a large time-shared Burroughs B-5700, a PDP 11/45, and a PDP 8/I) and a wide array of special information processing devices. Other computing resources available to students of the school are the UNIVAC 1108 computer in the Georgia Tech Computer Center and an IBM 360/50 computer by special arrangement with the Atlanta Public Schools.

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 the information, computer and systems sciences and professions, hospitable to multi-disciplinary objectives. The program has two primary directions. The first is the acquisition of marketable knowledge and skills for professional careers in computer systems design, programming systems and languages, numeric computation, natural language processing, information systems design (for management, health care, education, etc.), and modeling and simulation of complex systems. The second direction prepares students for theory-oriented graduate work in computer science, information science, systems science, artificial intelligence, logic, or linguistics.

A total of 194 credit hours are required for graduation. The 54 hours of electives include 24 hours of course work in one of the areas listed above.

Freshman Year

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Subject</th>
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<tr>
<td>Chem. 1 1101-2</td>
<td>General Chemistry</td>
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<td>Calculus I, II, III</td>
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<td>Analysis of Literature</td>
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<td>P.T.² 1010-20-50</td>
<td>Physical Training</td>
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<td>ICS 1100</td>
<td>Information, Computers, Systems: An Introduction</td>
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<td>ICS 1110</td>
<td>Reasoning and Computation</td>
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<td>Phys. 2122</td>
<td>Electromagnetism</td>
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<td>Optics and Modern Physics</td>
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<td>ICS 2400</td>
<td>Computer Programming</td>
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<td>ICS 2600</td>
<td>Computer Organization and Programming</td>
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<td>Econ. 2000-1</td>
<td>Principles of Economics</td>
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<td>Ling. 4002</td>
<td>Current Developments in Linguistics</td>
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<tr>
<td>Math. 4215</td>
<td>Problems in Probability and Statistics</td>
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<td>5-0-5</td>
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<td>I.Sy.E. 4000</td>
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Senior Year

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<td>Information Systems</td>
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*With the consent of the school, these courses may be substituted by other empirical science courses relevant to the student's program.

**Free elective courses, to be taken at any time during the course of study. If basic ROTC is selected to satisfy these six credit hours, it must be scheduled beginning the first quarter of the freshman year.

**Electives in the junior and senior years will include 24 credit hours in one of several areas of specialization recommended and approved by the School of Information and Computer Science.

PROFESSIONAL GRADUATE PROGRAM

The objective of this one-year graduate program is to offer career education terminating with the degree Master of Science in Information and Computer Science. The professional program is designed primarily for persons holding college or university degrees in quantitative fields other than computer science: mathematics, the physical and natural sciences, engineering, or the medical sciences. Graduates of this 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 M.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. A master's thesis is not required; qualified students may, however, request to write a thesis in lieu of 17 credit hours of graduate coursework. The four-quarter program begins in the fall quarter, and its flexible curriculum draws on over 20 graduate-level courses in applied information, computer science, 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 M.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 the calculus, differential equations, set theory, and introductory probability and statistics.

Computing competence of the entering students should include higher level assembly language programming, data structures, and knowledge of searching and sorting algorithms. Students having a weaker background are expected, without exception, to enter the school in the preceding summer quarter (or earlier) to take the coursework 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 conducting independently 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 requires approximately three years. The first year of residence, which terminates with the preliminary Ph.D. examination, is devoted to the student's formal preparation in the foundations of the discipline and its branches, his demonstration of creative problem solving, and his commitment to one of the major areas of the discipline as his research domain. The second phase of the Ph.D. program stresses individual study and guided research leading to the formulation of a thesis project. Thesis research and the dissertation defense complete the Ph.D. program.

The faculty is prepared to guide doctoral research in the theory of information, information processes, and information measures; systems theory, and modeling and simulation of complex systems; metatheory of computer science, including logic, automata theory, formal languages, and computational complexity; theory of computer systems, including design and evaluation; human and social information processes, including man-machine communication; and natural language linguistics.

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, logic, or other disciplines of science that encourage mathematical formalisms and abstract thought. The students are assumed to be competent in the use of computers.

GRADUATE PROGRAMS

IN BIOMEDICAL INFORMATION AND COMPUTER SCIENCE

(An cooperation with Emory University School of Medicine)

In 1972, the Georgia Institute of Technology introduced pioneering graduate-degree programs in biomedical information processing, intended for persons seeking interdisciplinary careers in health care and medicine. The programs,
which strive for a pedagogic integration of information/computer/systems
science with medicine, are offered jointly by the School of Information and Com-
puter Science and the Emory University School of Medicine, with support of the
National Institutes of Health. They lead to the degree Master of Science in Infor-
mation and Computer Science and Doctor of Philosophy, both awarded by the
Georgia Institute of Technology.

In format, the two degree programs parallel the regular graduate programs of
the School of Information and Computer Science. The professional, terminal
M.S. program emphasizes the engineering design of advanced information
processing applications and systems in health care. The doctoral program
stresses research in the areas of information, computer and systems science
relevant to biomedicine and health care. The curricula of these programs include
substantial course work and internships at the Emory University School of
Medicine and its clinical laboratories, affiliated hospitals, and libraries. Detailed
information concerning courses at Emory may be obtained from the School of
Information and Computer Science office.

These programs should prove attractive to two groups of persons seeking
professional or research careers in biomedical information processing: recent
college graduates in the abstract, natural or premedical sciences; 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/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.

The degree requirements and standards of the graduate programs in
biomedical information and computer science are identical to those of the
regular graduate programs of the School of Information and Computer Science.

ELECTIVE MINI-CURRICULA AND MINORS

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.

Five elective “mini-curricula” are offered for undergraduate students each
comprising six courses totalling 18 credit hours: computing for Science and
Engineering, computing for Industrial Management, computing for Social
Science and Humanities, computer systems, and information systems.

The first three 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 ICS faculty, programs of study that include formal training
in computing tailored to their educational objectives.
SCHOOL OF MATHEMATICS
(Established in 1952)


GENERAL INFORMATION
The two primary functions of the School of Mathematics are to provide basic knowledge and techniques of mathematics to students in other disciplines, and to provide courses of study for persons intending to become professional mathematicians. Programs of study are offered which lead to the degrees Bachelor of Science in Applied Mathematics, Master of Science in Applied Mathematics, and Doctor of Philosophy.

Increasingly, the School of Mathematics finds it desirable to offer courses at all levels that stress the interrelations of mathematics with areas of application. The use of computers plays an important role in these applications of mathematics.

For students indicating special interest and ability in mathematics, an honors program in the freshman-sophomore calculus sequence is available.

Only free electives in the degree program may be taken under the pass/fail option and not more than 12 hours are allowed under this option.

UNDERGRADUATE PROGRAM
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>Math. 1307-8-9</td>
<td>Calculus I, II, III</td>
<td>5-0-5</td>
<td>5-0-5</td>
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<tr>
<td>Chem. 1101-2</td>
<td>Inorganic Chemistry</td>
<td>4-3-5</td>
<td>4-3-5</td>
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<tr>
<td>Engl. 1001-2-3</td>
<td>Intro. to Literature</td>
<td>3-0-3</td>
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Sophomore Year (Cont.)

<table>
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<tr>
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<th>Subject</th>
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<tr>
<td>P.T.</td>
<td>1010-20-50 Physical Training</td>
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<td>0-4-1</td>
<td>0-4-1</td>
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<tr>
<td>Phys. 2121</td>
<td>Physics</td>
<td>4-3-5</td>
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<tr>
<td>Electives</td>
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Sophomore Year

<table>
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<th>Subject</th>
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<tr>
<td>Math. 2307-2308</td>
<td>Calculus IV, V</td>
<td>5-0-5</td>
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<tr>
<td>Math. 3308</td>
<td>Differential Equations</td>
<td>4-3-5</td>
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<td>Phys. 2122-23</td>
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<tr>
<td>Math. 3215</td>
<td>Probability/Statistics</td>
<td>2-3-3</td>
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<tr>
<td>I.C.S. 1700</td>
<td>Computer Programming</td>
<td>3-0-3</td>
<td></td>
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<tr>
<td>Math. 3110</td>
<td>Linear Algebra</td>
<td>5-0-5</td>
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<td></td>
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<tr>
<td>Hum./S.S./M.I.</td>
<td>3-0-3</td>
<td>3-0-3</td>
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<tr>
<td>Electives</td>
<td>3-0-3</td>
<td>3-0-3</td>
<td>3-0-3</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>14-6-16</td>
<td>15-3-16</td>
<td>16-0-16</td>
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</tr>
</tbody>
</table>

1Chem 1101-2 is a terminal sequence. Those desiring chemistry beyond the freshman level may replace this sequence with Chem. 1111-12-13 and use the extra hours as elective credit.
2See P.T. requirements and exemptions.
3See each ROTC section of this catalog for ROTC description.
4The degree program must include a total of 42 hours in humanities and social sciences, so chosen as to (1) include either a one-year sequence in a modern language or nine (9) hours of English beyond Engl.1001-2-3, and (2) satisfy, with regard to 36 of the 42 hours, the humanities/social sciences requirements for undergraduate degree programs in the General College, as listed in this catalog.

Junior Senior Years
1. The junior-senior year program must include the following courses to be completed with a minimum grade of C.
   Math 4110 ..................................................... 4 hours
   Math 4120 ..................................................... 4 hours
   Math 4311-4312-4313 ........................................... 12 hours
   Math 4321 ..................................................... 3 hours
2. In addition, a total of at least 20 hours of 4000-level mathematics courses must be completed with a minimum point average of 2.0, including at least two sequences (2 or 3 courses in one subject area) Of this requirement, at least ten hours, including one sequence, must include courses from at
least two of the following applied mathematics areas: probability, statistical, or stochastic processes; ordinary or partial differential equations; numerical analysis or mathematical optimization; and mathematical models in the physical, economic, or biological areas.

3. Physics 3121 and at least six additional hours of courses (normally junior level or above) are required in the engineering, physical, economic, or biological areas, which involve substantial applications of mathematics. Selections are subject to approval by the School of Mathematics.

4. Humanities and Social Science electives — 24 hours. (See footnote 4 in the sophomore year program.

5. Free electives — 19 hours.

GRADUATE PROGRAM

Prospective graduate students are strongly advised to include in the undergraduate program the 2000-level courses in French, German, or Russian; Math. 4431 (Topology); at least one course in numerical analysis; and in the applied mathematics requirement, at least three areas represented with two sequences chosen from two different areas.

A program of study for the master's degree should include Math 6501-2-3, either Math 6311-12-13 or math 6321-22-23, 15 hours of additional course work, and either a thesis or further course work (at least 17 hours). Variations in the program and courses used to replace the thesis are subject to the approval of the School of Mathematics. Of the courses used to replace the thesis, two must be taken outside of the School of Mathematics with total credit in these two courses of at least six hours but not exceeding ten hours. Before admission to candidacy for the master's degree, each student must pass a written and an oral examination on course work and general mathematical background. The examinations together constitute the Graduate Examination.

Prospective candidates for Ph.D. degree are required to stand the Graduate Examination normally at the end of the first full year of graduate study. For students who receive the master's degree in mathematics at Georgia Tech the graduate examination for the M.S. may serve in part or in whole to satisfy the requirement for the Ph.D. on recommendation of the examining committee.

After successful completion of the graduate examination the Ph.D. student will select a major field and plan a course of study. This course of study will include a minor field, which may be in another discipline or in an area of mathematics other than the student's area of specialization. At the completion of the approved program the prospective candidate will be required to stand a comprehensive examination.

Each prospective candidate must demonstrate proficiency in two foreign languages, normally selected from French, German, and Russian.

DEPARTMENT OF MILITARY SCIENCE

(Founded in 1917)

Professor of Military Science—Colonel Andrew J. Waldrop; Assistant Professors—Lieutenant Colonels William E. Branch, Marion F. Meador, Edgar R. Allingham; Majors Charles Anderson, Jr., James C. Fargo, Robert L. Philbrook, John L. Taylor; Captains Lonnie G. Hartley, Ignazio J. Licata, John F. Lukas, James W. Rundquist, James L. Singleton; Instructors—Sergeant Major Billy G. Warren; Master Sergeant Raymond D. Slattery; Sergeant First Class Harvey A. Genske; Staff Sergeants Michael J. Berry, Tony L. Foster, Anthony M. Frank, Daniel Ortiz, Vernon D. Sorrell, Roger W. Wilf.

GENERAL INFORMATION

The purpose of the U.S. Army's Senior Reserve Officers' Training Corps (ROTC) is to select for commissioning in the Reserve or Regular Components of the Army of the United States college students who receive a baccalaureate or higher degree and successfully complete a program of instruction in military science. The Department of Military Science at the Georgia Institute of Technology offers instruction in the two-and-four-year programs. The four-year program consists of the basic and advanced courses, each of two years duration. The two-year program is open to both undergraduate and graduate students who wish to take the advanced course, and attend a six week basic summer camp in lieu of the basic course prior to enrollment in the advanced course.

Students who have demonstrated a high leadership potential and meet the following requirements may be selected by the Professor of Military Science for enrollment in the advanced course: (1) complete the basic course or basic summer camp; (2) pass the ROTC Qualifying Examination or equivalent; (3) pass the officer physical examination; (4) normally have 6 academic quarters remaining; (5) be recommended by a board of officers; (6) and if selected, enlist in the enlisted reserves. When selected in the advanced course, the student must sign a written contract agreeing to meet certain requirements as to completion of the course including one summer training camp and acceptance of a commission if tendered. While enrolled in the advanced course, students receive a subsistence allowance of $100 a month, which is nontaxable.

Reserve officers serve either three to six months or two years on active duty. Educational delays to pursue a graduate degree may be granted on application depending upon the needs of the service. ROTC graduates who meet special requirements may apply for a Regular Army appointment.

THE BASIC COURSE CURRICULUM

The basic course consists of six military science (MS) courses which are normally taken in the following sequence:
THE ADVANCED COURSE CURRICULUM

The advanced course consists of six military science courses and one of three elective political science courses (political science 3203, political science 3204, or political science 3205). These are three-credit-hour courses presented by the Department of Social Sciences, and may be applied toward the humanities and social science requirements in all curricula leading to an undergraduate degree. Four of the military science courses constitute a core curriculum to be completed by all students enrolled in the advanced course. The remaining two military science courses are selected from the branch material course offering, and will be appropriate to the branch in which the commission is sought.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS 1100</td>
<td>Orientation: The Military Role in Perspective (1-1-1)</td>
<td>1</td>
</tr>
<tr>
<td>MS 1200</td>
<td>Terrain Analysis and Land Navigation (1-1-1)</td>
<td>1</td>
</tr>
<tr>
<td>MS 1040</td>
<td>Leadership Development (0-1-0)</td>
<td>0</td>
</tr>
<tr>
<td>MS 2100</td>
<td>Analysis of Command and Leadership (2-1-2)</td>
<td>2</td>
</tr>
<tr>
<td>MS 2200</td>
<td>Seminar In Communications and Instructional Methods (2-1-2)</td>
<td>2</td>
</tr>
<tr>
<td>MS 2300</td>
<td>Military History (3-1-3)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>9</td>
</tr>
</tbody>
</table>

A total of 6 credit hours of basic ROTC courses may be applied toward a degree.

GENERAL INFORMATION

The Department of Modern Languages seeks to give the student sufficient mastery of a foreign language to enable him to read and understand with reasonable facility the scientific and technical literature of that language. Further, it seeks to inform the student, through the medium of the foreign language, of the civilization and literature of the countries where that language is spoken. A student taking a language in which he has two or more years of high school credit or the equivalent is encouraged to register initially for a course not lower in number than 2001 in that language. However, if such a student is convinced that his knowledge of the language in question is inadequate for successful participation in this 2000-series course, he may register for any less advanced course available in the same language at his level of preparation. Beginning with that less advanced course he may then take, for full credit toward graduation, the entire complement of language courses approved for his program of study. A student who elects to take courses in his native language must schedule, as his first course, one not lower in number than Fren. 4001, Ger. 2011, Russ. 3001, or Span. 3007. Otherwise, the student in either of these situations may schedule the beginning courses of another language.

A student may take any course for which he has prerequisites. Credit will be given on a quarterly basis, as specified in the catalog description, but students are urged to plan at least a three-quarter sequence in a language to achieve a minimum level of proficiency.

The enrollment in German is larger than that in any of the other languages, and all three regular elementary German courses (Ger. 1001-1002-1003) are normally available each quarter. Consequently, students such as co-ops who are enrolled only every other quarter can easily complete the first year of their language study in German but might do so only with great loss of time in the other languages.

During freshman orientation placement examinations are available in French, German, and Spanish for students who wish to determine their proper course level. Students whose high schools provide such examinations are encouraged to have the results of those examinations sent to the department well before their registration at Georgia Tech.

All programs of study leading to undergraduate degrees require the completion of 18 quarter hours each in the humanities and in the social sciences.
Reference to "Information for Undergraduate Students" will indicate which courses taught by the Department of Modern Languages satisfy this requirement for each college.

Any of the five series of courses, French, German, Russian, Spanish and Linguistics 4075-6-7, may be taken under various programs of study. Any of these series may also be taken in satisfaction of the foreign-language requirement of the graduate division. Reference to "Information for Graduate Students" will provide full detail.

NOTE: With the approval of the student's major department, any course offered by the Department of Modern Languages may be taken on a pass/fail basis.

COLLEGE CREDIT FOR HIGH SCHOOL STUDY

Those students who have two or more years of high school credit (or the equivalent) in a language offered by the Department of Modern Languages at Georgia Tech; who do not speak the language in question as a native language; who do not have college credit anywhere for the 1000-level series of courses in that language; and who complete, as their first foreign-language course series taken at Georgia Tech, a 2000-, 3000-, or 4000-level series of three courses (in Russian, two courses) in the same language with an average grade of at least "C"; are automatically granted 9 quarter hours of Georgia Tech elective credit for the 1000-level series in that language (in Russian, 12 quarter hours).

NOTE: The 9 or 12 quarter hours of credit for the 1000-level series are not applicable toward the above-mentioned 36-hour social science and humanities requirement; credit for the 2000-, 3000-, or 4000-level series is applicable toward this requirement.

GRADUATE LANGUAGE REQUIREMENTS

The Department of Modern Languages currently serves the institute by meeting the needs of all Georgia Tech students for 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. The training is available to all undergraduate students and to all graduate students through the regular 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
- Ling. 4075-6-7—Comparative Analysis of Major European Languages.

1In German the 2000-level series must be German 2001-2002-2003.

These courses, although developed in response to a revision of the foreign-language requirement of the graduate division, are undergraduate courses.

ENGLISH FOR FOREIGN STUDENTS

The department also serves the graduate division by providing instruction in English for international students whose knowledge of English is inadequate for the study required of them. This instruction is made available partly through programs in intensive English for International Students (Intermediate and Advanced levels under the auspices of Department of Continuing Education); prerequisite—two years of high school English or equivalent. Courses in grammar, pronunciation, sentence patterns, reading and theme writing, and group and individual instruction in the language laboratory are also available. These intensive courses (20-25 hours per week) are usually offered during the summer quarter only.

For further information, write the Department of Continuing Education, Georgia Institute of Technology, Atlanta, Georgia 30332.
DEPARTMENT OF MUSIC

Department Chairman and Director of Bands, Ben Logan Sisk; Assistant Professor and Director of Glee Clubs, Jerry L. Black; Assistant Director of Bands, C. Lloyd Tarpley.

GENERAL INFORMATION

Musical activities at Georgia Tech are taking an increasingly important place in the school, and courses are offered for academic credit to band and glee club participants. At least 36 credit hours of humanities and social sciences must be included in all curricula leading to an undergraduate degree. Certain courses taught by the Department of Music can be used toward satisfying the humanities division of this requirement.

The band is nationally known through television performances at both bowl and regular season football games. During the winter and spring quarters, the band functions as a symphonic organization doing considerable sightreading as well as performing quality band literature.

The glee club, with a history of several trips abroad and two appearances on the Ed Sullivan Show, annually performs at a number of girls’ colleges in the Southeast and in numerous local concerts. A concert tour through nearby states is generally taken between the winter and spring quarters.

DEPARTMENT OF NAVAL SCIENCE

(Established in 1926)

Commanding Officer and Professor of Naval Science—Captain Ralph I. McFarland, USN; Associate Professor—Commander William B. Wright, USN; Assistant Professors—Major Ronald L. Bub, USMC; Lieutenant Commander Richard H. Schmidt, USN; Lieutenant William C. Stedfield, USN; Lieutenant John E. Monroe, USN; Lieutenant Albert M. Mangin, USN; Instructors—Master Sergeant William R. Morningstar, USMC; Chief Quartermaster Milan C. Harring.

GENERAL INFORMATION

Naval ROTC students are enrolled for four years. Students desiring commissions in the Marine Corps follow a different curriculum during the junior and senior years. Students may apply for flight or nuclear power training or for a commission in the Civil Engineer Corps, Supply Corps, or Unrestricted Line during the senior year. A government-financed flight indoctrination program consisting of ground and flight training is conducted by a civilian flying school during the junior or senior year for qualified students leading to a private pilot's license. The NROTC has three types of students: scholarship, college program, and two-year college program, which is open to beginning juniors in good standing who contact the NROTC Unit prior to April 1 of the sophomore year.

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 $100.00 per month. Students in this classification will not be entitled to receive simultaneous education benefits under the G.I. Bill. They 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 Corps 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 $100.00 per month. They must complete the prescribed Naval Science curriculum, make a summer cruise of approximately six weeks
during the summer after the junior year, and upon graduation accept a commis-

sion as Ensign, USNR or Second Lieutenant, USMCR.

In consideration for the benefits accruing 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. He must agree to
serve on active duty for not less than three years after appointment to com-
misioned rank in the U. S. Naval Reserve or Marine Corps Reserve, and to re-
tain his commission until the sixth anniversary of receipt of original commission.
After receiving their commissions, college program students may apply for com-
mision in the Regular Navy or Marine Corps. Students may receive these
benefits in addition to G. I. benefits to which they are entitled.

NAVAL SCIENCE STUDENTS

Any regularly enrolled undergraduate student may enroll as a naval science
student. Those enrolled as naval science students take naval science course 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.

SELECTION PROCEDURE

Scholarship students are selected in nationwide competitive examinations. 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 naval personnel for a scholarship. To apply for the
college program, a student must be enrolled in 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.

Three candidates may be nominated each year by the professor of naval
science to take competitive examinations for entrance to the United States Naval
Academy. These nominations are normally made during the winter quarter. Both
scholarship and college program students are eligible.

CURRICULUM

All NROTC students follow the same curriculum during their freshman and

sophomore years, attending two hours of Naval science class and one hour of
associated laboratory or drill each week.

Junior and senior line students attend three hours of naval science class and
one or two hours of associated laboratory and drill each week.

Junior and senior marine option students attend three hours of naval science

class and two hours of associated laboratory and drill each week of the fall and
winter quarters. Junior and senior marine option students attend two hours of
laboratory and drill each week of the spring quarter. In addition, during each of
the junior and senior years, the marine option requires a three- or four-credit
course selected from the following areas of study and approved by the professor
of naval science: sociology, English, systems engineering, information science,
psychology, philosophy and history of science, industrial engineering, industrial
management, modern languages, history, and political science.

In addition to the required naval science courses, the NROTC student must
successfully complete the following institute courses:

Math 1307, 1308 or Math. 1721, 1722. Phys. 2111, 2112, 2113 or Phys. 2121,
2122, 2123 or Chem. 1101, 1102. P.T. 1001. ICS. 1700 or Math. 4625 or I.M. 2000
or any other PNS approved computer course Pol. 3203, 3204, 3275 (Any two of
these three courses may be taken.)

These specific course requirements may be varied as course offerings vary.

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 may be applied

toward a degree.
DEPARTMENT OF PHYSICAL TRAINING
(Established 1942)

Acting Head—Bill D. Beavers; Associate Professors—Byron A. Gilbreath, John C. Hyder, James H. McAuley, Tommy Flaxico; Assistant Professors—Carlos E. deCubas, James P. Culpepper, Jr., Douglas L. Fowkes, David W. Houser; Instructor—Russell W. Polhemus.

GENERAL INFORMATION

The Department of Physical Training seeks to provide opportunities to develop new skills and gain information that will allow the student to lead a healthier and more productive life. The program of instruction includes both required and elective courses.

REQUIRED PHYSICAL TRAINING

The object of the required courses is to give the student sound basic concepts regarding personal health, physical fitness, and water safety.

All male students entering Georgia Tech as freshmen are required to take physical training four hours per week for three quarters, receiving one to three hours credit per quarter. The schedule will call for two two-hour periods on alternate days, one hour for class activity and one hour for dressing and shower. Female students must register for P.T. 1040, Health Education, to complete their physical education requirement.

All physically qualified male students will be required to complete P.T. 1010 (swimming) and any other two courses from the remaining three offered (P.T. 1020, 1040, or 1050). Students who are exempt from all or any one of P.T. 1010, 1020, or 1050 will be required to take P.T. 1040.

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

Transfer students will be granted hour-for-hour work taken at other institutions. Students twenty-one years of age or over on first admission to the Georgia Institute of Technology will be exempt from required physical training.

ELECTIVE PHYSICAL TRAINING

Following the completion of the physical training graduation requirement, the student may choose from a wide variety of elective courses to improve or maintain desired levels of physical fitness, or to learn new recreational and leisure time skills. Many of these courses are offered on a coeducational basis including tennis, volleyball, paddleball, bowling, fencing, and sports officiating.

SCHOOL OF PHYSICS
(Established in 1939)


GENERAL INFORMATION

Physics has been known primarily as a basic science, and fundamental research into the principles of physics continues to occupy the attention of many physicists. But the study of physics has also become increasingly important as a basis for fundamental research in interdisciplinary areas such as biophysics and chemical physics, and as an applied science in government and industry. Furthermore, as society becomes more technically oriented, an education in physics may provide an advantageous pre-professional foundation.

The School of Physics offers basic service courses to freshman and sophomores, some advanced service courses for students of engineering, science, or mathematics, and advanced work leading to the bachelor's, master's, and doctor's degrees in physics. The school seeks to provide great elective freedom in its undergraduate and graduate degree programs to enable students with a wide variety of interests to work out suitable programs 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 collisions, cosmic rays, elementary particle theory, low-temperature physics, many-body theory, molecular physics, nuclear physics, solid-state physics, statistical mechanics, physics instruction, and interdisciplinary areas in biophysics and materials science. Opportunities exist in these areas, as well as in some other areas by collaboration with faculty members of other departments, for undergraduate and graduate special problems and master's and doctor's theses.

UNDERGRADUATE PROGRAMS

Although the study programs for the freshman and sophomore years are shown in some detail, they need not be rigidly adhered to. Students who encounter
academic difficulties are encouraged to lighten their schedules. Students who find they can handle additional work may wish to schedule a few extra hours during the sophomore year, subject to institute regulations set forth in “Student Rules and Regulations.” As many courses are offered only one or two times a year, it is essential that students consult with faculty advisors and plan junior and senior study programs well in advance. A general guideline in the planning of study programs is to schedule required courses and courses that serve as prerequisites for other courses as early as possible without scheduling several highly demanding courses in a particular quarter.

A total of 196 credit hours is required for a bachelor’s degree in physics with a point average of at least 2.0 in physics courses numbered 3000 and higher.

### 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>Chem. 1101-2</td>
<td>General Chemistry</td>
<td>4-3-5</td>
<td>4-3-5</td>
<td></td>
</tr>
<tr>
<td>Physics 2121</td>
<td>General Physics</td>
<td></td>
<td></td>
<td>4-3-5</td>
</tr>
<tr>
<td>Math. 1307-8</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>Eng. 1001-2-3</td>
<td>Analysis of Literature</td>
<td>3-0-3</td>
<td>3-0-3</td>
<td>3-0-3</td>
</tr>
<tr>
<td>S.S.³</td>
<td>Social Science or M.L.⁴</td>
<td></td>
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</tr>
<tr>
<td>P.T.³</td>
<td>Modern Language</td>
<td>3-0-3</td>
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### Sophomore Year

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<td>Math. 2307-8</td>
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### Junior and Senior Years

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<tr>
<th>Course No.</th>
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<th>Credit Hrs.</th>
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<tr>
<td>Physics 3121-22-23</td>
<td>Classical Mechanics, Electricity and Magnetism</td>
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<tr>
<td>Physics 3141</td>
<td>Thermal Physics</td>
<td>15</td>
</tr>
<tr>
<td>Physics 3143</td>
<td>Quantum Mechanics I</td>
<td>5</td>
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<td>Physics Electives</td>
<td>Phys. 3121, 3224, 3226, 3229, 3244, 3253, 4211</td>
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<tr>
<td></td>
<td>4212, 4214, 4215, 4216, 4265, 4266, 4321, 4322, 4323, or other approved laboratory courses</td>
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<tr>
<td>Electives</td>
<td>to bring total hours to 196 (not more than 9 hours in advanced ROTC)</td>
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<tr>
<td><strong>Total, Junior and Senior Years</strong></td>
<td></td>
<td>90</td>
</tr>
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</table>

¹Students contemplating advanced work in chemistry should consider taking Chem. 1111-12 in lieu of Chem. 1101-2.

²Students who have demonstrated competence in mathematics should consider taking Phys. 2141-42-43 in lieu of Phys. 2121-22-23. Some students, e.g. biophysics students, will find it advisable to commence upper-level chemistry courses during their sophomore year. They should schedule Chem. 113 in the third quarter of the freshman year and defer the start of the Phys. 2121-22-23 sequence until the sophomore year.

³See “Information for Undergraduate Students” for information relative to the 18 credit hour requirement in the social sciences, and the United States and Georgia history and constitution requirements.

⁴Students who contemplate graduate work in physics are advised to schedule French, German, or Russian. The language may be scheduled as an elective.

⁵See “Department of Physical Training” P.T. requirements.

⁶These elective hours may be taken at any time during a student’s course of study. If ROTC is elected, the first course should be scheduled during the first quarter the student is in attendance. See each ROTC section of this catalog for further information.

⁷Physics majors are advised to elect Phys. 1000, “Physics Orientation,” during the freshman year. A course in computer programming is also recommended during the freshman or sophomore years. A list of approved computer programming course and other suggested electives is available from School of Physics office.

⁸Students who have demonstrated competence in mathematics should consider scheduling Math. 3308 in place of Math. 2309.

**USE OF ELECTIVE HOURS**

Students may use the considerable elective freedom in the physics curriculum to specialize in particular areas of physics, to prepare for careers in interdisciplinary areas of science, to create a pre-professional program, or to gain a background in other technical or non-technical disciplines. Students are urged to consult with members of the faculty in planning the use of their elective hours.

To prepare for graduate study in physics, a student should schedule Phys. 3223 or 3225 (or both), 4143, at least three but preferably more from 4145, 4261, 4262, 4263, and 4264, and one or more from 4321-22-23. If experimental work is contemplated, he should consider Phys. 3211, 3224, 3226, and perhaps 4211 and 4215. He should consider the following mathematics courses: 3310 and 4347-48-49. Two years study in German, French, or Russian is recommended.
TECHNICAL AREAS
To assist students in formulating plans for the use of their elective hours, suggested programs of study are available with emphasis in the following technical areas: acoustics, applied optics, biophysics, geophysics, health physics, instrumentation, and materials science. Suggested pre-professional programs for business/management and medicine are also available. Detailed descriptions of these areas are available from the School of Physics.

GRADUATE PROGRAMS
Master’s Program
The school offers two distinct master’s programs, a “regular” program and a program in applied physics. The requirements for the regular program 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. 4582 and 4321 or Math. 4347 and 4348. 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 8511-12-13).

The master’s program 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, or 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 (Phys. 4143, 6131, 6132, and 6231 and mathematics equivalent to 4582 and 4321) plus the student’s choice from a wide selection of specific programs in applied physics including acoustics, health physics, 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 engineering 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 coursework 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 an institute requirement of 15 hours in a minor field, there are no definite course requirements. Most students find that they will schedule about 65 hours of courses and that completion of Physics 6121, 6122, 6123, and 6141 is advisable prior to taking the comprehensive examination. Physics 6143 and mathematics equivalent to Math. 6511-12-13 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.

Students are encouraged to commence participation in the departmental research programs early in their graduate careers. The undertaking of a doctoral thesis problem 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)


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 curriculum in psychology stresses fundamentals, providing opportunity for broad training in mathematics, the natural sciences, humanities, and management. The large number of elective courses enables the curriculum to fulfill a wide variety of educational and vocational needs. Graduates have been able to engage successfully in post-graduate 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
The General Option, which is extremely flexible, permits students to prepare for post-graduate study in psychology and a number of other fields, or for employment immediately after graduation. Students in this option are, through appropriate choices of elective courses, able to create a minor area of study.

The Linguistic Option combines a major in psychology with a coherent minor in linguistics to prepare students for graduate study in linguistics or in areas of psychology relating to the study of language. It also prepares students for work with cultural groups in which linguistic problems exist as significant variables in education or in vocational preparation and placement. Specific details concerning this option are available in the School of Psychology office.

### Freshman Year

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<tr>
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<th>Subject</th>
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<td>Engl. 1001-2-3</td>
<td>Introduction to Literature</td>
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<td>Math. 1307-8-9</td>
<td>Calculus I, II, III</td>
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<td>M.L./S.S.¹</td>
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### Sophomore Year

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<td>Biol. 2210-11</td>
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Senior Year

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*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 modern language in either German, French, or Spanish. Three quarters of either M.L. or S.S. are required.
*Students exempted from all or any one of P.T. 1010, 1020, 1050 will take P.T. 1040.
*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 must be scheduled the first quarter the student is enrolled.
*A total of not more than 8 hours of electives may be in advanced ROTC.
*Psychology 4413 may be substituted for Psychology 1010 with the approval of the School of Psychology and dean of the Graduate School.

GRADUATE CURRICULA

Ph.D. and M.S. candidates share a core curriculum of required courses which include: three prosemiers 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 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, governmental, or educational positions, or for both. The master's degree will require two years for most students although a well-prepared candidate may complete all requirements for the degree in one calendar year. A master's thesis is required.

The doctoral program provides the student with an opportunity for advanced study in general experimental, industrial, 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)


GENERAL INFORMATION
The Department of Social Sciences offers coursework in four disciplines: history, philosophy and history of science, 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.

The Department of Social Sciences has developed eight unofficial minors options to assist the student in identifying flexible, yet coherent programs of study in areas other than his major: American political systems; history of science and technology; international affairs; philosophy of science; American studies; science, technology, and society; urban affairs; and sociopolitical systems (open to psychology majors only). Though not as extensive as a major, a minor will enable the student to acquire additional conceptual skills and perspectives. Development of minors is elective with no formal requirement as to number of hours; however, a minimum of 15 to 18 hours is recommended.

UNITED STATES 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 Pol. 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 history 1001, 1002, 3010, or 3011; or pass an examination on U.S. and Georgia history.

Examinations for both requirements are administered each quarter to first-quarter seniors by the Department of Social Sciences. Notice will be sent to each student classified as first quarter senior in the early part of each quarter announcing dates of the examinations that quarter. Students who do not take the exams or who are unsuccessful must then take the appropriate course(s) prior to graduation.
COLLEGE OF INDUSTRIAL MANAGEMENT


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 organization 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 Industrial Management, the Bachelor of Science in Management Science, and the Bachelor of Science in Economics; and offers graduate programs leading to the Master of Science in Industrial Management, the undesignated Master of Science, and the Doctor of Philosophy.

All three undergraduate degree programs contain an essentially common core. Each program allows sufficient flexibility for the student to follow his own educational goals. Complex problem-solving takes place in a technical, social and political environment; therefore, the tools of management and economics are enhanced by an understanding of the natural and life sciences, humanities, the social sciences, and the environment of the business enterprise. Every student is thus required to take substantial work in these subjects in addition to courses such as accounting, economics, computer applications, marketing, production, and finance.

Only students who demonstrate their ability to successfully complete the requirements of the program are permitted to transfer into the College of Industrial Management from other majors at Tech. Therefore, it is definitely to 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 analytical 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 advisor, to tailor a program to his 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

<table>
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<tr>
<th>Course No.</th>
<th>Subject</th>
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<td>Introduction to Literature</td>
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<td>S.S./M.L.</td>
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<td>Math.²</td>
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Sophomore Year

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Senior Year

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*Laboratory Science – 1 year of a laboratory science required – (Chemistry/ Biology/Physics) Must complete series in same area.
*The Math requirements may be satisfied with one of the following sequences as determined by the student's high school background: Math. 1710, 1721, 2010; Math 1721, 1722, 2010; Math. 1307, 1308, 2010.
*No student may receive credit for more than three hours of P.T. towards degree. P.T. 1010 and any other two 1000 level P.T. courses are required.

Bachelor of Science in industrial Management / 167
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.

The economics degree 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. One year of lab 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 1721, 1722, 2010; Math 1307, 1308, 2010.
3. No student may receive credit for more than three hours of P.T. towards degree. P.T. 1010 and any other two 1000 level P.T. are required.
4. One year required of approved (non-survey) engineering courses, lab science or advanced math not required by the core curriculum. Engineering orientation courses may not be used to fulfill the requirement.
5. English 2004 or 2007 may be substituted for English 2003.
6. May substitute economic elective.
7. Mgt. 3100, 4110, or 4100.

### 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 analytical 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 applied area or to strengthen his 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 analytical 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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<td>Management I</td>
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<td>Electives*</td>
<td>Integrated Management Problems</td>
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*Chemistry/biology/physics. Must complete series in same area.
*No student may receive credit for more than 3 hours of P.T. toward degree.
*An additional Math course in probability and statistics is required.
*Mgt. 3100, 4110 or 4100.
*M.Sci. concentration - 9 hours of advanced study in courses selected by the student and his adviser.
Nine hours of specialization electives, which is a concentration in a specific subject area determined by the student and his adviser, or three 3-hour courses (M.Sci. 4901, 4991, and 4992) of special project.
Approved advance math - 6 hours.
GRADUATE PROGRAM

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

The Master of Science in Industrial management program, accredited by the American Association of Collegiate Schools of Business, is designed to give a professional management education to students with engineering, mathematics, and science baccalaureate degrees. The program requires 72 hours of graduate coursework or its equivalent. Industrial management courses or approved graduate courses in other schools of the institute may be taken as electives. A student may enter the master’s program in any quarter without experiencing any scheduling difficulties, thus allowing the completion of the program, in six consecutive quarters.

In addition to the regular programs, the College of Industrial Management expects to offer an accelerated program that can be completed in four quarters, the first class, starting in September 1973. This program will be designed to take only well-qualified students and provide them with intensive and rigorous training for professional managers then place them in excellent positions upon completion. The program will take the student's full time with no time available for outside work.

The college also offers, in cooperation with the School of Nuclear Engineering, a Master of Science degree with an emphasis in nuclear power management.

A student may also pursue a program of study at the master's level in which a curriculum is designed to meet his individual needs. The course requirements are specified during a conference between the student and his advisor.

The Ph.D. program in the College of Industrial Management has three major areas of focus: economics, behavioral science, and management science. Each of these areas is designed to complement and reflect the technological emphasis of the institute.

Doctoral students in industrial management are required to take a minor in economics. Students in economics are required to take a minor either from the non-economics offerings of the College of Industrial Management or from the offerings of other schools at Georgia Tech.

Comprehensive examinations, which include both a general and a special examination, are required of all Ph.D. 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 course work. The student will be admitted to candidacy after successful completion of the special examination and the approval of the prospectus of his 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.

5. Courses of Instruction
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 part 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 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 Chemistry 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. 2100. Structures I 4-3-5. Prerequisite: Math. 2308 and E.S.M. 2201; 2.0 overall average and a 2.0 average in math and physics.
Introduction to the elements of structural mechanics basic in the design of aircraft and missile structures.

Description of the components of a modern digital computing system. Elementary FORTRAN programming. Introduction to aerospace engineering applications.

A.E. 2601. Computer Applications in Aerospace Engineering II 0-3-1. Prerequisite: A.E. 2600.
FORTRAN programming with emphasis on problem solving and program efficiency.

Advanced programming, including creation and manipulation of program and data files. Solution of problems related to aerospace engineering.

A.E. 3000. Fluid Mechanics I 4-3-5. Prerequisite: Math. 2309 and M.E.

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.

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 to airfoil theory.

A.E. 3100. Structures II 4-3-5. Prerequisite: Math. 2309 and A.E. 2100.
Analysis of three-dimensional trusses, thin-walled beams, and unsymmetrical bending. Introduction to theory of elasticity and application to two-dimensional problems.

A.E. 3101. Structures III 4-3-5. Prerequisite: A.E. 3100.
Principles of virtual work and energy principles. Applications in linear and nonlinear elasticity. Introduction to stability analysis with application to simple models and to columns.

A.E. 3102. Structures IV 4-3-5. Prerequisite: A.E. 3101.

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.

A.E. 4100. Advanced Structures 3-0-3. Prerequisite: A.E. 3102 or consent of department.
Beam columns, shear webs with cut-outs; shear lag, bending in the plastic range; curved beams, miscellaneous thin metal structural problems.

A.E. 4120. Thermal Stresses 3-0-3. Prerequisite: A.E. 3102 or consent of department.
Origin of thermal stress; constraints; determination of temperatures; equations of uncoupled isotropic thermoelectricity; solutions of typical problems; properties of material at high temperatures; creep consideration.

Structural dynamics of one-dimensional systems. Analyses of static aeroelastic phenomena and flutter. Equations of motion for complete aeroelastic system and solution techniques.

The theory and principles of jet propulsion. The mechanics and thermodynamics of combustion. Component and cycle analysis. Engine performance characteristics.

A.E. 4350-1. Aerospace Engineering Design Project I, II 2-6-4. Prerequisite: A.E. 4000 and A.E. 4500 or concurrently.
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, *Aircraft Performance, Stability and Control*.

A.E. 4400. Introduction to Propeller and Rotor Theory 3-0-3. Prerequisite: A.E. 4000 or concurrently, or consent of department. A study of the theory and equations used in the design of propellers and helicopter rotors.

A.E. 4500. Stability and Control 5-0-5. Prerequisite: A.E. 4000 and E.S.M. 4210. Principles of static lateral and longitudinal stability and studies of the equations and methods used in analysis. Applications to airplane and missile systems.

A.E. 4550. Instrumentation for Experimental Research I 2-3-3. Prerequisite: consent of department.

- Laboratory treatment of major and ancillary instrumentation used in solid and fluid mechanics research; voltage, current, resistance measurement; transducers, amplifiers, oscilloscopes; recording equipment.
- 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.


- Course material devoted to special topics of current interest; treatment of new developments in various areas of aerospace engineering.
- Viscous Flow I 3-0-3. Prerequisite: consent of department.

- Exact solutions of Navier-Stokes equations; Stokes flow; boundary layer equations; similarity solutions and integral methods for incompressible flow; compressible laminar boundary layer; viscous hypersonic flow.


- Development of the nonlinear and linearized unsteady potential flow equations. Solutions to incompressible flow problems of airfoils and wings undergoing steady, oscillatory and arbitrary motions.


A.E. 6040. Rarefied Gasdynamics I 3-0-3. Prerequisite: consent of department.

- Mass, momentum, and energy transfer in linearized rarefied gas flows; free molecular and internal flows; statistical models of collision integral of Boltzmann equation.


- Mass, momentum, and energy transfer in nonlinear rarefied gas and plasma flows; statistical models for diatomic and ionized gases; discussions of allied topics in ionospheric aerodynamics.

A.E. 6050. High-Temperature Gas Dynamics I 3-0-3. Prerequisite: A.E. 6260 or consent of department.

- 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. 6051. High-Temperature Gas Dynamics II 3-0-3. Prerequisite: A.E. 6050.

- Acoustic equations and rate equations. Viscous and chemical nonequilibrium flows, normal and oblique shock structures, theory of nonequilibrium characteristics, nonequilibrium acoustic waves, flow over corners.

A.E. 6100. Advanced Structural Analysis I 3-0-3. Prerequisite: A.E. 3101 or consent of department.


A.E. 6101. Advanced Structural Analysis II 3-0-3. Prerequisite: A.E. 6100 or consent of department.

A.E. 6122. Thermal Effects in Structures III
3-0-3. Prerequisite: A.E. 6100, E.S.M. 6372, or consent of department.
Phenomenological and mechanism interpretations of mechanical behavior of solids. Formulation and solution of problems involving elastic, plastic, linear and nonlinear viscoelastic and visco-plastic behavior.

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. 6200. Advanced Aeroelasticity I

A.E. 6201. Advanced Aeroelasticity II
3-0-3. Prerequisite: A.E. 6200.
Formulation of aeroelastic analyses associated with discrete and random dynamic loads, and dynamic and structural instabilities of fixed-and rotating-wing flight vehicles.

A.E. 6202. Experimental Aeroelasticity
3-0-3. Prerequisite: A.E. 6200.
Analog computing techniques with applications. Flexibility influence coefficient measurements. Vibration testing for modal identification. Wind tunnel and inflight flutter tests including model scaling and construction.

A.E. 6203. Special Topics in Aeroelasticity I
3-0-3. Prerequisite: A.E. 6200.
Current topics in aeroelasticity, 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 Aeroelasticity II
3-0-3. Prerequisite: A.E. 6200.
Continuation of A.E. 6203. Study of advanced problems in aeroelasticity, 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 department.
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 department.

A.E. 6262. Combustion II
3-0-3. Prerequisite: A.E. 6261.

A.E. 6300. Meteorology and Atmospheric Dynamics
3-0-3. Prerequisite: consent of department.
Introduction to dynamical and physical processes of natural weather systems; hydrostatic stability and convection; radiation and heat in atmosphere; planned and inadvertent weather modification.

A.E. 6301. Turbulence and Atmospheric Dynamics
3-0-3. Prerequisite: consent of department.
Introduction to turbulence; turbulent transport of momentum and heat; dynamics of turbulence; boundary-layer and wall-bounded shear flows; statistical description and spectral dynamics of turbulence.

A.E. 6302. Air Pollution Meteorology
3-0-3. Prerequisite: consent of department.
Fundamentals of air pollution meteorology; engineering approach to atmospheric diffusion; natural removal processes; urban and regional problems; meteorological instruments; air pollution climatology.

A.E. 6303. Atmospheric Boundary Layer
3-0-3. Prerequisite: A.E. 6300, or A.E. 6301, or consent of department.
Structure and aerodynamic characteristics of atmospheric boundary layer; turbulent transport of contaminants in environment; stratified and disturbed atmospheric boundary layer, free-convection layer; current problems.

A.E. 6304. Aerospace Systems and the Environment
3-0-3. Prerequisite: A.E. 6300 or consent of department.
Effects of aerospace vehicle on environment; pollutant emissions from vehicles; chemistry and effects of emissions in troposphere and stratosphere; methods of emission reduction; current problems.

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. 6460. 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 techniques and use of airframe transfer functions are emphasized. Survey of the load alleviation problem.

A.E. 6750. System Design Methodology
2-3-3. Prerequisite: graduate standing or consent of department.
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.S.M. 6372 and M.E. 6750.

A.E. 6751-2. Complex Systems Design
2-3-3. Prerequisite: graduate standing.
This two-quarter sequence permits students from all schools to meet, form an interdisciplinary team, and carry out a design project. Taught as E.E. 6751-2 and M.E. 6751-2.

A.E. 6760. Engineering Acoustics I
3-0-3. Prerequisite: consent of department.
Introductory analytical methods, stochastic processes, the wave equation in a compressible fluid, and problems in the radiation of sound. Also taught as E.S.M. 6760.

A.E. 6761. Engineering Acoustics II
3-0-3. Prerequisite: A.E. 6760.
Sound reflection and refraction, scattering and diffraction, sound radiation and duct acoustics. Also taught as E.S.M. 6761.

A.E. 6762. Engineering Acoustics III
3-0-3. Prerequisite: A.E. 6761.
Advanced duct acoustics, wave dispersion and attenuation, acoustics in moving media, geometrical acoustics, nonlinear acoustics. Also taught as E.S.M. 6762 and M.E. 6762.

A.E. 7000. Master's Thesis

A.E. 7600. Perturbation Methods in Engineering Analysis
3-0-3. Prerequisite: consent of department.
Regular and singular perturbation theory, WKBJ method and the method of weighted residuals. Problems drawn from fluid mechanics and structures.

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 M.E. 7760.

A.E. 7761. Magnetogasdynamics II
3-0-3. Prerequisite: A.E. 7760.

A.E. 7762. Magnetogasdynamics III
3-0-3. Prerequisite: A.E. 7761.
Engineering applications of magnetogasdynamics. Magnetogasdynamic power generation, space propulsion, pumps and meters. Available experimental data. Characteristics of magnetogasdynamic systems. Geophysical and astrononmical applications. Also taught as M.E. 7762.

A.E. 7763. Methods of Experimental Magnetogasdynamics
2-3-3. Prerequisite: A.E. 7762.
Laboratory plasma source and flow devices. 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 Ph.D.
Qualifying Exams. Noncredit. Prerequisite: consent of director.

A.E. 8000. Seminar
1-0-1.

A.E. 8103-13-23-33-43. Special Topics
3-0-3. Prerequisite: consent of department.
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
4-0-4. Prerequisite: consent of department.
Special topics of current interest; treatment of new developments in various areas of aerospace engineering.

5-0-5. Prerequisite: consent of department.
Special topics of current interest; treatment of new developments in various areas of aerospace engineering.

A.E. 8500-1-1-1. Special Problems in Aerospace Engineering
Credit to be arranged. Prerequisite: consent of department.

A.E. 8503-4-4-5. Special Problems in Aerospace Engineering
Credit to be arranged.

A.E. 8999. Preparation for Ph.D.
Dissertation. Noncredit. Prerequisite: consent of director.

A.E. 9000. Doctor's Thesis

AIR FORCE AEROSPACE STUDIES
GENERAL MILITARY COURSE
Aerospace Studies I—United States Military Forces in the Contemporary World
A.S. 1510. The United States Aerospace Organization and Strategic Offensive Forces 1-1-1.
United States Air Force doctrine, mission and organization; strategic offensive forces covered with emphasis on mission and employment.

A.S. 1520. The United States Aerospace Strategic Defensive and General Purpose Forces 1-1-1.
United States strategic defensive and general purpose forces; emphasis on their mission, employment, and the control over employment of nuclear weapons.

A.S. 1530. The United States Aerospace Support and General Purpose Forces 1-1-1.
Mission, resources and operation of tactical air forces; general-purpose forces and aerospace support forces.

Aerospace Studies II—United States Military Forces in the Contemporary World
Nature and principles of modern warfare with emphasis on instruments of national power and Department of Defense.

Military capabilities and policies of the United States, the Soviet Union, and China. General and limited war strategies.

United States defense policy including roles in defense policymaking of the president, the executive branch, agencies and the legislative branch.
Professional Officer Course
This two-year course concentrates on three main themes: aerospace power and space operations, the concepts and practices of leadership, and the concepts and practices of management, especially as related to the U.S. Air Force.

Aerospace Studies III—The Growth and Development of Aerospace Power
The development of doctrine, technology, organization and employment of this nation’s air arm.

Strategies and military programs in the contemporary nuclear age, employment of aerospace forces, and the future of manned aircraft.

The national space effort; characteristics of space; types of orbits and trajectories; space vehicle systems; concepts of space operations.

Aerospace Studies IV—The Professional Officer
Air Force leadership, human relations, and discipline in the military services. Command positions in leadership laboratory.

A.S. 4120. Command-Staff Relationships 3-1-3.
Variables affecting leadership and problem-solving. The commander and his staff. Introduction to Air Force management and military justice.

Functions of management, Air Force personnel policies, and information sciences. Briefing for commissioned service.

ARCHITECTURE

ARCHITECTURE

Arch. 1001, 1002, 1003. Design Fundamentals 1-12-5.
Introductory studies in visual and structural expression emphasizing the processes of problem identification, design method, and communication.

Arch. 1201, 1202, 1203. Architectural History 3-0-3.
A study of man’s architectural heritage from the beginning of recorded history to the present day. Open to all freshmen.

Basic composition, architectural problems, and presentation methods, structured to corequisite courses in technical subjects.

Introduction to building frames, components, and construction techniques; requirements and design of climate control systems; sound and lighting control.

Arch. 2361, 2362. Color Theory 1-3-2.
Lecture and laboratory experiments on the properties of color and its use in design.

Arch. 3001, 3002, 3003. Architectural Design 1-12-5. Prerequisite: Arch. 2003, 2303. Corequisite: Arch. 3401, 3421, 3441.
Elementary composition, architectural problems, and presentation methods, structured to corequisite studies in technical subjects.

Arch. 3201, 3202, 3203. History and Theory 3-0-3.
History of architecture in ancient Egypt and Mesopotamia, Greece, and Rome; Medieval Europe; the Renaissance in Continental Europe.

Arch. 3321, 3322, 3323. Structures and Materials I, II, III 4-3-5. Prerequisite: Arch. 2301, E.S.M. 3701.

Arch. 3351. Acoustics of the Built Environment 2-0-2. Prerequisite: Physics 2113.
The basic principles of and the design approach to the acoustics of buildings and their surroundings.

Arch. 3401, 3421, 3441. Urban Planning; Facilities Planning; Building Economics 3-0-3.
Survey and historic background of urban planning in the United States: criteria for design and evaluation of buildings; economics of building development, construction, and operation.

Arch. 3911, 3912, 3913, 3914. 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, 4002, 4003. Architectural Design 1-12-5. Prerequisite: Arch. 3003.
Intermediate problems in architectural design and presentation methods.

Arch. 4201, 4202, 4203. History and Theory 3-0-3. Prerequisite: Arch. 3202.
Renaissance architecture in England and America; the 19th and 20th centuries; history of town and city planning in Europe and America.

Arch. 4241, 4242, 4243. Art History 2-0-2.
A survey in the history of artistic manifestations from primitive times to our own day.

Arch. 4244, 4245. Art History 2-0-2.
History of Pre-Columbian and Oriental art and architecture.

Arch. 4246, Art History 2-0-2. Prerequisite: consent of department.
A survey of 19th and 20th century art in Europe and the United States.

Arch. 4321. Structural Integration 3-0-3. Prerequisite: consent of department.
An integration of information obtained in previous courses in structural design.

Arch. 4401. Introduction to Landscape Architecture 2-0-2.
History of landscape architecture and the study of principles of landscape design as applied to contemporary problems.

Arch. 4421. Housing Seminar 2-0-2.
Lecture and discussion broadly covering the housing field and the home building industry, housing needs, housing markets and financing, standards of design and construction, the government and housing.

Group 1. Advanced problems in architectural design with emphasis on the solution of complex building programs and site planning.
Arch. 4553. Design
0-2-9. Prerequisite: Arch. 4552, 4561.
Terminal project for the Bachelor of Architecture degree (Option I).
Arch. 4554. Design
0-2-9. Prerequisite: Arch. 4003.
Group II. Advanced problems in architectural design with emphasis on structural solutions, computations and details.
Arch. 4555, 4556. Structural Design
0-2-9. Prerequisite: Arch. 4554, 4561.
Terminal project for Bachelor of Architecture, Option II.
Arch. 4561, 4562, 4563. Seminar
2-0-2. Prerequisite: Arch. 4203.
Preparation of thesis program and research; lectures and discussions of current problems in architectural design and architectural education.
Arch. 4581, 4582, 4583. Professional Practice
3-0-3.
Conduct of architectural practice, office organization, competitions, contracts, legal and ethical problems; specification writing; estimating and supervision of construction.
Arch. 4751, 4752 (Psy. 4751, 4752). Psychology of Environmental Design
3-3-4. Prerequisite: consent of department.
See description under psychology listings.
Arch. 4753 (Psy. 4753). Special Problems in the Psychological Aspects of Environmental Design
Credit to be arranged. Prerequisite: Arch. 4751, 4752.
See description under psychology listings.
Arch. 4821, 4822, 4823. History and Theory
3-0-3. Prerequisite: consent of department.
Research in advanced areas of history and theory of architecture.
Arch. 4911, 4912, 4913, 4914. Visual Communications Studios
0-3-1 to 0-15-5.
Intermediate studio work in: (1) drawing and painting; (2) sculpture and three dimensional concepts; (3) photography; (4) graphic design and rendering.
Arch. 4915, 4916, 4917, 4918. Visual Communications Studios
Credit to be arranged. Prerequisite: consent of department.
Self-directed studies in visual communications arts.
Arch. 4951, 4952, 4953. Special Problems
Credit to be arranged.
Arch. 4954, 4955. Special Problems
Credit to be arranged.
Arch. 5644. Cost Analysis
2-3-3. Prerequisite: senior standing.
Principles and methods of cost analysis in the construction industry.
Arch. 6001, 6002, 6003. Architectural Design: Special Problems
2-21-9. Prerequisite: Arch. 4553 or equivalent.
Solution of a series of advanced problems approved by the committee on design. Subject material determined separately in the case of each candidate to develop his personal talents and general ability; investigation into special areas of architectural design. Research; sketches; presentation drawings, renderings and models; structural synthesis; working details; oral and written reports.
Arch. 6301. Advanced Building Construction
2-3-3.
Folded, saw-tooth, shell, umbrella, and lamella roofs. Bow-string trusses.
Arch. 6321. Membrane Structures in Architecture
3-3-4.
Structural behavior of membrane structures: requirements for stability, dimensional proportions, economic competitiveness, and application to architectural problems. Introduction to the analysis of cylindrical shells.
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. 6324. Advanced Structural Theory and Design
2-3-3.
Theory of model analysis of structures. Cantilevered, lattice, pin-jointed, and rigid frames.
Arch. 6351. Advanced Architectural Acoustics
3-0-3. Prerequisite: Arch. 2303, 3351, or equivalent.
Design requirements for noise control and acceptable room acoustics. Practical design problems, materials selection, and calculation of sound propagation parameters.
Arch. 6421. Industrialized Housing
3-0-3.
An examination of the problems and proposed solutions to the designing, manufacturing, marketing and utilization of industrialized building systems to provide housing.
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 bases for urban design.
Arch. 7401. Urban Design Survey, Analysis and Implementation Methods and Techniques
2-3-3.
Systematic methods for evaluating the built environment and of means to improve its quality. Implementation strategies within the framework of public policy and private decision-making.
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, 7805, 7806. Problems in Urban Design I, II, and III
2-21-9. Prerequisite: Arch. 4553 or equivalent.
Wide range of contemporary urban problems; considerations and judgments at regional, metropolitan/city and sub-city 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. 8521, 8522, 8523. Special Problems in Architectural History
Credit to be arranged.
Individual study of selected periods, architects, schools, or building types.
Arch. 8531. Special Problems
Credit to be arranged (only for students majoring in structures).
Arch. 8532. Special Problems
Credit to be arranged (only for students majoring in structures).
Arch. 8541, 8542, 8543. Special Studies in Urban Problems
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.
BUILDING CONSTRUCTION

B.C. 1851. Building Construction Seminar 0-3-1. Introduction to the field of construction through lectures, discussions, field trips and related reading assignments.


B.C. 3441. Building Production 3-0-3. Processes by which building facilities are produced and delivered.

B.C. 4441. Land Development 3-0-3. The 1970 Occupational Safety and Health Act as it applies to the building contractor to provide safe working conditions and to the designer to provide safety in buildings.

B.C. 4442. Value Engineering in Construction 3-0-3. Analysis of materials, equipment, facilities, procedures, and supplies to achieve lowest possible cost consistent with performance requirements to attain optimum quality in building.

B.C. 4443. Industrial and Construction Safety 3-0-3. The history, background, and legal limits and statutory requirements for construction.

B.C. 4444. Real Estate Investment 3-0-3. Real estate as an investment, joint ventures, real estate trusts, financial analysis, tax considerations.


B.C. 4951, 4952, 4953. Special Problems in Construction Credit to be arranged. Corequisite: senior standing and special permission. Special problems in construction methods, schedules, or management for students in advanced architectural design or construction projects. Research in innovative methods, processes, systems of construction.

CITY PLANNING

C.P. 4401. Urban Planning Communication 1-3-2. Organizing oral presentations; developing speech aids; use of radio, television, conferences and public meetings to communicate planners' ideas.

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. 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. 6040. Resource Development 3-0-3. A study of natural resources, their adequacy for future needs; influence of technology; evaluation of policies to assure adequate resources for the future.

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 are examined in detail. The history, background, organization, and techniques and methods are studied.

C.P. 6070. Public Works Planning 3-0-3. Planned change in context of public works planning and development; plan implementation; population analysis; public participation; conflict value assessment; and information transfer.


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 town; 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 plan including traffic volume estimates, fringe area annexation study, neighborhood conservation plan and program.

C.P. 6120. Problems in City Planning 2-12-6. An in-depth study on 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 1 3-0-3. Identification and quantitative analysis of air, water, noise, spatial pollution; influence on urban development, health and well-being. 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 environmental or community generated noise; analysis of noise impact; noise measurement; instrumentation; rating methods. Evaluation of laws and management programs.

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, new communities, etc.

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 handling population, employment and income data.

C.P. 6280. State and Local Finance
3-0-3.
Extension of C.P. 6090; 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.
Basic concepts of scientific method relevant and applicable to planning practice and theory.

C.P. 6360. Intermediate Scientific Methods in Urban and Regional Planning
2-6-4. Prerequisite: C.P. 6350 or consent of department.
A continuation of 6350, this course covers the intermediate level of modeling and other scientific methods that are relevant and applicable to city planning practice and theory.

C.P. 6370. Systemic Planning Methods in Urban and Regional Planning
2-6-4. Prerequisite: C.P. 6360 or consent of department.
A continuation of C.P. 6360, this course examines the philosophical and intellectual content of the systems approach to city planning.

C.P. 7000. Thesis
Credit to be arranged.
A research problem in city planning, selected by the student in consultation with the graduate staff. Requires one full quarter of work as a minimum with technical direction available from the graduate staff.

C.P. 8010-20-30-40-50. Seminar
1-0-0.
A student-faculty discussion seminar devoted to planning topics in the daily news and the topics of special interest to the group. Visiting lecturers.

INDUSTRIAL DESIGN
I.D. 1261, 1262, 1263. History of Design
2-0-2.
A history of design, technology and innovation, with emphasis on their influence in historic cultures. Open to all freshmen and the general campus.

1-12-5. Corequisites: I.D. 2301, 2302, 2303.
Elements of industrial design; stress on design procedures and problem-solving.

I.D. 2301, 2302, 2303. Materials and Process Design
1-3-2.
Characteristics of material and production processes, their influence on design: wood, thermoplastics, and thermostets.

I.D. 3001, 3002, 3003. Industrial Design
1-12-5. Prerequisite: I.D. 2003.
Corequisites: I.D. 3001, 3002, 3003.
Problems of a more complex nature, emphasizing the human factors in design.

I.D. 3301, 3302, 3303. Materials and Process Design
1-3-2.
Characteristics of materials and production processes, their influence on design: fibers and ceramics, ferrous and non-ferrous metals.

I.D. 4001, 4002, 4003. Industrial Design
1-18-5. Prerequisite: I.D. 3003.
A advanced industrial design problems, accentuating individual work in special areas of concentration.

BIOLOGY

Biol. 1001. Orientation to Biology
1-0-1.
Orientation to the biology program at Georgia Tech. The nature of biology, contemporary research in biology, and career opportunities.

Biol. 1710-11-12. Introduction to Biology I, II, III
3-3-4. Prerequisite: Biol. 2212 or consent of department.
For students interested in one year of laboratory science. Principles of genetics, physiology, taxonomy, and evolution in plants and animals are discussed. Non-credit for biology majors.

Biol. 2110-11-12. Principles of Biology
4-3-5,4-3-5. Prerequisite: Biol. 1712 or consent of department; the biology courses to be taken in sequence.
An intensive introduction to the cell integrated into the physiology, development, anatomy and behavior of the intact organism and the biology of ecosystems.

Biol. 3310. General Microbiology
3-6-5. Prerequisite: Biol. 2212; Chem. 3312.
Study of bacteria and other microorganisms.

Biol. 3711. Anatomy and Physiology
3-0-3. Prerequisite: junior standing or consent of department.
Study of human anatomy and fundamental physiological mechanisms. Designed for the advanced student in fields interdisciplinary with the life sciences. Non-credit for biology majors.

Biol. 3316. Industrial Hygiene
3-0-3.
Problems of health in industry; industrial poisons, occupational hazards and diseases, industrial fatigue, ventilation, and accident prevention.

Biol. 3333. Biostatistics
3-3-4. Prerequisite: Math. 1309; Biol. 2212.
An introduction to statistical methods and their use in the preparation and interpretation of biological experiments.

Biol. 3334. Genetics
3-3-4. Prerequisite: Biol. 2212 or consent of department.
An introduction to the principles of heredity.

Biol. 3335. General Ecology
3-0-3. Prerequisite: Biol. 1712 or 2212, or consent of department.
Introduction to the concepts of ecology, designed for biology majors but appropriate for interested non-majors. Emphasizes structure and function of natural populations, communities, and ecosystems.

Biol. 3336. General Ecology Laboratory
0-3-1. Prerequisite: Biol. 3335 or consent of department; may be taken concurrently with or following Biol. 3335.
Designed to be taken with Biol. 3335. Important aspects of ecological theory, analytical techniques, and physical and chemical methods useful in ecological studies. Text: At the level of Cox, Laboratory Manual of General Ecology.

Biol. 3343. Developmental Vertebrate Biology
2-6-4. Prerequisite: Biol. 2212 or equivalent.

Survey of the anatomy, embryology and phylogeny of vertebrate organ systems. Laboratory work involves dissection of adult organism and study of embryological slides.

Biol. 4407. Advanced Microbiology
3-4-4. Prerequisite: Biol. 3310, Chem 3312.

Advanced discussion and laboratory procedures in bacteriology and general microbiology.

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 department.

A general survey of biological systems and their responses to various kinds of radiations. Text: At the level of Casarett, Radiation Biology.

Biol. 4431. Cytology
3-6-5. Prerequisite: Biol. 2212.

Modern aspects of the morphologic, functional and cytotoxic organization of the cell. Preparative techniques and procedures for observations in light, phase and electron microscopy.

Biol. 4435, 4436. Applied Biology
3-0-3. Prerequisite: consent of department.

Selected topics in modern biology.

Biol. 4443, 4444, 4445. General Physiology
3-6-5, 3-6-5, 3-6-5. Prerequisite: Biol. 3310, Chem. 3313.

The chemical and physical responses and function of living systems, cellular biochemistry and metabolism, tissue and organ function, response of the organism to its environment.

Biol. 4450. Seminar
2-0-2. Prerequisite: normally taken by seniors.

Student and staff presentations of reports on laboratory or literature searches.

Biol 4478. Physical Biology
4-0-4. Prerequisite: Physics 2121, Chem. 3312, or consent of department.

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 4729. Biological Principles of Radiobiology
3-3-4.

A survey of the biological principles necessary as a prerequisite for the study of radiobiology. Non-credit for biology majors.

Biol. 4774. 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. 4960, 4961, 4962. Special Problems.

Hours to be arranged. Prerequisite: Biol. 2212.

Special laboratory problems in biology, to be given any quarter with credits (not to exceed 6) to be arranged.

Biol. 6619. Ecological Systems
3-0-3. Prerequisite: consent of department.

Ecosystem structure and function. Fundamentals of ecology, approaches and problems associated with analysis of ecosystems. Applications of systems analysis to aquatic and terrestrial ecosystem models.

Biol. 6622. Special Topics in Ecology
1-2-2. Prerequisite: Biol. 6619 or consent of department.

Topics of current interest in environmental science such as: systems analysis, indicators of pollution, environmental impact evaluation, and environmental monitoring.

Biol. 6632. Design of Experiments in Quantitative Biology
3-3-4. Prerequisite: Anal Biol. 3333.

The philosophical and statistical basis for design of experiments in biology. Selected examples from the research of individual faculty 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 multihit phenomena.

Biol. 6634. Selected Topics in Experimental Cell Biology
3-3-4. Prerequisite: Biol. 6635.

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 department.

Designed to acquaint engineers and scientists with the biological aspects of air pollution as one factor in the total environment of living animals and plants.

Biol. 6640. Instrumental Methods in Biology
3-6-5. Prerequisite: consent of department.

Biophysical and biochemical methods for the study of macromolecules, cell components, multicellular and organism level organisms. Techniques by electron microscopy, spectroscopy, centrifugation and other methods.

Biol. 6641. Electron Microscopy Laboratory
0-6-2.

Techniques for the fixation, lyophilization, staining and sectioning of biological materials.

Biol. 6730. Biological Effect of Radiations
3-3-4. Prerequisite: consent of department.

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. 8504-05-06. 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. 2004. Ceramic Data Handling
2-3-3.

Study of testing, rational economic value of tests 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; Holscher, Simplified Statistical Analysis.
Cer. E. 2080. Ceramic Survey
2-0-2 General Elective for Non-Majors.
A survey of the classifications and physical properties of ceramic products, materials and manufacturing processes.
Text: At the level of Mitchell, Ceramics – Stone Age to Space Age.

Cer. E. 2090. Ceramic Survey Laboratory
0-3-1. General Elective.
Plant trips to local ceramic plants, flow sheets of processes; production of simple pottery and ceramic pieces.

Cer. E. 3005. Phase Equilibria for Ceramists
3-0-3. Prerequisite or Corequisite: Chem. 3411.
Interpretation of phase equilibria in non-metallic 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 McMurtrie, Phase Diagrams for Ceramists (Monograph by the American Ceramic Society).

Cer. E. 3010. Principle Materials of Ceramics
2-3-3. Prerequisite: consent of department.
Relation of physical properties to structure and bonding; properties of suspension, morphology, particle size analysis, design of ceramic compositions, property measurements on ceramic materials.

Cer. E. 3012. Processing and Forming
3-3-4. Prerequisite: Cer. E. 2004 or consent of department.
Extraction, refining and preparation of ceramic raw materials; methods and mechanisms of processing and forming ceramic products; the control of the properties of the products.
Text: At the level of Jones, Ceramics; Kingery, Ceramic Fabrication Processes.

Cer. E. 3015. Solid State Ceramics
3-0-3. Prerequisite: Cer. E. 3012.
Physical and chemical properties of ceramic materials; control of the phases and microstructure of ceramic products to develop the desired properties, sintering and densification phenomena.
Text: At the level of Kingery, Introduction to Ceramics.

Cer. E. 3018. Pyrometry and Instruments
1-3-2. Prerequisite: Physics 2122.
Principles of heat measurements by thermoelectric thermometry, optical and radiation pyrometry, melting points; thermal expansion and resistance bridges; temperature control instrumentation.
Text: At the level of Precision Measurement and Calibration: Vol. 2 Temperature (NBS Special Publication 300).

Cer. E. 3020. Glass
2-3-3. Prerequisite or Corequisite: Cer. E. 3005.
The fundamentals of glass structure, composition, manufacture, properties and applications are described. In the laboratory many glass batches are melted and analyzed.
Text: At the level of Scholes, Modern Glass Practice; Shand, Glass Engineering Handbook.

Cer. E. 4006-7-8. Seminar
2-0-2. Normally scheduled by seniors.
Discussion of current ceramic and scientific literature and reports of investigations. Courses may be repeated with different numbers.
Text: At the level of the Journal of the American Ceramic Society.

Cer. E. 4018. Drying and Psycho-metry
2-0-2. Prerequisite: Cer. E. 3015.
Fundamentals of water removal from unfired ceramic products by heat and air. Control of humidity, temperatures, air velocity, and volume; economy and efficiency of driers.
Text: At the level of Moody, Drying.

Cer. E. 4019. Firing and Combustion
2-3-3. Prerequisite: Physics 2123, M.E. 3720 or equivalents.
Combustion of fuels; mechanisms of heat transfer and refractory selection; kiln operation and control techniques; thermomechanical behavior of materials.

Cer. E. 4021-2-3. Thesis
1-0-1, 0-6-2, 0-6-2. Normally scheduled by seniors.
Each student conducts an investigation on a ceramic subject under supervision of his advisor. These courses stress independent study and application of skills developed previously.

Cer. E. 4025. Physical Ceramics
3-3-4. Prerequisite: Cer. E. 3015, Chem. 3411, and Phys. 2123.
Application of physical chemistry, crystal chemistry, colloid chemistry, and solid state physics to ceramics. Dispersion, viscosity, plasticity, grain size, crystal structure as related to properties.
Text: At the level of Kingery, Introduction to Ceramics.

Cer. E. 4026. Physical Ceramics
Chemical thermodynamics is reviewed and used to predict reaction directions and study vaporization processes in high-temperature systems.
Text: At the level of Reed, Free Energy of Formation of Binary Compounds – An Atlas of Charts for High Temperature Chemical Calculation.

Cer. E. 4031-2-3. Design and Construction
1-3-2, 0-6-3. Normally scheduled by seniors.
Design and investigate the economics of ceramic equipment and/or layouts. Technical and economic aspects of the structure, constitution, and behavior of these materials under reactor conditions.
Text: At the level of Hausner, Materials of Nuclear Reactors.

3-0-3, 3-3-4, 3-0-3. Prerequisite: consent of department.
The physicochemical properties of the plastic and anti-plastic hydrous aluminosilicates are considered. The control of plasticity, viscosity, adherence, permeability, dispersion, and flocculation is studied with industrial applications.
Text: At the level of Van Olphen, An Introduction to Clay Colloid Chemistry; Lawrence, Clay-Water Systems.

Cer. E. 6014-5. Ceramic Applications to the Phase Rule
3-0-3, 3-0-3. Prerequisite: Cer. E. 3005 or consent of department.
Phase equilibria in one-, two-, and three-component systems reviewed.
Melting and solidification behavior in complex three-component systems examined. Effect of oxygen measure on phase relations in selected two- and three-component systems described; techniques of studying phase equilibrium in nonstoichiometric compounds surveyed. Application of thermodynamics to phase diagrams reviewed.

Text: At the level of Prince, Alloy Phase Equilibria.


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 substituted for the hard-sphere crystal chemistry approach in analyzing the various glass structures. The different experimental techniques available to study glasses are reviewed.


Nature of crystals growth, mechanical; relationship of crystal structure to chemical and physical properties; structure of various clays and complex oxide ceramics; high temperature crystal growth techniques. Text: At the level of Evans, Crystal Chemistry. Wells, Structural Inorganic Chemistry; Buckley, Crystal Growth.

Cer. E. 6035. Research and Control Methods 2-3-3. Prerequisite: consent of department.

Emphasis on the experimental and instrumental techniques for research and control measurements. Review of optical, electrical, mechanical, mechanical measurement techniques, instrumentation; laboratory demonstrations. Text: At the level of Wilson, Introduction to Scientific Research; Ackoff, Scientific Method.

Cer. E. 6040. Crystal Studies I 2-3-3. Prerequisite: Cer. E. 4025 or consent of department.

Fundamentals, methods, and instruments in applications of x-ray diffraction, especially the powder method, to problems in ceramics and metallurgy. Text: At the level of Azaroff, Elements of X-ray Crystallography.

Cer. E. 7000. Thesis (MS)

Cer. E. 8001-8006. Seminar 1-0-0

Current ceramic developments.

Cer. E. 8102-8119. Special Topics Credit to be arranged.

Specific, well-defined study and measurement problems will be considered and approved for credit upon completion.

Cer. E. 8501-2-3. Special Problems Credit to be arranged.

Cer. E. 9000. Thesis (Ph.D.)

CHEMICAL ENGINEERING

CHEMICAL ENGINEERING

Ch. E. 1101. Introduction to Chemical Engineering 1-0-1

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 2-3-3

An introduction to chemical engineering design in which simplified problems of current interest are discussed in the lectures and demonstrated in the laboratory.

Text: At the level of Badger and Bancroft, Introduction to Chemical Engineering.

Ch. E. 2207, 2208. Chemical Process Principles I, II 3-0-3. Prerequisite: Chem. 2113 or concurrently with Chem. 2113 and Math. 1306.

Stoichiometric principles, physical and chemical properties, thermophysics and thermochemistry leading to rather detailed material and energy balances on chemical, metallurgical, and petroleum processes. Text: At the level of Himmeblau, Basic Principles and Calculations in Chemical Engineering.

Ch. E. 2209. Computers in Chemical Engineering 2-3-3. Prerequisite: Math. 2308 and Ch. E. 2208 or concurrently with Ch. E. 2208.

A study of the application of digital and analog computers to the solution of chemical engineering problems. Text: At the level of Peterson, Analog computation; Murrill & Smith, Fortran IV. Programming for Engineers and Scientists.

Ch. E. 3304. Transport Phenomena I 3-0-3. Prerequisite: Math. 2308 and Ch. E. 2208 or concurrently with Ch. E. 2208.

Fundamental principles of momentum and energy transfers are developed. Application of these principles are stressed. Text: At the level of Bird, Stewart and Lightfoot, Transport Phenomena.

Ch. E. 3305. Transport Phenomena II 3-0-3. Prerequisite: Ch. E. 3304.

The development of Ch. E. 3304 is extended to include mass transfer. Major emphasis is placed on applications involving heat and mass transfer. Text: At the level of Bird, Stewart and Lightfoot, Transport Phenomena.

Ch. E. 3306. Unit Operations I 3-0-3. Prerequisite: Ch. E. 3304 and Ch. E. 3305 or concurrently with Ch. E. 3305.

The analysis of chemical engineering processes and operations involving fluid and heat transfer. Text: At the level of McCabe and Smith, Unit Operations of Chemical Engineering.

Ch. E. 3315. Unit Operations II 3-0-3. Prerequisite: Ch. E. 3304.

Stagewise operations. Text: At the level of McCabe and Smith, Unit Operations of Chemical Engineering; Perry, Chemical Engineer's Handbook; Notes.

Ch. E. 3339. Chemical Engineer Literature 1-0-1. Prerequisite: Ch. E. 3304, Chem. 3111, 3411.

Training of students in the use of sources of chemical and chemical engineering information. Use of the library, literature searching.


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.


Introduction to the engineering of chemical reactions involving colloidal and amorphous materials. Text: At the level of Golden, Polymers and Reina; Jergensons and Straumanis, A Short Textbook of Colloid and Surface Chemistry.

Ch. E. 4413. Unit Operations III 3-0-3. Prerequisite: Ch. E. 3305.

Diffusion, processes, including combined mass and heat transfer. Text: At the level of Perry, Chemical Engineer's Handbook; McCabe and Smith, Unit Operations of Chemical Engineering.

Ch. E. 4415. Reactor Design 3-0-3. Prerequisite: Ch. E. 3315, Chem. 3313 and Chem. 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 semi-batch reactors.
Text: At the level of Levenspiel, Chemical Reaction Engineering

Ch.E. 4416. Process Control
3-3-4. Prerequisite: Ch.E. 3305; E.E. 3700 recommended.
Dynamics of chemical processes and theory of control techniques. Mathematics primarily Laplace transforms is applied with instrumentation and process constraints to system design.
Text: At the level of Murrill, Automatic Control of Processes

Ch.E. 4431. Chemical Engineering Economics
3-0-3.
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: Ch.E. 4431 or concurrently with Ch.E. 4431 and Met. 3301.
Comprehensive problems for each of the basic types of chemical process equipment: reactor, 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. 3339, 4413, 4414, 4416, 4441, 4452, 4453.
A comprehensive problem in plant design.

Ch.E. 4438. Chemical Engineering Thermodynamics
4-0-4. Prerequisite: Chem. 3412, Ch.E. 3315.
Principles of thermodynamics with industrial applications. Flow of compressible fluids; thermodynamic properties, charts, tables; power and refrigeration cycles and processes; phase equilibria; chemical equilibria.

Text: At the level of Smith and Van Ness, Introduction to Chemical Engineering Thermodynamics.

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 Strauss, Air Pollution Control.

Ch.E. 4449. Computer Aided Process Design
2-3-3. Prerequisite: Ch.E. 3306, 4413, 4415 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 Crowe et al., Chemical Plant Simulation.

Ch.E. 4453. Polymerization Process Analytical
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, Physics 2123.
An introduction to the chemistry and structure of polymers. Polymerization processes, major polymer systems, and methods of polymer identification are presented.

Text: At the level of Rodriguez, Principles of Polymer System; also taught as Text. 4750.

Ch.E. 4751. Polymer Science and Engineering II
3-0-3. Prerequisite: Ch.E. 5750.
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
0-3-1. Prerequisite: Ch.E. 5751 or concurrently with Ch.E. 5751.
Experiments in polymerization, processing, and property evaluation of polymers. Also taught as Text. 4752.

Ch.E. 4901-4902-4903. Special Problems
Credit to be arranged. Prerequisite: Ch.E. 3305.
The student is given an opportunity to develop initiative and to apply fundamental principles by doing original laboratory investigation 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.

Ch.E. 6604-6605-6606. Organic Chemical Technology
3-0-3. 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.

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 gaseous and particulate matter is presented.
Text: At the level of Strauss, Air Pollution Control.

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 Butcher and Charlson, An Introduction to Air Chemistry.

Ch.E. 6613. Technology of Fine Particles
3-0-3. Prerequisite: Ch.E. 3305 or consent of school.
An examination of the properties of finely divided materials. Size, surface pores are treated in relation to reactivity, adsorption, catalytic behavior, and process engineering operations.
Text: At the level of Gregg and Sing, Adsorption Surface Area and Porosity.
Ch.E. 6615. Transport Phenomena I 3-0-3. Prerequisite: Ch.E. 3305 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. 4413, Math 2309.
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 Mickley, Sherwood and Reed, Applied Mathematics 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 Mickley, Sherwood and Reed, Applied Mathematics 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 O'K. Applications to cryogenic processes. The emphasis will vary from year to year.

Ch.E. 6628. Advanced Unit Operations 3-0-3. Prerequisite: Ch.E. 4413.
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 3-0-3. Prerequisite: Ch.E. 4413.
Thermal radiation in furnaces, measurement of elevated temperatures, condensation of mixed vapors, and evaporation.
Text: At the level of McAdams, Heat Transmission.

Ch.E. 6633. Inorganic Chemical Technology 3-0-3. Prerequisite: consent of school.
Technology of selected inorganic processes and industries, especially the ammonia, nitric acid, ammonium nitrate, urea, phosphoric acid, ammonium phosphate, superphosphate, and potash industries.

Ch.E. 6635. Advanced Unit Operations 3-0-3. Prerequisite: Ch.E. 4413.
Vapor liquid equilibrium and separation by distillation of binary and multicomponent systems. 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 3-0-3. Prerequisite: Ch.E. 4413 or consent of school.
An advanced study of absorption and stripping in simple and in multicomponent systems. Designs and performance of equipment. Liquid-liquid and liquid-solid extraction.

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. 6648-6649. Chemical Plant Design 1-3-3. Prerequisite: Ch.E. 4434 or consent of school.
Selected methods of chemical plant design.

Ch.E. 6750. Polymer Structure and Physical Properties 3-0-3. Prerequisite: consent of school.
Morphology and structure, linear and non-linear systems, 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 Technology Laboratory 3-18-9. Prerequisite: permission 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 Chem. 6753 and Physics 6753.

Ch.E. 7000. Master's Thesis

Ch.E. 7716. Advanced Unit Operations 3-0-3. Prerequisite: Ch.E. 4413.

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 non-catalytic flow reactors, flame reactors, 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 and chemical reaction, 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. 7999. Preparation for Ph.D. 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, 8002, 8003. Seminar 1-0-0
A discussion group composed of staff and graduate students, where assigned topics from the literature and 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 Credit to be arranged.
Lectures, laboratory and library work on special problems of current interest in chemical engineering.

METALLURGY

Met. 3301. Principles and Applications of Engineering Materials 4-3-5. Prerequisite: Chem. 2113, Physics 2123
The principles of engineering materials directed toward their application in engineering design. Equilibrium and non-equilibrium structures and properties. Corrosion. Engineering application and failure analysis.

Text: At the level of Van Viack, Materials Science for Engineers.
Met. 3325. General Metallurgy 3-0-3. Prerequisite: Chem. 1102 and Physics 2123
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. 4403. Introductory Nuclear Metallurgy 3-3-4. Prerequisite: Chem. 1102 and Physics 2123
Fundamentals of physical metallurgy, metal crystals, phase diagrams, properties, fabrication, and testing with emphasis on refractory metals and fuel materials.

Met. 4411. Basic Extractive Metallurgy 3-0-3. Prerequisite: Chem. 3413 or equivalent
Theory and practice of extraction and refining of ferrous and non-ferrous metals. Calculations and reactions related to pyrometallurgical and hydrometallurgical extractive processes will be emphasized.

Text: At the level of Newton, Extractive Metallurgy.
Met. 4421. Nonferrous Metallurgy 3-3-4. Prerequisite: Met. 3301 or equivalent
The influence of processing variables on the structure and properties on non-ferrous alloys. Pyrometric instrumentation applied to heat treating and thermal analysis.

Text: At the level of Kehl, Metallographic Laboratory Practice.
Met. 4422. Ferrous Metallurgy 3-3-4. Prerequisite: Met. 3301, 4421, or equivalent
The influence of processing variables on the microstructure and properties of steels and ferrous alloys. Heat treating and thermal analysis 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, rolling, forging, extrusion, drawing, machining and welding.

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 3-3-4. 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
Nondestructive and nondestructive test methods are outlined. The emphasis will be on the significance of results and the choice of materials based on test data.

Text: At the level of Cullity, Elements of X-ray Diffraction and Azaroff and Donahue, Laboratory Experiments in X-ray Crystallography.
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 secondary fabricated metal structures.

Met. 4491. Corrosion and Protective Measures 3-0-3. Prerequisite: Chem. 3413 and Met. 3325 or 4401
Introduction to the electrochemical theory of corrosion; recommended materials and protective measures for chemical processing equipment and for atmospheric, underground, underwater, and elevated temperature exposures.

Text: At the level of Cottrell, An Introduction to Metallurgy
Met. 6005. Dental-Medical Materials 2-0-2. Prerequisite: Met. 3301 and Met. 4411
Theoretical requirements and compatibility of metals as medical implants and a review of up-to-date research. Special lectures will be given by visiting researchers.

Met. 6014. Electrometallurgy 2-3-3. Prerequisite: Chem. 3413 or equivalent
Electrolytic dissolution and deposition of metals, electrolys tic purification, electropolishing, 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.

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. 4402 and 4491

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. 6091. Advanced Theory of Metal Corrosion 3-3-4. Prerequisite: Met. 4491
The subject matter covers the latest theories and concepts of metallic corrosion.

Met. 7041. Advanced Physical Metallurgy I
3-0-3. Prerequisite: Met. 4441.
Lattices, melting points, Young's modulus, alloy formation, heat content, conductivity, and electrical properties of metals and alloys. Electron energy band and other theories are applied.
Text: At the level of W. Hume-Rothery, Atomic Theory for Students of Metallurgy.

Met. 7045. Advanced Electron Microscopy I
3-0-3. Prerequisite: Met. 7051.
This course will emphasize the dynamical theory of image contrast in thin crystalline foils and its application to the interpretation of lattice defects.

Met. 7051. Advanced Mechanical Metallurgy
3-0-3. Prerequisite: Met. 4463.
Application of theoretical mechanics to metallurgy. Elastic theory. Crystal plasticity and plastic deformation based on dislocation theory. Rolling and recrystallization textures from theoretical considerations.
Text: At the level of Cottrell, Dislocation and Plastic Flow in Crystals.

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. 7052. Magnetism in Metals
3-0-3. Prerequisite: Met. 6231; Met. 4441; Met. 7061.

Met. 7068. Neutron Diffraction
3-0-3. Prerequisite: Met. 4446; Phys. 6231; Met. 4441.
Text: At the level of Bacon, Neutron Diffraction, second edition.

Met. 7081. Metallurgical Thermodynamics
3-0-3. Prerequisite: Met. 7041.
Text: At the level of Darken and Gurry, Physical Chemistry of Metals.

Met. 7085. Metallurgical Kinetics
3-0-3. Prerequisite: Met. 7081.
Reaction kinetics and rate processes applied to physical metallurgy reactions. Theoretical heat transfer in metals. An introduction to theoretical nuclear radiation reaction in metals.

Met. 8001, 8002, 8003. Seminar
2-0-1. Prerequisite: graduate standing.
The latest advances in metallurgical research and development will be presented by the enrolled students from articles in recent issues of recognized periodicals.

Met. 8100. Special Topics in Advanced Physical Metallurgy
3-0-3. Prerequisite: consent of school.
Representative subjects include alloy theory, phase transformations, magnetic and electric phenomena in metals and special topics in diffraction analysis.

Met. 8500. Special Problems. (M.S.)
Credit to be arranged.
Lectures, laboratory, and library work on special topics of current interest in metallurgy suitable for a master's candidate.

CHEMISTRY
NOTE: All students are required to wear safety glasses while working in the laboratories. The glasses will be provided at the students' expense.

Chem. 1101, 1102. General Chemistry
4-3-5. Prerequisite: entrance requirements.
Fundamental laws and theories of chemistry for students who do not plan to take more advanced chemistry courses.
Text: At the level of Masterson, Sliwinski, Chemical Principles, 3rd ed.

Chem. 1111, 1112. General Chemistry
4-3-5. Prerequisite: entrance requirements.
In-depth studies of chemical principles for students planning to pursue advanced courses in chemistry. Techniques of quantitative analysis necessary for advanced courses in chemistry.
Text: At the level of Daniels and Albery, Physical Chemistry.

Chem. 3411, 3412, 3413. Physical Chemistry
3-0-3. Prerequisite: Chem. 2113, Physics 2122, and Math. 2308.
Physico-chemical properties of matter in the gaseous, liquid, and solid states; solutions, equilibrium, kinetics, and thermodynamics of chemical reactions, electrochemistry.
Text: At the level of Cavan, et. al., Organic Chemistry.

Chem. 3481. Physical Chemistry Laboratory
0-6-2. Prerequisite: concurrent with or following Chem. 3412.
Applications of physical chemistry principles.

Chem. 3491. Physical Chemistry Laboratory
0-6-2. Prerequisite: Chem. 3481.
Concurrent with or following Chem. 3413.
Applications of vibration, rotation, and electronic spectroscopy, electric and magnetic susceptibility, and resonance techniques to the study of molecular structure.
Chem. 3511. Biochemistry 3-0-3. Prerequisite: Chem. 3312. Introductory course in biochemistry dealing with the chemistry and biochemistry of proteins, lipids, carbohydrates, nucleic acids, and other biomolecules.

Chem. 3541. Biophysical Chemistry 3-0-3. Prerequisite: Chem. 2113. Studies of physical concepts (thermodynamics, equilibrium, electrochemical, redox reactions, kinetics, and physical properties of macromolecules) as related to biological systems.

Chem. 4111, 4112. Advanced Inorganic Chemistry 3-0-3. Prerequisite: Chem. 3411 and Chem. 4411. Selected topics with emphasis on laws, principles, and generalizations; the periodic classifications, atomic structure, natural and artificial radioactivity, valence, complex compounds, and other topics. Text: At the level of Jolly, The Chemistry of the Nonmetals; Douglas and McDaniel, Concepts and Models of Inorganic Chemistry.

Chem. 4181. Synthetic Inorganic Chemistry 0-0-2. Prerequisite: concurrently with or following Chem. 4111. 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.

Chem. 4211. Instrumental Analysis I 3-6-5. Prerequisite: concurrent with or following Chem. 3411. Introduction to both theory and practice of modern instrumental methods: polarography, spectroscopy, colorimetry, microscopy, polarimetry, electroanalytical methods. Text: At the level of Flaschka, Barnard, and Sturrock, Quantitative Analytical Chemistry, Vol. I.

Chem. 4212. Instrumental Analysis II 3-6-5. Prerequisite: Chem. 4211 or consent of department.

Continuation of Instrumental Analysis I. Text: At the level of Willard, Merritt, and Dean, Instrumental Methods of Analysis.

Chem. 4231. Advanced Analytical Laboratory 1-6-3. Prerequisite: Chem. 4211 or consent of department. Advanced analytical techniques and investigations of newer analytical methods in the practice of analysis.

Chem. 4281. Analytical Laboratory 0-6-2. Prerequisite: Chem. 4212. Advanced techniques and investigations of newer analytical methods in the practice of analysis.


Chem. 4401. Physical Chemistry 3-0-3. Prerequisite: Chem. 2113, Phys. 2123 and Math. 2308 or consent of department. Application of molecular spectroscopy, electron diffraction, X-ray diffraction, neutron diffraction, and magnetic methods to the determination of molecular structure.

Chem. 4411. Physical Chemistry 3-0-3. Prerequisite: Chem. 2113, Phys. 2123 and Math. 2308 or consent of department. A study of the relation of atomic and molecular structure to the physical properties of matter and the nature of chemical bonding. Text: At the level of Royer, Bonding Theory.

Chem. 4452. Chemistry of the Solid State 3-0-3. Prerequisite: Chem. 3413 or consent of department. Applications of the concepts developed in Chemistry 4741 to the structure of solids and their chemical and physical properties. Text: At the level of Barrow, Physical Chemistry.

Chem. 4511, 4512, 4513. Biochemistry 3-0-3. Prerequisite: Chem. 3511 or consent of department. Lectures, independent reading, and discussion of topics related to the chemistry and metabolism of plant and animal products. Text: At the level of Lehninger, Biochemistry.

Chem. 4581. Biochemistry Laboratory 0-6-2. Prerequisite: concurrent with or following Chem. 4511. Laboratory techniques and practices in biochemistry.

Chem. 4701. Chemistry of Nuclear Technology 3-3-4. For students in nuclear engineering only. Principles of inorganic, radiation, and radiochemistry, separation methods for actinide elements and fission products, and topics related to production and utilization of nuclear energy.

Chem. 4741. Physical Chemistry for Engineers 3-0-3. Prerequisite: M.E. 3720 or equivalent. Familiarizes students having some thermodynamics in other areas with applications of thermodynamics to chemical systems and with a foundation of the modern theory of chemical bonding. Text: At the level of Barrow, Physical Chemistry.

Chem. 4901, 4902, 4903. Special Problems Credit to be arranged. Prerequisite: departmental approval.

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 including applications involving the measurement of air contaminants. Text: At the level of Willard, Merritt, and Dean, Instrumental Methods of Analysis. Jacobs, The Chemical Analysis of Air Pollutants.

Chem. 6111, 6112, 6113. Advanced Inorganic Chemistry 3-0-3. Prerequisite: Chem. 4112 or consent of department. The chemistry of inorganic coordination compounds, non-aqueous solvents, the chemistry of uranium, and other selected topics. Text: At the level of Cotton, Wilkerson, Advanced Inorganic Chemistry, 2nd ed.

Chem. 6141. Chemical Applications of Group Theory 3-0-3. Prerequisite: Chem. 4141 or consent of department. An 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 department. 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. 6211-6212. Analytical Chemistry 3-0-3. Prerequisite: consent of department.


A general survey of reaction mechanisms and stereochemistry as a guide in design of synthetic sequences. Text: At the level of Breslow, *Organic Reaction Mechanisms*, 2nd ed.


Significant principles of stereochemistry and conformation analysis, spectroscopy, and similar topics which are applicable to an understanding of synthetic organic chemistry.


Properties and structure of the atomic nucleus; radioactivity and decay schemes; interaction of radiation with matter; detection and experimental methods, nuclear reactors, radiochemical techniques. Text: At the level of Evans, *The Atomic Nucleus*.


Text: At the level of Lingane, *Electroanalytical Chemistry*.

Chem. 6342. Instrumental Methods of Organic Analysis 3-0-3. Prerequisite: Chem. 4331 or consent of department.

Interpretation of spectroscopic and other common methods of organic analysis, and structure determinations.

Chem. 6351. Organometallic Chemistry 3-0-3. Prerequisite: consent of department.


Radiochemistry, theory and applications of optical and geometrical isomerism, and conformational analysis. Text: At the level of Willard, *Organometallic Compounds*.


A discussion of molecular structure based upon quantum mechanical principles and its significance in the physical and chemical properties of matter.

Chem. 6421-6422-6423. Chemical Thermodynamics 3-0-3. Prerequisite: Chem. 3413.

Laws of thermodynamics and their chemical applications.

Chem. 6631. Radiochemistry 3-0-3. Prerequisite: Chem. 3413.

Introduction to the 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. 6861. Inorganic Stereochemistry 3-0-3. Prerequisite: Chem. 4112 or consent of department.

Properties of the ion. Properties of the molecule. Applications to the electronic structure and properties of inorganic compounds.
Chem. 7141. Mechanisms of Inorganic Reactions
3-0-3. Prerequisite: Chem. 4112 or consent of department.
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. 7311-7312-7313. Organic Chemistry
3-0-3. Prerequisite: consent of department.
Syntheses and properties of hydrocarbons, alcohols, ethers, halogen, carboxylic acids, sulfur, and nitrogen compounds including carbohydrates, steroids, terpenes, and other natural products.

Chem. 7311-7312-7313. Structure Elucidation of Natural Products
3-0-3. Prerequisite: Chem. 6341 or consent of department.
The structure elucidations and detailed chemical syntheses of naturally occurring, physiologically active compounds are studied.

Chem. 7341. Structure Elucidation of Natural Products
3-0-3. Prerequisite: Chem. 6341 or consent of department.
The structure elucidations and detailed chemical syntheses of naturally occurring, physiologically active compounds are studied.

Chem. 7342. Natural Products Synthesis
3-0-3. Prerequisite: Chem. 6312 or consent of department.
Recent advances in the synthesis of naturally occurring compounds such as mono-, sesqui-, di-, and triterpenes, steroids, alkaloids, and certain animal and plant hormones will be discussed.

Chem. 7351-7352. Organic Chemistry
3-0-3. Prerequisite: Chem. 6323 or consent of department.
A rapid survey of the fundamental theoretical and synthetic aspects of organic chemistry, including energy transfer and primary photochemical processes.
Text: At the level of Lamola and Turro, Energy Transfer and Organic Photochemistry, Vol. XIV, Technique or Organic Chemistry.

Chem. 7411-7412-7413. Molecular Spectra
3-0-3. Prerequisite: consent of department.
Outline of experimental methods and discussion of spectra and structure of diatomic and polyatomic molecules; electronic spectra and dissociation phenomena emphasized.

Chem. 7421. Statistical Thermodynamics
3-0-3. Prerequisite: Chem. 6422.
Introduction to the methods of statistical mechanics based primarily on Boltzmann statistics; the statistical concept of entropy; approach to thermodynamics through the partition function.

Chem. 7431-7432. Principles of Quantum Mechanics
3-0-3. Prerequisite: Chem. 6411.

Chem. 7451. Chemical Kinetics
3-0-3. Prerequisite: Chem. 6421.
Rate and mechanism of chemical reactions including kinetic theory of reactions, activation energy, influence of added electrolytes, and influence of solvent.

Chem. 7461-7462. Polymer Chemistry
3-0-3. Prerequisite: Chem. 6422.
The physical chemistry of addition and condensation polymerization processes. The relationship between physical properties and molecular structure. Recent advances will be stressed.
Text: At the level of Flory, Principles of Polymer Chemistry.

Chem. 7611. Nuclear Spectroscopy
2-0-2. Prerequisite: Chem. 6612 or consent of department.
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, Vols. I and II.

Chem. 8001-8002-8003. Seminar
1-0-0.
Discussion group composed of staff and graduate students.

Chem. 8111, 8112. Special Topics in Inorganic Chemistry
3-0-3. Prerequisite: Chem. 4112.
Topics to be discussed 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
2-0-3. Prerequisite: Chem. 3413 and consent of department.
Discussions of specialized areas of analysis: spectrophotometry, polarography, potentiometric methods, coulometry and chromatography. Content of course varies from year to year.

Chem. 8311-8312. Special Topics in Organic Chemistry
3-0-3. Prerequisite: consent of department.
Topics vary from year to year; will include such subjects as evaluation of synthetic methods and their application to research in organic chemistry.

Chem. 8411-8412. Special Topics in Physical Chemistry
3-0-3. Prerequisite: Chem. 3413.
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 department.
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

CHINESE
(See Modern Languages)

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; 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.Gr. 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.

C.E. 2753. Elementary Surveying
2-3-3. For non-C.E. students.
Use of tape, transit and level with applications to planimetric and topographic mapping; traverse and area computations; stadia; construction surveys.

C.E. 3053. Fluid Mechanics I
3-0-3. Prerequisite: E.S.M. 3201.
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 similarity.

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
5-3-6. Prerequisite: E.S.M. 3301.
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 II
3-3-4. Fall and spring quarters. Prerequisite: C.E. 2254.
Field astronomy, Precise taping, leveling, triangulation, sub-tense bar, adjustments of leveling nets and triangulation figures; special problems in land division; introduction to photogrammetry.

C.E. 3009. Materials of Construction
3-3-4. Prerequisite: E.S.M. 3301 and Geol. 2500.
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. 3704. Structural Analysis II
3-3-4. Prerequisite: E.S.M. 3702. No credit for C.E. students.
Analysis of structures to find reactions, deflections and internal forces with emphasis on methods of analysis for statically indeterminate structures.

C.E. 4003. Construction
2-3-3. Prerequisite: C.E. 4154 and I.Sy.E. 4725.
The relations of construction to design and ultimate use; the construction contract; basic machinery and construction operations; job planning, estimating; cost accounting; preparation of bids.

C.E. 4053. Applied Hydraulics
3-0-3. Prerequisite: C.E. 3054 and 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: junior standing.

C.E. 4113. Sanitary Engineering II
3-0-3. Prerequisite: C.E. 4103, 4353.

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 inspection reports.

C.E. 4133. 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 and Geol. 2500.

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; footing and pile foundations, retaining walls, bulkheads fills, embankments, control of landslides.

C.E. 4204. Metal Structural Components
3-3-4. Prerequisite: C.E. 3309 and C.E. 3216.
Principles of behavior of tension and compression members, beams and connections with application to the design of elementary structures.

C.E. 4213. Structural Analysis II
2-3-3. Prerequisite: C.E. 2502 and 3216.
General elastic solution of indeterminate framed structures using digital computer. Stiffness and flexibility matrices; frames and trusses in plane and space; grids; nonprismatic members.

C.E. 4214. Concrete Structural Components
3-3-4. Prerequisite: C.E. 3309 and 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, and 4154.
Design of structures in metal and concrete with emphasis on buildings and bridges.

C.E. 4233. Design in Timber and Prestressed Concrete
Principles of behavior of timber and of prestressed concrete structures; application to the design of elementary structures.

C.E. 4253. Elementary Aerial Photogrammetry
2-3-3. Prerequisite: C.E. 3254.
Principles of stereoscopy and stereoscopic instruments. Analytical solutions of altitude, base line, line of flight and parallax. Radial line plotting for planimetric and topographic maps.

C.E. 4263. Engineering Astronomy
2-3-3. Prerequisite: Math. 2308. Spring quarter.
Study of the celestial sphere including horizon and equator systems. Study of the sun, moon, earth and planets, including man's early theories of the universe.

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
3-0-3. 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. 4535. 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 and 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
2-2-3. Prerequisite: C.E. 4353. Spring quarter.
Comprehensive planning for water resources management; identification of needs, problems and issues; alternative creative solutions; economic and financial evaluation; institutional setting and public participation.

C.E. 4383. Groundwater Hydrology
3-0-3. Prerequisite: C.E. 4353 and Geol. 2500. Spring quarter.
Occurrence, distribution and movement of water below the surface of the earth; groundwater resources and dependable supply rates from wells; artificial recharge and waste disposal.

C.E. 4703. Reinforced Concrete Design I
3-0-3. Prerequisite: E.S.M. 3702 and Arch. 3323. No credit for C.E. students.
Principles of behavior of reinforced concrete beams and columns with application to the design of elementary structures.

C.E. 4713. Reinforced Concrete Design II
2-3-3. Prerequisite: C.E. 3704 and 4703. No credit for C.E. students.
Analysis and design of reinforced concrete foundations, slabs and building frames.

C.E. 4774. Application of Microbiology in 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. 4900. Special Problems.
Credit hours to be arranged.

C.E. 6003. Construction Administration
2-3-3. Fall quarter.
Management tools used to carry out a modern construction project. Such areas as safety, cost control, equipment usage, incentive plans, labor relations, material purchase and delivery.

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
2-3-3. Prerequisite: C.E. 6013 and I.Sy.E. 6734. Spring quarter.
Continuation of C.E. 6013. Additional applications of scientific methods for management of construction projects. Bidding strategy, allocation of resources using linear programming, and value engineering.

C.E. 6053. Steady Flow in Open Channels I
3-0-3. Prerequisite: C.E. 3054 and 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. 6055. Intermediate Fluid Mechanics
3-0-3. Prerequisite: C.E. 3054. Fall quarter.
Fundamental treatment in which basic principles of hydromechanics are applied systematically to limitations imposed by properties of real fluids.

C.E. 6058. Intermediate Fluid Mechanics
3-0-3. Prerequisite: C.E. 3054. Winter quarter.
Flow of liquids in channel transitions, bends and obstructions, contractions and controls; hydraulic jump; stilling basins; hydraulic analysis and design of low weirs, free overfalls, control gates.

C.E. 6083. Steady Flow in Open Channels II
3-0-3. Prerequisite: C.E. 3054 and 3061.
Winter quarter.
Flow of liquids in channel transitions, bends and obstructions, contractions and controls; hydraulic jump; stilling basins; hydraulic analysis and design of low weirs, free overfalls, control gates.

C.E. 6088. Advanced Topics in Hydromechanics
3-0-3. Prerequisite: C.E. 6058. Winter quarter.
Potential-flow analysis, Navier-Stokes equations. Turbulent flow. Laminar and turbulent boundary layers; boundary-layer controls. Diffusion and momentum transfer, cavitation, air-entrainment.

C.E. 6073. Transient Flow in Enclosed Conduits
3-0-3. Prerequisite: C.E. 3054. Spring quarter.
Unsteady flow of compressible and incompressible fluids in conduits; pressure wave propagation, frequency-dependent friction; one-dimensional wave equations, method of characteristics; pulsating flow, water hammer.

C.E. 6078. Engineering Hydrodynamics
3-0-3. Prerequisite: C.E. 6058 and Math. 4321. Spring quarter.
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 and analysis; scour and scour protection at engineering structures; reservoir silting; desilting devices.

C.E. 6098. Gravity-Wave Phenomena
3-0-3. Prerequisite: C.E. 6058 and Math. 4582. Spring quarter.
Hydrodynamic equations of water waves; reflection, transmission and refraction; tides and wind-generated waves; wave forces of structures: unsteady 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 to wells, 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, groundwater, 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. Winter 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. 4113. Spring quarter.
Evaluation of industrial waste problems; character and quantity of wastes produced from various industrial activities; application of engineering principles to treatment and disposal techniques.

C.E. 6114. Sanitary Engineering Design II
3-3-4. Prerequisite: C.E. 4113. Spring quarter.
The theory and design of structures for the collection, treatment and disposal of municipal sewage and industrial wastes; the industrial processes which produce liquid wastes.

C.E. 6118. 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 department. Fall quarter.
An introduction to radiological health and its influence on the general environment and occupational activities; personnel, survey and laboratory instrumentation.

C.E. 6134. Analytical Methods for Air Pollution Studies
3-3-4. Prerequisite: consent of department. Winter quarter.
The study of the methods used for analyzing atmospheric samples; chemical and spectrophotometric analysis; emphasis on organic constituents of air samples.

C.E. 6138. Applied Limnology
2-3-3. Spring quarter.
Consideration and application of limnological principles as they pertain to evaluating the 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 and 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 and 4113. Winter quarter.
Study of physical processes common to many water and waste treatment systems. Continuous flow models, flocculation, mixing, sedimentation, cake and filter medium filtration, gas and heat transfer.

C.E. 6145. Field Methods in Sanitary Engineering
0-15-5. Prerequisite: C.E. 6123 and 6138. Summer quarter.
Provides experience in the organization and conduct of sanitary surveys and field studies in stream analysis and applied limnology.

C.E. 6148. Advanced Microbiology of Water and Wastes
2-3-3. Prerequisite: C.E. 4774. Winter quarter.
Microbial growth in water and waste treatment systems, enrichment cultures and their application in process design. Respiratory mechanisms and fermentations in waste treatment and stream pollution.

C.E. 6149. Sanitary Engineering Processes II
3-3-4. Prerequisite: C.E. 6144. Spring quarter.
Study of biological and chemical processes employed in water and waste treatment system. 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.
Function, design and construction 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 Physico-Chemical Properties of Soils
3-0-3. Prerequisite: C.E. 4154. Fall quarter.
Formation of soils, physical chemistry 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 foundations, theories of earth pressure, design of earth-retaining structures.

C.E. 6172. Soil Testing
1-3-2. Prerequisite: C.E. 4194. Winter quarter.
Theory of physical testing of soils for engineering design and research: laboratory exercises in consolidation and shear testing, illustrations of test procedure effects on character of data.

C.E. 6173. Terrain Evaluation and Applications
2-3-3. Prerequisite: C.E. 4163. 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. 6174. Dynamic Characteristics of Soils
3-3-4. Prerequisite: C.E. 6163 and 6164. Spring quarter.
Determination of basic dynamic properties of soils subjected to vibratory, impact, transient or other dynamic loading: moduli of elasticity, wave propagation, damping and resonance phenomena.

C.E. 6183. Soil Construction
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. Summer 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. Prerequisite: C.E. 6163. Winter 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. Spring quarter.
Theories of plastic equilibrium of soil masses; application to analysis of complex soil engineering problems. Pressures on earth retaining structures, anchored bulkheads, laterally-loaded piles.

C.E. 6203. Structural Planning
3-0-3. Prerequisite: C.E. 3216. Spring and summer quarters.
Introduction to planning aspects of structural design; economic proportions; erection procedures; comparison of determinate 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; ultimate strength behavior.

C.E. 6213. Experimental Analysis I
3-0-3. Winter quarter.
Data acquisition from models. Stress analysis through strain measurements. Transducers, 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. Winter quarter.
Study of principles and fundamental theorems of structural analysis with applications to indeterminate structures, beams, frames and trusses.

C.E. 6233. Indeterminate Structural Theory II
3-0-3. Prerequisite: C.E. 6214. Spring quarter.
Continuation of C.E. 6214 with further applications to multistory and space frames, arches and closed rings.

C.E. 6234. Advanced Structural Mechanics
4-0-4. Prerequisite: Math 2309. Winter quarter.
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.

C.E. 6244. Plastic Design in Steel
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 department. Fall quarter.
Analysis and design of structures subject to dynamic and static loading, single degree of freedom approach; vibration of structural components, including damping and elasto-plastic behavior.

C.E. 6249. Reinforced Concrete Structures III
4-0-4. Prerequisite: C.E. 6209 and Math 2309. Spring quarter.
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. 6253. Advanced Aerial Photogrammetry
2-3-3. Prerequisite: C.E. 4253. Winter quarter.
Tilt determinations. Space resection and intersection. Principal point computations for extension of horizontal control. Special problems.

C.E. 6263. Geodetic Engineering
2-3-3. Prerequisite: C.E. 3254. Winter quarter, alternate years.
Geodesy; theory and practice of precise survey for surveys of large extent; instrumentation and specifications. Theory of errors; adjustment of observations by approximation, least squares.

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 deed descriptions.

C.E. 6303. Pavement Design
3-0-3. Prerequisite: C.E. 4304, 4154. Winter quarter.
Theory of flexible and rigid pavement behavior, stress conditions and deflection, climate, pavement design methods and evaluation of pavement performance.

C.E. 6308. Concrete Technology
2-3-3. Prerequisite: C.E. 3309 and 4214. Winter quarter.
Design theories for concrete mixes; mixes for specific conditions of workability, density, strength; admixtures and air entrainment. Preparation and testing of concrete mixes, 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.

C.E. 6318. Asphalt Technology
2-3-3. Prerequisite: C.E. 4313 and 4154. Spring quarter.
Theory of asphaltic 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.
Advanced study of national transportation policies, financial problems, administrative procedures relating to development of transportation facilities.

C.E. 6328. Mass Transit Planning
3-0-3. Prerequisite: consent of department. Winter quarter.
Characteristics and costs of present and innovative mass transit systems. Roles of engineer, planner and others in estimating transit usage and choosing optimal plan.

C.E. 6333. Traffic Engineering
2-3-3. Prerequisite: C.E. 4304. Winter quarter.
Characteristics of drivers and vehicles; traffic studies; capacity, signal systems; engineering solution of traffic movement problems. Supervised traffic engineering studies.

C.E. 6338. Advanced Traffic Operations
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.
C.E. 6343. Design of Highways and Transit Facilities
2-3-3. Prerequisite: C.E. 6333. Spring quarter.
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. 6343. Spring quarter.
Planning or urban transportation facilities, mathematical models for prediction of traffic flow, assignment, interrelationship of land use and trips, parking and the transportation problem.

C.E. 6348. Theory of Traffic Flow
Traffic flow phenomena; description of traffic arrival, merging movements, shock waves by mathematical models; simulation of traffic flow processes and applications.

3-0-3. Fall quarter.
Discounting techniques for public works planning. Microeconomics in project formulation. Applications from welfare economics, capital formation theory, input-output analysis.

C.E. 6358. Issues in Water Resources Planning and Management
3-0-3 Fall quarter.
Major public policy issues in water resource planning and management. Emphasis on American issues, but appropriate reference to issues in other countries.

C.E. 6363. Economics of Water Resources Development
Principles of resource allocation, benefit-cost analysis re: water-resources project formulation, justification; allocation of joint costs in multipurpose developments.

C.E. 6368. Applied Environmental Resources Management
1-4-3. Spring quarter.
Field, laboratory and classroom studies applied to the solution of an environmental management problem under the direction of a multidisciplinary faculty team.

C.E. 6373. Flood Management
3-0-3.

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.

C.E. 6383. Hydrologic Models
3-0-3. Prerequisite: C.E. 4353. Winter quarter.
Techniques for the statistical analysis of hydrologic data; construction of statistical models of hydrologic processes. Methods of frequency analysis, linear and non-linear least squares.

C.E. 6388. Hydrologic Simulat-ion
3-0-3. Prerequisite: C.E. 6378. Winter quarter.
Digital computer simulation of the land phase of the hydrologic cycle: processes and their interaction; optimization and sensitivity; calibration of a model; measured data; use of the model in a simulation experiment.

C.E. 6393. Urban Hydrology
2-3-3. Prerequisite: C.E. 4353. Spring quarter.
Effects of urbanization on storm runoff, sedimentation, water quality and water supply. Modeling of urban runoff. Urban watershed in planning and design.

C.E. 6398. Hydrology of Floods
2-3-3. Prerequisite: C.E. 6353. Spring quarter.

C.E. 6399. Water Resources Systems Engineering
3-0-3. Prerequisite: C.E. 6383. Summer quarter.
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
3-0-3. 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, 6752. Complex Systems Design
2-4-3. 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. 6783. Environmental Radiation Surveillance
3-0-4. Prerequisite: C.E. 6133. Spring quarter.
A study of sources and types of radioactive pollutants in the environment with special emphasis on sampling assay and survey techniques.

C.E. 7000. Master's Thesis
Credit hours to be arranged.

C.E. 7999. Ph.D. Examinations Preparations
Credit hours to be arranged.
For students preparing for Ph.D. qualifying or language examinations or both.

C.E. 8001. Seminar in Sanitary Engineering
0-2-1. Prerequisite: consent of department.
Developments in sanitary engineering science and technology; current research and special topics related to environmental quality assessment and control.

C.E. 8011, 8021. Seminar in Environmental Resources Problems I and II
0-2-1. 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
1-0-1. Prerequisite: C.E. 6154. Corequisite: C.E. 6164. Spring quarter.
Case histories of design, construction and performance of foundations. Special topics such as machine foundations, foundations in seismic regions.

C.E. 8051. Seminar in Transportation Engineering
1-0-1. Prerequisite: consent of department. Spring quarter.
Development 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. 6003.
Engineered construction. Whenever possible, guest speakers from the con-
struction industry. Graduate students will present results of required special research projects and thesis research.

**C.E. 8101. Special Course**
1 credit hour.

**C.E. 8102. Special Course**
2 credit hours.

**C.E. 8103. Special Course**
3 credit hours.

**C.E. 8104. Special Course**
4 credit hours.

**C.E. 8105. Special Course**
5 credit hours.

**C.E. 8113. Special Course**
3 credit hours.

**C.E. 8114. Special Course**
4 credit hours.

**C.E. 8123. Special Course**
3 credit hours.

**C.E. 8500, 8501, 8502. Special Problems.**
Credit hours to be arranged.

**C.E. 8756. M.S. Special Research Problem.**
Credit hours to be arranged.

Six to twelve hours of M.S. research problem to be scheduled by M.S. students not writing thesis; take during two or more successive quarters.

**C.E. 8999. Ph.D. Thesis Preparation**
Credit hours to be arranged.

For student in preliminary stages of formulating Ph.D. research program but who has not obtained formal approval of thesis topic.

**C.E. 9000. Ph.D. Thesis**

**ECONOMICS**
(See Industrial Management)

**ELECTRICAL ENGINEERING**

**E.E. 1001. Introduction to Electrical Engineering 1-0-1.**
An introduction to electrical engineer-

ing, both at Georgia Tech and in industry. Lectures, discussion and outside work provide insight to the exciting directions the profession is taking.

**E.E. 1010. Computer Programming and Graphics 2-3-3.**

**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. 1900 through 1999. Special Problems**
Credit to be arranged. Prerequisite: normally taken by freshmen.

Special engineering problems are assigned according to each student’s needs, interests, and capabilities.

**E.E. 2900 through 2999. Special Problems**
Credit to be arranged. Prerequisite: 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: E.E. 3200 or E.E. 3700.


**E.E. 3032. Computer Engineering I 3-0-3.**
Prerequisite: E.E. 1010 or equivalent

Machine language, machine organization and design concepts of digital com-

**E.E. 3033. Computer Engineering II 3-3-4.**
Prerequisite: E.E. 1010 or equivalent.


**E.E. 3034. Computer Engineering III 3-0-3.**
Prerequisite: E.E. 3032 or E.E. 3033 or the equivalent of either of these courses.


**E.E. 3035. Introduction to Digital Systems Design 3-3-4.**
Prerequisite: E.E. 3250.


**E.E. 3036. Computational Methods for Simulation 3-0-3.**
Prerequisite: Math. 2309 or Math. 3308.


**E.E. 3042. Electrical Measurements 3-3-4.**
Prerequisites: E.E. 3250 and E.E. 3400.
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 Electrical Engineering
3-0-3. Prerequisite: Physics 2122 and Math 2307.
Circuit elements, network theorems, general voltage and current variable analysis techniques, models of active devices, steady state and transient solutions.

E.E. 3210. Circuits and Systems
3-0-3. Prerequisite: E.E. 3250.
System analysis in the time and frequency domains. Convolution, Poissons and zeros. Fourier series and transforms, bilateral and unilateral Laplace transforms, and their applications.

E.E. 3220. Circuits and Systems
3-0-3. Prerequisite: E.E. 3210.

E.E. 3250. Elements of Electrical Engineering
3-0-3. Prerequisite: E.E. 3200.
Operation and modeling of electronic devices with emphasis on biasing, stability, two-port representation, input, output and transfer impedances, mutual inductance and basic circuit configurations.

E.E. 3260. Engineering Electronics
3-0-3. Prerequisite: E.E. 3250.
Frequency analysis of active electronic devices, equivalent circuit modeling of multistage amplifiers, operational amplifier concepts, feedback amplifiers, oscillators, rectifiers and power supply circuits. Text: Angelo, Electronics: BJT's, FET's, and Microcircuits.

E.E. 3270. Nonlinear Devices and Circuits
3-0-3. Prerequisite: E.E. 3210 and E.E. 3260.
Analysis and synthesis of nonlinear devices and circuits. Nonlinear shaping circuits, logic circuits, general analysis techniques applicable to nonlinear systems. Text: Millman and Toub, Pulse, Digital, and Switching Waveforms.

E.E. 3300. Electromagnetics
3-0-3. Prerequisite: Math. 2309, Physics 2122, and E.E. 3250.

E.E. 3320. Electromagnetics
3-0-3. Prerequisite: E.E. 3300 and E.E. 3210.

E.E. 3330. Electromechanical Systems and Energy Conversion
3-0-3. Prerequisite: E.E. 3310 and E.E. 3210.

E.E. 3340. Random Signals and Noise
3-0-3. Prerequisite: E.E. 3210.

E.E. 3400. Instrumentation Laboratory I
1-3-2. Prerequisite: E.E. 3200.

E.E. 3410. Junior Electrical Engineering Laboratory I
0-3-1. Prerequisite: E.E. 3250 and E.E. 3400.
Experiments in linear circuits and electronics, including circuit theorems, FET's, BJT's diodes, vacuum triodes, and integrated circuits. Text: Circuits & Electronics Lab Folio of Experiments, School of E.E., Georgia Tech.

E.E. 3420. Junior Electrical Engineering Laboratory II
0-3-1. Prerequisite: E.E. 3260 and E.E. 3410.
Experimental investigations of functional electronic circuits with emphasis on non-linear operation. Experiments include logic gates and flip-flops, operational amplifiers, silicon-controlled rectifiers, oscillators, and multivibrators.

E.E. 3430. Junior Electrical Engineering Laboratory III
0-3-1. Corequisite: E.E. 3320.
Experiments in electromagnetics.

E.E. 3700. Elements of Electric Circuits and Instruments
3-0-3. Prerequisite: Physics 2122 and Math 2307. For non-electrical engineering students.
Elements of electric and electronic circuits principally from a terminal characteristics viewpoint. Applications to instrumentation are stressed.

E.E. 3710. Introduction to Electronic Systems
3-0-3. Prerequisite: E.E. 3700. For non-electrical engineering students.
Fundamental active circuits are reviewed and basic linear and digital "building blocks" developed. Modular approach to system design is stressed through the use of integrated circuits. Text: Belove, Schachtel, and Schilling, Digital and Analog Systems, Circuits and Devices: An Introduction.

E.E. 3720. Rotating Electrical Machine Applications
3-0-3. Prerequisite: E.E. 3700 or E.E. 3250.
Basic motor and generator theory with main emphasis on motor application. The principles of motor selection based upon electrical and mechanical considerations are examined. Text: Smeaton, Motor Application and Maintenance Handbook.

E.E. 3725. Electric Circuits and Fields
2-3-3. Prerequisite: Physics 2122 and Math 2309. For mechanical engineering students.

E.E. 3726. Elementary Electronics
2-3-3. Prerequisite: E.E. 3725. For mechanical engineering students.
An introduction to electronic and semiconductor devices and a study of circuits containing such elements. Both linear and digital systems are considered. Laboratory experiments. Text: Smith, Circuits Devices and Systems.

E.E. 3727. Electric Power Conversion
2-3-3. Prerequisite: E.E. 3725. For mechanical engineering students.
A study of energy conversion principles and devices such as motors, generators, transformers, and rectifiers.
Lecture, computation and laboratory periods.
Text: Fitzgerald, Higginbotham, and Grabel, Basic Electrical Engineering.
E.E. 3740. Electrical Instrumentation Laboratory
An introduction to the operation and application of basic electrical instruments. Coordinated descriptive lectures and laboratory exercises.

E.E. 3741. Electronic Systems Laboratory
0-3-1. Corequisite: E.E. 3710. For non-electrical engineering students.
An introduction to the design of simple linear and digital electronic systems with the aid of commercially available integrated circuit modules.

E.E. 3742. Electric Machinery Laboratory
0-3-1. Corequisite: E.E. 3720.
An introduction to the principles and application of rotating electrical machines.

E.E. 3900 through 3999. Special Problems
Credit to be arranged. Prerequisite: normally taken by juniors.
Special engineering problems are assigned according to each student's needs, interests, and capabilities.

E.E. 4012. Electric Energy Conversion
3-3-4. Prerequisite: E.E. 3330.
Principles of rotating a-c and d-c machines. Analysis techniques and application studies of individual and interconnected devices. Coordinated laboratory exercises.

E.E. 4015. Principles of Feedback Control
3-3-4. Prerequisite: E.E. 3220.
A study of automatic control systems. Basic control principles, system modeling and analysis techniques. Coordinated laboratory exercises.

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.
Text: Strauss, Wave Generation and Shaping.

E.E. 4019. Power System Analysis
3-0-3. Prerequisite: E.E. 3330 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.
Study of underlying physics and resultant terminal properties of solid-state devices such as transistors, charge coupled devices, and microwave 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 to transducers, memories, logic elements, and microwave devices.

E.E. 4022. Industrial Electronics
3-3-4. Prerequisite: E.E. 3210 and E.E. 3260.
Components 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 of electronic applications offered by circuit configurations available in digital and linear ICs.
Text: Fitchen, Electronic Integrated Circuits and Systems.

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, vocoders, vocal track analysis, spectral analysis of speech.

E.E. 4025. Information Theory
3-0-3. Prerequisite: E.E. 4061 or equivalent.
Definitions of information, the measure of information, redundancy, channel, channel capacity, and mutual information, and Shannon's coding theorems are presented and applied to communication problems.
Text: Abramson, Information Theory and Coding.

E.E. 4026. Audio Engineering
3-0-3. Prerequisite: E.E. 3270 and E.E. 3310.
An introduction to the application of the tools of electrical engineering to the detection, measurement, processing, control, and reproduction of audio frequency signals.
Text: Olson, Modern Sound Reproduction.

E.E. 4027. Computer Graphic Design
3-3-3. Prerequisite: E.E. 1010 or equivalent and junior standing.
Principles 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 and E.E. 3260.
Circuit design for communication system devices operating below one kilo­mega Hertz. Oscillators, amplifiers, mixers, discriminators, modulators, detectors, primarily for analog system applications.

E.E. 4030. Communication Engineering
3-3-4. Prerequisite: E.E. 3210 and E.E. 3260.
Theory and practice in the design of radio and television receivers. 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. 3220.
A study of the transport communication circuits by means of methods of modern network synthesis.
Text: Kuh and Pederson, Principles of Circuit Synthesis.

E.E. 4034. High-Frequency Measurements
3-0-3. Prerequisite: E.E. 3320.
High-frequency measurements emphasizing the characteristics of standard laboratory equipment together with the techniques of high-frequency measurements. Includes system design and state-of-the-art measurements.

E.E. 4036. Ultra-High-Frequency Techniques
3-3-4. Prerequisite: E.E. 3320.
Introduction to waveguides, cavities, klystrons, magnetrons, traveling wave tubes, impact diodes, and ferrite gyrotrons and circulators. Associated laboratory emphasizes microwave measurements.
Text: Ishii, Microwave Engineering; Hewlett Packard Engineering Staff, Microwave Theory and Measurements.

E.E. 4037. Antennas
3-3-4. Prerequisite: E.E. 3320.
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. 4039. Electrical Sensors and Transducers
3-0-3. Prerequisite: senior standing or consent of school.
Survey 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. 4081. Introduction to Biotechnics 3-0-3. Prerequisite: E.E. 3260 or consent of school. An introduction to the study of the properties of biological systems. The measurement and control of biological systems.

E.E. 4082. Linear System Theory 3-0-3. Prerequisite: E.E. 3220. Linear system theory with emphasis on transform and state-variable methods. Applications to both continuous and discrete systems.


E.E. 4085. Electronic Design Laboratory 0-0-3. Corequisite: E.E. 4084. Practical design problems which emphasize creativity and imagination are posed and their solutions are individually implemented in the laboratory.

E.E. 4090. E.E. Senior Seminar 1-0-1. Prerequisite: normally taken by seniors. Bridge between an undergraduate E.E. education and a postgraduate career. Talk followed by a question and answer period with various authorities.


E.E. 4350. Materials Science 3-0-3. Prerequisite: E.E. 3320 and E.E. 3260. 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.

E.E. 4410. Senior Electrical Engineering Laboratory I 0-3-1. Prerequisite: E.E. 3330. Experimental studies in electromechanics and control.

E.E. 4420. Senior Electrical Engineering Laboratory II 0-3-1. Prerequisite: E.E. 3340. Experiments in communications systems and signals. Various modulation systems are operated over an additive Gaussian noise channel, demodulated, and performance measures conducted.

E.E. 4430. Project Laboratory 0-3-1. Prerequisite: normally taken by seniors. Individual experimental investigations and projects tailored to student interests. Projects are selected in consultation with student's faculty advisor.

white noise, unknown attenuation, fading. Continuous wave modulation, linear, twisted, frequency modulation, PCM.

E.E. 6063. Methods in Pattern Recognition
3-0-3. Prerequisite: E.E. 6988.
Introduction to pattern recognition. Several approaches to pattern classification will be presented, including the linear discriminant function approach, perceiving, Bayes learning, and nearest neighbor rule.

E.E. 6071. Communication Circuits and Signals
3-0-3. Prerequisite: Graduate standing or consent of school.
Discussion of topic (Fourier transform theory) from moderately advanced viewpoint. Emphasis on applications to electrical networks, sampling, antennas, statistics, optics, and transform-domain reasoning and insight stressed.

E.E. 6081. Information Theory
3-0-3. Prerequisite: E.E. 6988.
Introduction to information theory. The concepts of information, information rate, and channel capacity are developed and applied to communication theory problems. Rate-distortion theory is introduced.

E.E. 6092. Coding
3-0-3. Prerequisite: E.E. 6988.
Coding techniques for efficient, reliable communication are introduced. Techniques studied include: Parity-check, maximal-length, Hamming, BCH, and convolutional codes, sequential decoding, and coding for burst-noise channels.

E.E. 6091. Radar Engineering
3-0-3. Prerequisite: E.E. 6131 and E.E. 6061.

3-0-3. Prerequisite: Graduate standing.
Provides information necessary for the design or analysis of computer-to-computer data transmission systems.

E.E. 6100. Linear Networks and Systems
3-0-3. Prerequisite: Graduate standing.
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 characteristics. Systems representation and properties of the presentation. Linearization techniques. Stability analysis using Lyapunov 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 approach, dynamic programming, and calculus of variations and maximum principle.

E.E. 6112. Feedback Control Systems
3-0-3. Prerequisites: E.E. 6111 and E.E. 6101 or consent of school.

E.E. 6113. Feedback Control Systems
3-0-3. Prerequisite: E.E. 6100.
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. Prerequisites: E.E. 6051 and E.E. 6101 or consent of school.

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. 6505 or consent of school and elementary programming ability.
Non-deterministic systems - a study of problems associated with generating and analyzing random time series 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 sequential operations of digital computers. Number representation, digital arithmetic, computer elements, micro-operations, and sequences for instruction, execution and control; and command logic.

E.E. 6162. Digital Systems Engineering II
3-0-3. Prerequisite: graduate standing.
Concepts, technology related to microprogramming. Comparison of sequential hardware control and microprogrammed control. Design parameters, tradeoffs for control memory, control word structures, Evaluation of several microprogrammable systems. Future impact.

E.E. 6163. Digital Systems Engineering III
3-0-3. Prerequisite: graduate standing.
Assembly language programming. The "MIX" machine simulated on the U-1108. Programming problems in "MIX". Advanced programming techniques. Information structures, dynamic storage allocation.

E.E. 6201. Automata Theory
3-0-3. Prerequisite: graduate standing.
An introduction to broad classes of digital systems including computer components as special cases. A detailed study is made of steps leading to optimum design.

E.E. 6202. Automata Theory
3-0-3. Prerequisite: E.E. 6201.
A continuation of digital system study including fault detection and decomposition of systems. Reliability, memory span and quadded logic are also examined.

E.E. 6203. Automata Theory
3-0-3. Prerequisite: E.E. 6202 or consent of school.
An introduction to finite automata through study of sequential circuits. Concepts in modern algebra are developed for direct application to sequential circuits.

E.E. 6211. Digital Systems Engineering Laboratory
0-3-1. Prerequisite: E.E. 6161 or equivalent.
Digital computer engineering. Registers, transfer level logic devices, hardwired structures, microprogrammed structures, memory, input-output.

E.E. 6251. Applied Electromagnetics
3-0-3. Prerequisite: graduate standing or consent of school.
Advanced electromagnetic theory. Particular and complementary solutions to the symmetric wave equations for both the discrete and continuous cases. Analysis, synthesis, and boundary value problems.

E.E. 6252. Microwaves
3-0-3. Prerequisite: E.E. 6251.

E.E. 6253. Antennas
3-0-3. Prerequisite: E.E. 6251.
E.E. 6301. Electro-Optics
3-0-3. Prerequisite: graduate standing.
Introduction to electro-optics with emphasis on lasers and modern optics, parametric interactions, Kerr and Pockels effect, harmonic generation. Applications include communications, data processing.

E.E. 6351. Advanced Electrical Measurements
3-3-4. Prerequisite: graduate standing.
Emphasis on parametric interactions, Kerr and Pockels effect, harmonic generation. Application of these networks in integrated circuits is also considered.

E.E. 6401. Advanced Network Theory
3-3-4. Prerequisite: graduate standing.
Special techniques of network analysis that are not usually covered in an undergraduate curriculum. Topics include networks involving active elements, multiterminal elements, pathological elements.

E.E. 6402. Advanced Network Theory
3-3-4. Prerequisite: graduate standing.
A survey of various techniques of passive analog filter design. The objective is to enable the student to design practical filters with understanding of underlying principles.

E.E. 6403. Advanced Network Theory
3-3-4. Prerequisite: graduate standing.
Techniques of synthesizing networks using active elements such as gyrators, controlled sources, immittance transducers, operational amplifiers. Practical filter design using these elements.

E.E. 6411. Distributed-Parameter Networks
3-0-3. Prerequisite: graduate standing.
Analysis and synthesis of distributed-parameter networks. Uniform and non-uniform loss and lossless transmission lines. Application of these networks in integrated circuits is also considered.

E.E. 6412. Time-Domain Synthesis of Linear Networks
3-0-3. Prerequisite: graduate standing.
Methods of specifying a network function to give a prescribed time-domain response. Mathematical techniques suitable for obtaining the time-domain approximating functions.

E.E. 6413. Digital Filters
3-0-3. Prerequisite: graduate standing or consent of school.

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, rook polynomials, and Polya's theorem.

E.E. 6422. Advanced Network Theory II
3-0-3. Prerequisite: graduate standing.

E.E. 6423. Advanced Network Theory II
3-0-3. Prerequisite: consent of school.
Specialized topics of current interest in network theory.

E.E. 6451. Electrical Properties of Materials
3-0-3. Prerequisite: graduate standing or consent of school.

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.
Dielectrics, piezo- and ferroelectrics and their application to electromechanical devices. Quantum basis of magnetism. Magnetic interactions, domains, resonance and devices.

E.E. 6453. Solid-State Electronic Devices
3-0-3. Prerequisite: graduate standing or consent of school.
Study of charge and energy transport in semiconductors with applications in p-n junction, interface and thin film, optoelectronic, and bulk-effect devices.

E.E. 6461. Modern Magnetic Materials and Devices
3-0-3. Prerequisite: E.E. 6452 or consent of school.
Basic operation and design of magnetic memories and microwave devices. Crystal structure, chemical composition, and properties of ferrites, garnets, and orthoferrites.

E.E. 6500. Introduction to Management and Control of Energy Systems
3-0-3. Prerequisite: E.E. 6100 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 and E.E. 6050 or consent of school.
An introduction to planning procedures for large scale technical operations. Technical and economics constraints on planning. Techniques for formulation of rational planning problems.

E.E. 6502. Control and Operation of Interconnected Power Systems
3-0-3. Prerequisite: E.E. 4019 and E.E. 6100 or consent of school.
Operation of interconnected systems. Models for system interaction, techniques for control and management of power flow and reliability.

E.E. 6503. Evaluation of Power System Reliability
3-0-3. Prerequisite: E.E. 4019 and E.E. 6050 or consent of school.
Techniques for the study of power system reliability. Probabilistic models for power system performance. Techniques for subsystem and composite system reliability analysis.

E.E. 6511. Transmission Lines
3-3-4. Prerequisite: graduate standing.
A study of electric power transmission parameters, models and techniques for analysis of steady state and transient conditions. A-c, d-c, HV and underground transmission.

E.E. 6521. Power System Stability
3-0-3. Prerequisite: E.E. 6100.
Static and dynamic stability, generator swing equation. Techniques for stability analysis. Voltage and frequency control.

E.E. 6750. Systems Design Methodology
2-3-3. Prerequisite: graduate standing or consent of school.
An introduction to complex system design, interdisciplinary. Also taught as A.E. 6750, M.E. 6750.

E.E. 6751-6752. Complex System Design
2-4-3. Prerequisite: graduate standing or consent of school.
The class acts as an interdisciplinary team to carry out a significant relevant preliminary design of a complex system. Also taught as A.E. 6751-6752, M.E. 6751-6752.

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; includes scattering of ions and...
Electronics in gases and scattering from solid surfaces. Also taught in the School of Physics.

E.E. 6988. Noise in Communications Systems 3-0-3. Prerequisite: E.E. 5062. Basic binary and m-ary digital signaling techniques are studied, with emphasis on the effects of noise in these systems.


E.E. 6990. Plasma Diagnostics 3-0-3. Prerequisite: E.E. 6989. Diagnostic techniques applicable to determining properties of plasmas. Topics include macroscopic measurements, electric and magnetic probes, optical and microwave techniques. Selected laboratory experiments.


E.E. 7000. Master's Thesis


E.E. 7251-7252-7273. Advanced Electromagnetic Theory 3-3-4. 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. 8011-8012-8013. Seminar 1-0-0.


E.E. 8240 through 8249. Special Topics 2-0-2.

E.E. 8340 through 8349. Special Topics 3-0-3.

E.E. 8430 through 8439. Special Topics 4-0-4.

E.E. 8440 through 8449. Special Topics 5-0-5.

E.E. 8500 through 8998. Special Problems credited to be arranged.

Problems meeting the special problems of the student. Approval to schedule must be obtained in advance of registration.

E.E. 9000. Doctor's Thesis

ENGINEERING SCIENCE AND MECHANICS

E.S.M. 1101. Introduction to Engineering 2-3-3.

The engineer and design; relation between the student's curriculum and his career in engineering. Emphasis placed on student participation in creative design process. Text: Seeley and Leach, Engineering: An Introduction to a Creative Profession.

E.S.M. 2101. Engineering Design 1 0-3-1. Prerequisite: E.S.M. 1101 or consent of department.

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 0-6-2. Prerequisite: E.S.M. 2101.

Continuation of E.S.M. 2101. Design of problem to be completed, a model to be submitted as part of final report.

E.S.M. 2201. Statics 3-0-3. Prerequisite: Physics 2121; Math 2307 or concurrently.

Elements of statics in two and three dimensions; centroids; analysis of structures and machines; friction. Text: Beer and Johnston, Vector Mechanics for Engineers: Statics; or Lnenicka, Bernhard, Stoneking, Programmed Statics.

E.S.M. 3111. Experimental Methods in Engineering Science 2-3-3. Prerequisite: E.E. 3400; Math 2309; E.S.M. 3202; E.S.M. 3301.

Methods used to observe behavior of physical parameters in engineering problems; photo-optics, signal analysis, transducers and transducer circuits, models and analogies. Text: Tuve and Domholdt, Engineering Instrumentation.

E.S.M. 3201. Dynamics I 3-0-3. Prerequisite: E.S.M. 2201 and Math 2307.


E.S.M. 3202. Dynamics II 3-0-3. Prerequisite: E.S.M. 3201.

Kinematics and kinetics of three-dimensional motion of rigid bodies. Text: Beer and Johnston, Vector Mechanics for Engineers: Dynamics

E.S.M. 3301. Mechanics of Deformable Bodies 5-0-5. Prerequisite: E.S.M. 2201; Math 2306 or concurrently.

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. Text: Popov, Introduction to the Mechanics of Solids.


Analysis and design of: beams (using singularity functions); various structural elements (using energy methods); thick-walled cylinders; rotating disks; curved beams. Theories of failure.

E.S.M. 3451. Computer Applications in Engineering Science and Mechanics 2-3-3. Prerequisite: E.S.M. 3022, E.S.M. 4210, and E.S.M. 3501 or concurrently or consent of department.

Introduction to the use of the digital computer; Fortran languages; computer solutions of problems in statics, dynamics, mechanics of deformable solids, vibrations and fluid mechanics.

E.S.M. 3501. Fluid Mechanics 5-0-5. Prerequisite: Math 2308 or concurrently and E.S.M. 3202.

Kinematics of fluid motion; material and spatial coordinates, acceleration, continuity, vorticity; perfect fluid motion; introduction to the motion of a viscous fluid. Text: 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: Beer and Johnston, Mechanics for Engineers: Statics.

E.S.M. 3702. Mechanics of Materials 3-0-3. Prerequisite: E.S.M. 3701.

Simple stresses and strains; mechanical properties of materials; Hooke's Law; moment of inertia of area; analysis and design of beams and columns; deflection of beams.


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: Work, A Programmed Instruction In Dynamics.

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 gages; transducer design and application.

Text: Holister, Experimental Stress Analysis.

E.S.M. 4121. Projects in Engineering Science 3-0-3. Prerequisite: consent of department.

Experimental and/or theoretical investigation of an engineering problem; individual student effort with faculty project advisor; written report.

E.S.M. 4201. Intermediate Dynamics I 3-0-3. Prerequisite: E.S.M. 3202, or consent of department.

Conservation of energy, moments; applications include motion in resisting medium, redistribution of mass, central force motion, effects of earth rotation.

Text: Marris and Stoneking, Advanced Dynamics.

E.S.M. 4202. Intermediate Dynamics II 3-0-3. Prerequisite: E.S.M. 4201 or consent of department.

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, E.S.M. 3301 and Math. 2309 or their equivalent.

Single degree-of-freedom system, two degrees-of-freedom system, and finally many degrees-of-freedom system; complex representation; applications.


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 solutions; vibrations of strings, beams, and membranes; approximate methods.


Small strain linear elasticity in two and three dimensions; applications in generalized plane stress and plane strain, torsion and bending of non-circular 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.


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. 4582 or equivalent; E.S.M. 3501 or equivalent.

Mechanical modeling of human body; muscle mechanics; steady non-Newtonian flows; material properties of human body; hemodynamics; anomalies of blood; wave propagation in arteries.

E.S.M. 6111. Theory of Experimental Stress Analysis 2-3-3. Prerequisite: E.S.M. 6341 or equivalent. Winter quarter.

Study of surface stress and strain using brittle coatings and electrical resistance strain gages; strain gage circuits; static and dynamic problems; transducer design and circuits.

E.S.M. 6115. Introductory Photoelasticity 1-6-3. Prerequisite: E.S.M. 6341 or consent of department. Spring quarter.

Polarized light; mathematical description and light transformations; solution of plane stress problems using transmitted light; separation of principal stresses; photoelastic models.

E.S.M. 6116. Photoelasticity 1-6-3. Prerequisite: E.S.M. 6115. Winter quarter.

Three-dimensional stress analysis using transmitted light and scattered light methods; birefringent coatings; Moire fringes; numerical methods.

E.S.M. 6201. Advanced Dynamics I 3-0-3. Prerequisite: E.S.M. 4210 and Math. 2309, or equivalent. Fall quarter.

Kinematics and kinetics of particles; angular velocity; inertia properties; rigid body dynamics; generalized coordinates and forces; nonholonomic systems; solutions by vector methods and Lagrange's equations.

E.S.M. 6202. Advanced Dynamics II 3-0-3. Prerequisite: E.S.M. 4202 or E.S.M. 6201, Winter quarter.

A continuation of E.S.M. 6201. Hamilton's principle; Hamilton's canonical equations; energy and momentum integrals; Hamilton-Jacobi theory; study of selected papers from recent dynamics literature.

E.S.M. 6221. Theory of Oscillations 3-0-3. Prerequisite: Math. 4582 or consent of department. Fall quarter.

Lagrange's equations, normal modes, orthogonality, dynamic coupling; small oscillations of conservative systems; non-conservative systems; vibrations of flexible strings and elastic bars.

E.S.M. 6222. Vibration of Elastic Bodies 3-0-3. Prerequisite: E.S.M. 6221, E.S.M. 6341, Winter quarter.

Free and forced longitudinal, torsional, and lateral vibration of beams, with and without damping; vibration of membranes, plates and shells; waves in isotropic elastic media.

E.S.M. 6241. Gyroscopic Motion and Devices 3-0-3. Prerequisite: E.S.M. 6201 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 department. Winter quarter.

Celestial sphere, aberration, parallax; Laplace's and Gaus's methods; three- and n-body problems; Lagrangian
E.S.M. 6263. Dynamics of Space Vehicles
3-0-3. Prerequisite: E.S.M. 6201, E.S.M. 6231. Spring quarter.
Single-stage and multistage rockets; bending and torsional vibrations; propellant sloshing; basic equations of motion; control system stability; control elements; response of space vehicles to winds.

E.S.M. 6281. Random Vibrations I
3-0-3. Prerequisite: Math. 4215 and E.S.M. 4210, or consent of department. Winter quarter.
Statistical analysis of mechanical systems; correlation function, power spectral density; response to random inputs; method of normal modes, fatigue failures, non-stationary 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. 6301. Advanced Strength of Materials
3-0-3. Prerequisite: Math. 2309 and 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 department. Fall quarter.
Introduction to generalized tensors; analysis of deformation; equations of motion; 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 department. Winter quarter.
Continuation of E.S.M. 6341; linear elasticity; Saint-Venant's theory of torsion, bending of beams; Love's strain function; Galerkin's vector, Papkovitch-Neuber representation; stress potentials, Airy's stress function.

E.S.M. 6343. Theory of Elasticity III
3-0-3. Prerequisite: E.S.M. 6342 or consent of department. 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. 6361. Theory of Elastic Stability I
3-0-3. Prerequisite: E.S.M. 3301 and Math. 4582 or consent of department. Winter quarter.
Various stability methods and their applicability; the elastic problem; snap and bifurcation approximations; 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 department. Spring quarter.
Stability of various systems - velocity dependent, conservative, dissipative, circulatory, and instationary, 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. 4582 or equivalent. Spring quarter.
Von Karman 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 department. 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 department. Spring quarter.
Stress-strain relations in three dimensions; three-dimensional yield conditions and flow laws; thick-walled 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 department. 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. 6401-6402. Optimization Techniques I and II
3-0-3. Prerequisite: graduate standing. Winter and spring quarters.
Applications of calculus of 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. 3301 and Math. 4582 or consent of department. Summer quarter.

E.S.M. 6760, 6761, 6762. Acoustics I, II and III
3-0-3. Prerequisite: Math 4349, or consent of department. Winter and spring quarters.
Introductory analytical methods, and stochastic process, the wave equation in a compressible fluid; radiation of wind; reflection, refraction, diffraction and scattering of round waves; duct acoustics. Also listed as A.E. 6760, 1, 2 and M.E. 6760, 1, 2.

E.S.M. 7221. Nonlinear Vibrations I
3-0-3. Prerequisite: E.S.M. 4210, E.S.M. 6201, and Math. 4582 or their equivalents. Winter quarter.
Vibrations of autonomous one degree-of-freedom systems; method of approximated characteristics; topological methods, analysis of singularities and stability; free damped nonlinear vibrations; self-excited oscillations.

E.S.M. 7222. Nonlinear Vibrations II
3-0-3. Prerequisite: E.S.M. 7221. Spring quarter.
Nonlinear vibrations of nonautonomous one-degree-of-freedom systems; method of Duffing; perturbation method, Bogoliuboff method; Ritz-average method; stability criteria; subharmonics; two-degree-of-freedom systems.

E.S.M. 7223. Selected Topics in Nonlinear Vibrations
3-0-3. Prerequisite: E.S.M. 7222 or consent of department. Fall quarter.
ENGLISH

Engl. 0050. Reading for Speed and Comprehension 2-0-0. Prerequisite: None. Mechanics of reading. Exercises in increasing speed and improving comprehension. The course is conducted as a laboratory.


Engl. 3037-8-9. Acting and Producing the Play 0-3-1. Prerequisite: Consent of the department. Participation in the Drama Tech productions of various kinds of plays, including the presentation of one play before an audience.


Engl. 3039. Public Speaking 3-0-3. 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. 3041. Writers in the Age of Galileo 3-0-3. Prerequisite: Engl. 1001-2-3. Study of works of three of the following: Descartes, Galileo, Newton. Emphasis on their reflection of humanism, the scientific revolution, the age of exploration.

1. **Bible:** writings, with emphasis on literary quality and intellectual content. Discussion of the cultural heritage of the Western World.

   - An examination of Chaucer's language and the political, social, and religious history of his times, and a careful study of Chaucer's narrative poetry.

   - A brief statement of the life and times of Shakespeare and a careful study of certain of his principal works. Lectures, reports, papers, quizzes.

   - An analytical survey of prominent playwrights and trends in contemporary drama. 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 New Testament.

   - Intensive study of individual writers, movements, periods, or themes in literature, with the purpose of developing knowledge in depth, critical independence, and expository skill.

   - 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.

   - 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.

    - 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.

    - An analytical study of prominent writers and trends in contemporary fiction. Lectures, reports, collateral reading, quizzes.

    - Intensive study of works of modern literature which treat the theme of Man and Society as these works reflect problems of concern to contemporary times.

    - Intensive study of works of modern literature which depict issues of immediate concern to contemporary times.

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**FRENCH**

(See Modern Languages)

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**GEOPHYSICAL SCIENCE**

    - A survey of planetary science, atmospheric science, and oceanography giving general insight into the nature of man's environment.

15. **Geol.** 2100. General Geology 3-0-3.
    - Earth's structure and composition, and the record of geologic time. Origin of rocks; evolution and migration of the continents.

    - Selected topics from geological, physical, chemical, and biological oceanography; marine technology; marine environment; resources from the sea. Relationships between man and the sea.

    - Introduction to nature of minerals and rocks, processes forming them, and their pattern in space and time. Laboratory exercises on minerals, rocks, and geologic maps.

18. **Geol.** 3000. Earth Resources 3-0-3.
    - 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.

19. **Geol.** 3100. History of the Earth 3-0-3. Prerequisite: Geol. 2100 or Geol. 2500.

20. **Geol.** 3400. Mineralogy 3-0-3. Prerequisite: Geol. 2500 or consent of school.
    - Crystal bonding and symmetry; crystal structure and crystal chemistry; application to geologically important minerals. Laboratory devoted to hand specimen identification, X-ray diffraction, chemical analysis.

21. **Geol.** 3410. Optical Mineralogy 1-3-2. Prerequisite: Geol. 3400 or consent of school.
    - A brief introduction to the use of the polarizing microscope for the identification and study of thin sections of rocks and minerals.

22. **Geol.** 3500. The Earth—Moon System 3-0-3. Prerequisite: Phys. 2123.
    - Physical interactions of earth, moon, and sun; structure and evolution of earth and moon as a planetary system; introduction to lunar geology.

23. **Geol.** 4100. The Influence of Man's Activities on the Global Environment 3-0-3. Prerequisite: Geol. 2500.
    - The interaction of atmosphere, hydrosphere, biosphere, and lithosphere. The interfering effects of human activities on the Earth's environment.
man's activities on the cyclic equilibria on the earth.

Geol. 4150. Petrology of the Sedimentary Rocks
2-3-3. Prerequisite: Geol. 3410 or Cer. E. 4120.
Texture, composition, and structure of sediments and sedimentary rocks; sedimentary processes (hydraulics and aqueous geochemistry); analysis of sedimentary environments.

Geol. 4200. Structural Geology
3-3-4. Prerequisite: Geol. 2500.
Structures produced by rock deformation during tectonic and metamorphic activity. Primary structural features. The laboratory will include several field trips.

Geol. 4240, 4241, 4242. Field Methods in Geology
0-6-2. Prerequisite: Geol. 2500.
Methodology of description, mapping, and analysis of rock units and structures in the field.

Geol. 4250. Engineering Geology
3-3-4. Prerequisite: Geol. 2500.
Applications of geological science to problems of civil engineering.

Geol. 4300. Introduction to Physical and Chemical Oceanography
3-0-3. Prerequisite: Geol. 2500 or consent of school.
Ocean geometry; physical properties of sea water; water movements and energy fluxes; sediments; marine geochemistry; marine geophysics and tectonics; ocean history.

Geol. 4400. Petrology of Igneous and Metamorphic Rocks
3-3-4. Prerequisite: Geol. 3410 and Geol. 4200.
Composition, texture, and structure of igneous and metamorphic rocks. Physical, chemical, and geologic conditions controlling metamorphism and igneous activity.

Geol. 4500. Introduction to Geophysics
3-0-3. Prerequisite: Introductory geology.
General survey of terrestrial geophysics. Topics discussed include the earth's seismicity, internal structure, shape, gravity, magnetic field, paleomagnetism, heat flow, and global tectonics.

Geol. 4550. Applied Geophysics
3-3-4. Prerequisite: introductory geology and physics.
Theory of electrical, magnetic, gravity, seismic refraction and reflection exploration methods. The laboratory provides exercises in instrumentation and data interpretation.

Geol. 4600. Introduction to Geochemistry
3-3-4. Prerequisite: Geol. 3400.
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.

Geol. 4800. Special Topics
0-6-2.
Geol. 6050. Geophysics I—Seismology and Heat Flow
3-3-4. Prerequisite: consent of school.
An intense theoretical survey of terrestrial geophysics. Topics include seismology, wave motion, structure of the earth's interior, and heat flow. Laboratory stresses directed projects.

Geol. 6051. Geophysics II—Gravity
3-3-4. Prerequisite: consent of school.
An intense theoretical survey of terrestrial geophysics. Topics include potential theory, shape of the earth, and physical geodesy.

Geol. 6052. Geophysics III—Geomagnetism and Paleomagnetism
3-0-3. Prerequisite: Geol. 6051 or consent of school.
Topics include magnetohydrodynamics, origin and description of earth's magnetic field, rock magnetism, remanent magnetism, geophysical evidence for global tectonics and tectonic mechanisms.

Geol. 6100. Clay Mineralogy
3-0-3. Prerequisite: consent of school.
The composition and structure of clay minerals; physical and chemical properties; X-ray identification; geologic distribution and significance; origin; clay-water relations.

Geol. 6110. Advanced Clay Mineralogy
2-3. Prerequisite: Geol. 6100.
Continuation of Geol. 6100, emphasizing effects of crystal structure and composition of clay minerals. Laboratory involves X-ray, electron microscope, and other techniques.

Geol. 6150. Sedimentary Geology
3-3-4. Prerequisite: Geol. 2500.
Composition and texture of sediments and sedimentary rocks; sedimentary processes; primary sedimentary structures; weathering; transportation; diagenesis; environments of deposition; stratigraphy of sedimentary rocks.

Geol. 6160. Stratigraphy and Sedimentation
3-0-3. Prerequisite: Geol. 6150.
Continuation of Geol. 6150 with emphasis on sedimentary environments, recent and ancient. Principles of correlation, stratigraphic mapping, and stratigraphic analysis.

Geol. 6180. Geology of Ground Water
3-0-3. Prerequisite: Geol. 4200.

Geol. 6210. Global Tectonics
3-0-3. Prerequisite: Geol. 4200.
Geological aspects of the new global tectonics.

Geol. 6220. Advanced Structural Geology
3-0-3. Prerequisite: Geol. 4200.

Geol. 6300. Principles of Physical Oceanography
3-0-3. Prerequisite: consent of school.
Temperature, salinity, and density in the oceans. Dynamics of ocean currents. Theory of ocean waves. Selected topics with application to coastal and estuarine circulation.

Geol. 6310. Principles of Chemical Oceanography
3-3-3. Prerequisite: Chem. 3412 and Geol. 4300 or consent of school.
Brief overview of the chemistry of sea water and marine sediments. Detailed discussion of selected topics.

Geol. 6400. Igneous Petrology
3-4-4. Prerequisite: Chem. 3412 and Geol. 4400.
Microscopic study, classification, physical chemistry, and evolution of igneous rocks.

Geol. 6450. Metamorphic Petrology
3-4-4. Prerequisite: Chem. 3412 and Geol. 4400.
Study and classification of chemical and physical changes induced in rocks upon metamorphism.

Geol. 6510. Analytical Methods in Geophysics
3-3-4. Prerequisite: Geol. 6050 and Geol. 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.

Geol. 6520. Analytical Methods in Geophysics II
3-3-4. Prerequisite: Geol. 6050 and Geol. 6051.
Theory of magnetotelluric and electromagnetic methods; conductivity of earth materials; theory of direct current resistivity; spontaneous potential and induced potential.

Geol. 6550. Observational Seismology
3-3-4. Prerequisite: Geol. 4500.
A study of the nature of earthquake motion and the damage it causes. The laboratory provides exercises in the interpretation of seismograms.

Geol. 6560. Theoretical Seismology
3-3-4. Prerequisite: Math. 4321 and Geol. 6550.
Theory of elastic wave propagation in the earth. Topics include reflection of waves, surface waves, head waves and use of seismograms.
Geol. 6600. Aqueous Geochemistry 3-0-3. Prerequisite: Chem. 3412, and Geol. 2500 or consent of school. Reactions of minerals in earth surface and near-earth-surface waters.


Geol. 6751. Introductory Diffraction Studies 3-6-4. Prerequisite: consent of school. Introductory theory and practice of the most widely applicable X-ray and neutron diffraction techniques. Identification, lattice parameters, textures, line breadth, and crystal orientation. Cross-listed with Phys. 4751 and Cer.E. 6751. The two 6751 courses will involve an additional assignment to be negotiated with the instructor.

Geol. 7000. Master's Thesis 1-0-0.

Geol. 8000, 8001, 8002. Seminar 1-0-0.

Geol. 8101, 8102, 8103. Special Topics 2-0-2, 2-0-2, 3-0-3.

Geol. 8500, 8501, 8502. Special Problems Credit to be arranged.

Geol. 9000. Doctor's Thesis

HEALTH SYSTEMS

H.S. 3011. Introduction to the Health Field 3-0-3. Brief 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 and Problems 3-0-3. Prerequisite: H.S. 2011 or equivalent. Internal structure, functions, and management problems of hospitals, including departmental interactions; systems analysis and flow process charts of materials, supplies, personnel, patients, paperwork, and information.


H.S. 3111. Methods Improvement in the Health Sciences 3-0-3. Prerequisite: H.S. 2011 or equivalent. Work simplification, operations analysis, multiple activity charting, methods design, forms design, paperwork simplification, job analysis and evaluation, incentive plans, merit rating, and employee suggestion plans.

H.S. 3121. Work Measurement in the Health Services 3-0-3. Prerequisite: H.S. 3101 and M.Sci. 3110, or equivalents. Time and mathematical relationships, time study, predetermined motion-times, statistical methods, evaluating alternative work methods, work sampling, standard data, scheduling, quality control, and staffing methodologies.


H.S. 3211. Data Processing in the Health Services 3-0-3. Prerequisite: H.S. 3011, M.Sci. 2000, Mgt. 3700. Hospital and medical information systems; data collection, storage, processing, and reporting; file design, record structure, processing requirements, controls, report formats; medical records, statistical audits, other applications.

H.S. 3351. Health Systems Projects and Reports 3-0-3. Prerequisite: H.S. 2011 or consent of department. Methods and techniques of proposing, planning, conducting, and reporting health systems projects; the scientific method; interpersonal relationships and ethics; written and oral expression; audiovisual practice.

H.S. 3971, 3972, 3973. Special Problems Credit to be arranged. Prerequisite: prior arrangements with department. 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. 4141. Health Facility Planning 2-3-3. Prerequisite: normally taken by seniors. Methods and techniques of proximity analysis, layout, costing, economic evaluation, materials handling, logistical support, automation, architecture, and construction; shared services and community health planning.

H.S. 4471, 4472, 4473. Health Systems Practicums 0-12-4 each. Prerequisite: H.S. 3131, 3211, 3351. Training field for individual students in actual health care institutions within commuting distance of campus in each of the senior year quarters; projects and reports.

Text: HSRD Field Training Manual.

H.S. 4581. Health Systems Externship 0-36-12. Prerequisite: H.S. 3131, 3211, 3351, Three months of full-time field-training experiences for individual students in actual health care institutions or agencies affiliated with HSRD; projects and reports.

Text: HSRD Field Training Manual.

H.S. 4691. Health Systems Seminar 2-0-2. Prerequisite: H.S. 4471 or 4581. Guest speakers, discussions of health systems issues and problems, techniques for achieving results, overcoming resistance to change, review of field training experiences, employment opportunities.

H.S. 4765. Hospital Management Systems 3-0-3. Prerequisite: normally taken by seniors. Case study of hospital management systems; improvement review of the application of industrial engineering and health systems principles and techniques. Crosslisted as ISyE 4765; may be taken for graduate credit.

Text: of Smalley and Freeman, Hospital Industrial Engineering.

H.S. 4861, 4862, 4863. Health Systems Topics 3-0-3. Prerequisite: consent of department.

GERMAN

(See Modern Languages)
Provides formal coursework on special topics not included in regular health systems courses.

H.S. 6765. Case Studies in Hospital Management Systems 3-0-3. Prerequisite: H.S. 4765 or equivalent.
A study of complex problems facing hospital management, the systems approach to their solution, and critical reviews of studies reported in the technical literature. Crosslisted as I.Sy.E. 6765.

H.S. 7765. Projects in Hospital Management Systems 3-0-3. Prerequisite: H.S. 6765 or equivalent.
Individual student projects in actual hospital situations under faculty direction, with emphasis upon unusual applications of industrial engineering and health systems to hospital management problems. Crosslisted as I.Sy.E. 7765.

HISTORY
(See Social Science)

INDUSTRIAL DESIGN
(See Architecture)

INDUSTRIAL MANAGEMENT

ECONOMICS

The behavior of economic units in pricing and output decisions.


Surveys national income, employment, money and banking, and international trade. Relates consumer, business, government, and international sectors to the aggregate economy.

Intermediate price theory with applications to management problems.

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.

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. 3000-3001.
Topics for discussion will be chosen to encourage the student to focus his understanding of economic theory on a substantive problem. Designed for economics majors.

Econ. 3100. Econometrics I 3-0-3. Prerequisite: 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.

The forces, unique characteristics, and problems associated with American industrialization.

General theories of economic development. Each student will be required to analyze the economy of a developing country.

The logical structure of scientific theory as it applies to knowledge about political and economic situations and events.

A theoretical perspective to explain and predict the effects of actual and proposed public policy and to generate some standards of evaluation.

Econ. 3502. Political Economy: Public Policy Analysis II 3-0-3. Prerequisite: Econ. 3501.
Uses the theoretical tools that Public Policy Analysis I develops to analyze and evaluate specific areas of public policy.

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.

This course emphasizes the application of mathematical tools to economic analysis. Topics include mathematical programming, game theory, difference and differential equations, and optimal control theory.

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 security 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 NLRB rulings on labor-management relations.

Foreign trade and commercial policy, international finance, and current problems of international economic relations.

Analyzes government's role in resource allocation, income distribution, stabilization, and growth through the economic effects of government spending and revenue-raising activities.

Econ. 4320. Managerial Economics 3-0-3. Prerequisite: Econ. 3000.
Relationships between economic concepts and managerial decisions. Topics covered include non-profit goals of the firm, unstructured managerial problems, and the determinants of good managerial decisions.
Theories of regional income determination and regional growth, special economic structure, central-place theory, and regional effects of public policy.

The economic dimensions of the processes and problems associated with urbanization are examined in this course.

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.

The competitive structure of the American economy in terms of economic models, alternative public policy goals, and the development of anti-trust laws.

The problems and policy options associated with government regulation of particular industries.

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.

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.

Econ. 4901-2-3. Special Problems in Economics Credit to be arranged.
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. 4904. Individual Research in Economics Credit to be arranged.
Designed to permit independent study with a faculty member. To register, a professor's approval in writing of a research proposal must be obtained.

Econ. 4990. Georgia Internship Program Credit to be arranged.
Prerequisite: consent of the college.
Broaden the scope of the college curriculum by offering students a community-based learning experience which stress the completion of a specific task.

Econ. 6000. Microeconomic Analysis and Policy 3-0-3.
Theoretical analysis of the determination of prices and output. The objective is to develop the basic economic concepts.

Econ. 6001. Macroeconomic Analysis and Policy 3-0-3.
National income accounting methods and the theory of national income determination.

Econ. 6002. Applied Welfare Economics 3-0-3. Prerequisite: Econ. 6001.
Offers to non-economists, as well as to economists, and opportunity to broaden their decision-making framework by stressing the role and contribution of economic theory.

Econ. 6050. Monetary Theory 3-0-3. Prerequisite: Econ. 6001.
Theories of the role of money and the monetary system in economic stabilization and growth: analyses of monetary and fiscal policies.

Econ. 6120. Economic Forecasting 3-0-3. Prerequisite: Econ. 6001 or equivalent.
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.
Case course involving contract negotiations, grievance handling and arbitration.

Econ. 6265. Protective Labor Legislation 3-0-3.
Survey of federal and state laws pertaining to wages, hours, workmen's compensation, child labor, training, unemployment, and other employment security matters.

Econ. 6266. Wage and Employment Theory 3-0-3. Prerequisite: Econ. 6000 and Econ. 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 non-profit 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 and employment, and economic growth.

Econ. 6331. Economics of Industrialization 3-0-3.
An examination of long-run growth processes seeking causes of under-development, exploring theories of economic growth, and applying these explanations to developed and underdeveloped economics.

Econ. 6340. Industry and Government 3-0-3. Prerequisite: Econ. 6000 or equivalent.
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 and 6001 and consent of the IM College.
Credit not given for both Econ. 4420 and 6410.
Development of the various schools of economic thought and their contributions to the present body of economic theories.

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 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. Non-market Processes and Economic Decisions
3-0-3. Prerequisite: consent of the IM 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. 6760-NE. 6760. Financial Management and Economics of Nuclear Power
3-0-3. 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 economics.

Econ. 7001. Advanced Microeconomic Analysis
3-0-3. Prerequisite: Economics 6000 or equivalent and consent of the IM College. Analysis of resource allocation and income distribution.

Econ. 7002. Advanced Macroeconomic Analysis
3-0-3. Prerequisite: Econ. 6001 or equivalent and consent of the IM College. Interrelationships among the major aggregated sectors of a national economy taking special cognizance of institutions which exist in U.S.

Econ. 7003. Seminar in Microeconomics
3-0-3. Prerequisite: Econ. 7001 and consent of IM College.

Students have an opportunity to pursue in depth some topic or problem in the area of macroeconomics.

Econ. 7004. Seminar in Macroeconomics
3-0-3. Prerequisite: Econ. 7002 and consent of the IM 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 the IM College. Methods used in empirical economic research.

Econ. 7101. Seminar in Econometrics
3-0-3. Prerequisite: Econ. 7100 and consent of the IM College. An analysis of the problems of heteroscedasticity, multicollinearity, underidentification and autocorrelation as a whole.

INDUSTRIAL MANAGEMENT

3-0-3. Prerequisite: sophomore standing. Provide a basic understanding of general and cost accounting systems and the utilization of reported financial information.

Mgt. 3010. Taxation

Mgt. 3050. Computer-based Management Systems
3-0-3. Prerequisite: M. Sci 2000. An introduction to concepts used in the design of management systems relying on computers and information technology.

Mgt. 3060. Finance I
3-0-3. Prerequisite: Econ. 2000 and Mgt. 2001. Introduces the institutions and instruments for acquisition of funds, and stresses their utilization within an economic environment for making 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.

Mgt. 3070. Mgt. Science Models in Finance
3-0-3. Prerequisite: Mgt. 3060. 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. 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, and 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.

Mgt. 3160. Management in a Changing Society
3-0-3. Role of the manager in today's era of pervasive change, viewing the firm as a socio-economic agent of the society.

Mgt. 3161. Management as a Creative Force
3-0-3. Prerequisite: Mgt. 3160. Describes the manager's role in accomplishing the entrepreneurial mission of the enterprise. Each student analyzes and reports on an existing organization.

Mgt. 3260. Law I
3-0-3. Development and function of the law, court organization and procedure, and substantive law in the following areas: contracts, business organizations, and agency.

Mgt. 3261. Law II
3-0-3. Legal problems encountered in an urban environment within a socio-economic and political atmosphere, specifically, in the areas of consumer problems, bankruptcy, and constitutional law.

Mgt. 3300. Marketing I
3-0-3. Prerequisite: Microeconomics Econ. 2000. Marketing's role in the 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. Analysis of 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. Research orientation, planning an investigation, questionnaires, sampling, interpretation of results, report presentation.

Mgt. 3320. Management Science Models in Marketing
3-0-3. Prerequisite Mgt. 3300. 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. Course is designed to encourage students to examine the principles of
marketing in light of contemporary thinking concerning social, economic, and technological development.


Mgt. 3701. Finance Survey 3-0-3. Covers the more popular types of business organizations, with emphasis on the corporation, its organization, management and types of securities issued. Credit cannot be given for Mgt. 3701 and Mgt. 3060 and 3061.

Mgt. 4020. Auditing and Accounting Systems 3-0-3. Prerequisite: Mgt. 2001 and Mgt. 3060. Emphasizes both the design of accounting systems and internal and internal auditing and control procedures.

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. Prerequisite: normally taken by 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: Mgt. 3100 and Mgt. 4100 or consent of college. Investigations, analysis, critiques and reports of current 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 to the firm of 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. 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 career paths, 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. Last quarter in residence. IM students only or consent of college. 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. 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. 4230. Economics of the Labor Market 3-0-3. The application of microeconomic theory to wages, employment, and productivity.

Mgt. 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.


Mgt. 4250. Nonmarket Environment of the Firm 3-0-3. Normally taken by seniors. An examination of the socio-cultural factors which must be taken into account in the management decision process, and of 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 an 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. 4350. Production Management 3-0-3. Prerequisite: Mgt. 3150 and Econ. 3000. Develops understanding of the organizational, economic, and physical framework within which the manufacturing division functions.

Mgt. 4901-2-3, Special Problems in Industrial Management Credit to be arranged. Permits groups of students to pursue areas of management not extensively treated in other courses, or to engage in minor research or special problems.
Mgt. 4904. Individual Research in Industrial Management
Credit to be arranged.
Designed to permit independent study with a faculty member. To register, a professor's approval in writing of a research proposal must be obtained.
Mgt. 4990. Georgia Internship Program
Credit to be arranged. Prerequisite: consent of college.
Broaden 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 the IM College.
Cover the use of accounting systems to provide information for performance evaluation.
Mgt. 6001. The Budgetary Process
3-0-3. Prerequisite: Mgt. 6000 or equivalent; consent of IM College.
Develop the concepts of planning, budgeting, and control as they relate to large resource allocation decisions.
Mgt. 6030. Financial Control I
4-3-4.
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 or equivalent.
Principles, problems and methods of accumulating, analyzing, and interpreting accounting data.
Mgt. 6032. Financial Control III
3-0-3. Prerequisite: Mgt. 6031 or equivalent.
Applies decision principles developed in Mgt. 6031.
Mgt. 6060. Financial Management I
3-0-3. Prerequisite: graduate standing and Mgt. 6000 or equivalent.
Instruments and institutions of finance, the creation and modification of the financial structure of the firm.
Mgt. 6061. Financial Management II
3-0-3. Prerequisite: Mgt. 6060.
Procurement and the application of funds within the firm in a manner consistent with predetermined objectives.
Mgt. 6100. Organization Processes
3-0-3. Prerequisite: consent of the IM College.
Introduction to analysis of individual behavior and to individual and group performance in organizations.
Mgt. 6101. Organizational Design
3-0-3. Prerequisite: consent of the IM 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. Administrative Processes I
3-0-3. Prerequisite: graduate standing - consent of the IM College.
Combines the theory of management with a workable knowledge of the behavioral sciences in achieving the objectives of management.
Mgt. 6106. Administrative Processes II
3-0-3. Prerequisite: Administrative Processes I.
Administrative problems that arise in the relationships among people in organizations.
Mgt. 6140. Management Systems Analysis
Prerequisite: basic knowledge of computers, accounting, and management operations.
Concepts and techniques of managerial process simulation; analysis of computer-based management information and control systems.
Mgt. 6150. Organization Theory
3-0-3.
Background for student to build sound organizational structure within the objectives of the enterprise.
Mgt. 6155. Development of Management Thought
3-0-3.
A survey of the development of management thought based upon a critical examination of the "classic" works in management literature.
Mgt. 6160. Management Theory
3-0-3. Prerequisite: consent of the IM 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 department.
Critical examination of business concepts, organizational structures and control processes of multinational corporation in different political and economic environments.
Mgt. 6195. Managerial Policy
3-0-3. Prerequisite: accounting, finance, marketing and production.
Concepts of competitive and governmental forces affecting managerial decision-making. Should not be taken until the student's last quarter.
Mgt. 6200. Labor Problems
3-0-3.
An examination of the union-management relationship. Includes analysis of labor agreements, 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 or equivalent.
Theory and techniques of marketing analysis and its use in the formulation 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. Prerequisite: Mgt. 6300.
Recent issues in consumerism; the performance of marketing activity within our society.
Mgt. 6350. Manufacturing Management I
3-0-3.
Provides 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. Corequisite: Mgt. 6350.
Further development and application of managerial and economic concepts in the solution of problems in the manufacturing firm.
Mgt. 7000. Master's Thesis
Mgt. 7090. Management Research Methods
3-0-3. Prerequisite: consent of the IM College.
Seminar in research techniques being employed in the current literature of management and economics.
Mgt. 7091. Seminar in Management and Economic Research
3-0-3. Prerequisite: consent of the IM College.
Management Science

3-0-3. Sophomore standing.
Provides a technical foundation for the development of computer-based management systems.

M.Sci. 3100. Survey of Statistics
3-0-3. Prerequisite: Math 1722.
A survey of discrete probability and statistics with emphasis on economic and business applications. Serves as core requirement for I.M. degree mainly for those who do not take Math. 1722.

M.Sci. 3110. Statistics I
Emphasis on continuous probability models and discrete models. Required of economics majors and recommended to those wanting a two course sequence in statistics.

M.Sci. 3111. Statistics II
Classical inference and estimation, drawing heavily on calculus for such topics as maximum likelihood estimation, evaluation of decision rules, etc. Serves as core requirement for I.M. degree and recommended for those with Math. 1721-22.

M.Sci. 3200. Management Science I
3-0-3. Applications of linear programming to the analysis of managerial problems. Topics include duality, transportation problems, network flows, postoptimality analysis, and decomposition.

M.Sci. 3201. Management Science II
3-0-3. Prerequisite: Math 4215.
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.Sci. 3300. Decision Analysis in Management
3-0-3. Prerequisite: Math 2010.
An introduction to decision models for management situations under risk and uncertainty including fundamental economic concepts of a theory of rational choice.

M.Sci. 3400. Analytical Methods in Management I
3-0-3. Prerequisite: Math 2010.
Introduction to management science. Analytical models of management decision situations. Topics include classical optimization and linear programming.

M.Sci. 3401. Analytical Methods in Management II
3-0-3. Prerequisite: M.Sci. 3400.
Additional applications of linear programming to analysis of management decision problems. Topics include alternatives to the simplex algorithm.

M.Sci. 3402. Analytical Methods in Management III
3-0-3. Prerequisite: M.Sci. 3400.
Introduction to the theory and applications of dynamic, integer and nonlinear programming in the analysis of management decision problems.

M.Sci. 3403. Analytical Methods in Management IV
Analytical and simulation approaches to the analysis of queueing and inventory systems.

M.Sci. 4100. Statistical Analysis
3-0-3. Prerequisite: consent of college.
Statistical fundamentals and techniques for graduate students with diverse backgrounds.

M.Sci. 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.Sci. 4120. Nonparametric Statistics
3-0-3. Prerequisite: Statistical Inference.
A survey of some of the more widely used nonparametric statistical tests in management and economic research.

M.Sci. 4990. Georgia Internship Program
Credit to be arranged. Prerequisite: consent of college.
Broaden the scope of the college curriculum by offering students a community-based learning experience which stresses the completion of a specific task.

M.Sci. 4991-2. Special Problems
Credit to be arranged. Prerequisite: consent of the college.
The special project is designed to provide the student an opportunity to apply his full training to the analysis of an applied or theoretical problem.

M.Sci. 4904. Individual Research in Management Science
Credit to be arranged. Normally taken by seniors.
Designed to permit independent study with a faculty member. To register, a professor's approval in writing of a research proposal must be obtained.

M.Sci. 6000. Quantitative Decision Procedures I
3-0-3. Prerequisite: consent of the IM College.
Introduction to mathematical analysis of managerial and economic decision problems. Deterministic models and methods and some required mathematical concepts are studied.

M.Sci. 6010. Analytical Methods in Management
3-0-3. Introduces beginning graduate students to scientific methods of decision-making in dealing with economics problems.

M.Sci. 6050. Management Systems and Information Technology
3-0-3. Prerequisite: consent of the IM College.
Management use of information technology to capture, process, and distribute information for support of managerial decision-making.

3-0-3. Prerequisite: M.Sci. 2000 or equivalent.
Techniques of simulating general management decisions utilizing information from the areas of marketing, production, finance, and industrial relations.

M.Sci. 6101. Applications of Statistical Methods to Management Decision-making
3-0-3. Prerequisite: M.Sci. 4100 or equivalent.
Theory and applications of elementary multiple regression analysis and elementary statistical decision theory in a management framework.

M.Sci. 6102. Application of Regression Analysis
3-0-3. Prerequisite: M.Sci. 6101 or equivalent; matrix algebra.
Special problems in regression analysis 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. 6410. Mathematical Programming 3-0-3. Prerequisite: M.Sci. 6010 or equivalent; consent of the IM College. The theory of mathematical programming and its applications in managerial planning, budgeting and decision-making.

M.Sci. 6411. Seminar in Mathematical Programming 3-0-3. Prerequisite: M.Sci. 6410. Student research and/or in-depth study of recent literature on theory and application of mathematical programming in management and economics.

INDUSTRIAL AND SYSTEMS ENGINEERING

I.Sy.E. 1010. Basic Concepts in Industrial and Systems Engineering 2-3-3. Available to freshmen only. May substitute for E.Gr. in BIE curriculum. 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. 3015. Analysis of Production Operations 4-0-4. Analysis, synthesis, and improvement of individual work operations within production systems. Emphasis on production measurement, data collection, work center design, and work system design.


I.Sy.E. 3027. Applications of Probability 3-0-3. Prerequisite: Math 2308. Introduction to probability, emphasizing applications in science and engineering. Topics include probability concepts, random variables, discrete and continuous distributions.

I.Sy.E. 3028. Engineering Statistics I 3-0-3. Prerequisite: I.Sy.E. 3027 or equivalent. Introduction to statistical methodology, emphasizing applications in science and engineering. Topics include estimation, hypothesis testing, and process control.

I.Sy.E. 3029. Engineering Statistics II 3-0-3. Prerequisite: I.Sy.E. 3028 or equivalent. 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. 3080. Systems Engineering I 2-3-3. Prerequisite: Math 2309 or equivalent. Introduction to systems engineering and its methodological and conceptual foundations. Integrated use of mathematical and engineering concepts for analysis and design of interdisciplinary systems.


I.Sy.E. 3749. Elementary Quality Control 3-0-3. Not available to I.Sy.E. students, or students with credit for I.Sy.E. 4039. Introduction to industrial quality control using statistical methods. Includes methods of data analysis, sampling, and control charts as applied to manufacturing processes.

I.Sy.E. 4000. Introduction to Systems Theory 3-0-3. Prerequisite: consent of department. The basic, classical, and modern concepts and tools required for modeling, analysis, and synthesis of linear, discrete and continuous, deterministic and dynamic systems.


Optimization in integer by cutting planes, branch and bound, and implicit enumeration.

I.Sy.E. 4007 Applications of Network Flow Theory 3-0-3. Prerequisites: I.Sy.E. 3033 or equivalent.

Uses of graph and network theory in modeling and solving transportation, assignment, location, scheduling, distribution, and traveling salesman type problems.


Analysis of linear deterministic systems emphasizing matrix theory and the state variable sets of ordinary differential equations for systems representations.


Analysis of linear stochastic systems emphasizing statistical descriptions of random processes and the response of linear systems to stationary random input processes.


Study of principles used to establish wage rates and salaries. Emphasizes characteristics and objectives of wage incentive plans and design and analysis of incentive formulas.


Development of procedures and techniques for analysis and solution of materials handling problems. Plant trips and laboratories utilized to illustrate modern materials handling methods.


Examination of feedback processes as causes of dynamic behavior in socioeconomic and managerial systems. Emphasizes feedback loop performance characteristics and computer simulation of multivariate nonlinear systems.

I.Sy.E. 4033. Electronic Data Processing 3-0-3. Prerequisite: Senior standing or consent of department.

Survey of electronic data processing including important applications, characteristics of data processing equipment, programming systems, and methodology for analysis and design of management information systems.

I.Sy.E. 4035. Project Management Systems Design 2-3-3. Prerequisite: senior standing or consent of department.

Project planning and control using activity network analysis. Emphasizes network logic, scheduling computations, resource scheduling, time-cost tradeoff algorithms, and multiproject resource allocation.


Nature and extent of industrial accident problems including identification and solution of technical accident problems using engineering design and analysis techniques for accident prevention.

I.Sy.E. 4037. Industrial Safety Administration 3-0-3. Prerequisite: senior standing or consent of department. Not available to students with credit for I.Sy.E. 4036.

Control of industrial accidents by non-technical measures. Emphasizes modern organizational relationships in developing safety programs including accident control measurement systems, cost-oriented decision-making.

I.Sy.E. 4038. Industrial Fire Prevention and Protection 3-0-3. Prerequisite: senior standing or consent of department.

Economics of industrial fire risks. Emphasizes design of fire protection facilities and reduction of fire hazards in plants, processes, and individual work centers.

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 department.

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. 4041. Sales Engineering 3-0-3. Prerequisite: senior standing or consent of department. Available to engineering students only.

Introduction to problems involved in selling technical goods and services requiring engineering skill and knowledge in the design, application, installation, and servicing of such products.


Simulation methodologies including random generation, time-keeping, and statistical techniques used to solve discrete unit flow systems and sequencing problems. Simulation languages enabling model building and computer solution required.


Emphasizes procedural, systematic, analytical and creative approaches to a spectrum of pragmatic problems developing the student's systems design capability and appreciation for alternative operating solutions.


Senior group design project requiring system definition, analysis, synthesis, specification and installation of design.

Problem areas chosen from research and professional interests of involved faculty and students.

I.Sy.E. 4052. Design II 2-6-4. Prerequisite: I.Sy.E. 4051.

Continuation of I.Sy.E. 4051 with same design group personnel. Project conclusion requires presentations for formal reporting of results to the external sponsoring organization.

I.Sy.E. 4053. Introduction to Socio-Economic System Analysis 3-0-3. Prerequisite: senior standing or consent of department.

Applications of operations research/systems analysis technology and methodology to current social problems. Topics include human resources development, transportation systems, environmental quality, and management of municipalities.

I.Sy.E. 4054. Projects I 0-12-4. Prerequisite: senior standing or consent of department. Available to B.E.E.S. degrees only. Prior faculty approval required.

Senior group project intended as an integrative experience for students dealing with socio-economic problems related to the B.E.E.S. students' area of major selection.

I.Sy.E. 4055. Project II 0-12-4. Prerequisite: I.Sy.E. 4054.

Continuation of I.Sy.E. 4054 with same project group personnel. Project conclusion requires pilot implementation of project results and recommendations to external sponsoring environment.

I.Sy.E. 4056. Technological Forecasting 3-0-3. Prerequisite: senior standing or consent of department.


Senior group design project for students interested in complex inter-disciplinary preliminary systems design. Background lectures and case studies emphasize trade-offs between subsystems of interest.


Continuation of I.Sy.E. 4061 with same design group personnel. Project conclusion requires presentations and publica-tion of final report to the external sponsoring systems oriented organization.


Fundamental design procedures and techniques used to create a product or service oriented economic enterprise. Emphasizes organization, methods, materials flow, and performance design of the enterprise.


Senior group design project for students interested in operations and facility design in economic enterprises. Background lectures assist groups to develop feasibility study of project environment.


Continuation of I.Sy.E. 4071 with same design group personnel. Project conclusion requires final design documents, economic evaluation, and presentation to the external sponsoring economic enterprise.


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 transpor-tation.


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.


Procedures and methods for designing the enterprise environment emphasizing building design concepts, construction methods, environmental systems, plant services, noise and pollution control, and their cost factors.


Analytical methods of production/inventory control emphasizing forecasting techniques, inventory models, application of mathematical programming and network models, sequencing and scheduling techniques, and line balancing.


Senior group design project for students interested in management information and control systems design. Background lectures develop competency for design of inventory, quality, manpower, and fiscal control systems.


Continuation of I.Sy.E. 4081 with same design group personnel. Project conclusion requires design of integrated information-decision system and presentation to the external sponsoring organization.

I.Sy.E. 4090. Legal and Ethical Phases of Engineering 3-0-3. Prerequisite: senior standing or consent of department.

Introduces the engineer to the ethical, legal, and professional attitudes to be encountered in his future working environment. Includes business, patent, and copyright law considerations.

I.Sy.E. 4500. Director's Honor Seminar 3-0-3. Prerequisite: senior standing in I.Sy.E. and 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 3-1-3. 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 projects including economic measures of effectiveness, time value of money, cost estimation, breakeven and replacement analysis.

I.Sy.E. 4726. Engineering Economic Analysis in the Public Sector 3-0-3. Prerequisite: sophomore standing. Not available to I.Sy.E. students or students with credit for I.Sy.E. 4725.

Fundamental principles and basic techniques of engineering economic analysis with emphasis on public works projects. Includes evaluation of economic impact, and methods for financing public works.

I.Sy.E. 4765. Industrial Engineering in Hospitals 3-0-3. Prerequisite: senior standing or consent of department.

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.

I.Sy.E. 4897, 4898, 4899. Topics 3-0-3. Prerequisite: consent of department.

I. Credit which allow the School of I.Sy.E. to offer courses in special topics of timely interest to the profession conducted by resident or visiting faculty.

I.Sy.E. 4991, 4992, 4993. Special Problems
Credit to be arranged. Prerequisite: senior standing in I.Sy.E. and prior faculty topic approval.

A 1-3 hour credit opportunity to develop initiative and apply fundamental principles by performing seminominal laboratory or research work in industrial and systems engineering.

I.Sy.E. 4994, 4995, 4996. 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 department.

A comprehensive study of the theories of industrial organization with particular emphasis on analyzing, evaluating, and integrating organizational activities.

I.Sy.E. 6102. Project Selection Methodology for Research and Engineering 3-0-3. Prerequisite: I.Sy.E. 6734 or equivalent with consent of department.

The processes of idea flow, project selection, resources allocation, and evaluation in R and E will be analyzed using readings from the current literature.


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. 6104. The Operating Characteristics of Industrial Engineering Functions 3-0-3. Prerequisite: consent of department.

The design, measurement, and evaluation of work activity; the design, measurement, and evaluation of other aspects of operating activity; operating efficiency from the control viewpoint.
Concepts of the management of improvement endeavors, strategies and tactics for achieving continual improvement within organizations. Theoretical bases and approaches to encourage innovation are studied.

I.Sy.E. 6212. Design of Industrial Engineering Programs 3-0-3. Prerequisite: consent of the department.
Deals with the development of industrial engineering, and proceeds to problems in organizing, planning, operating, evaluating, and increasing effectiveness of the industrial engineering function.

Deals with the engineering oriented management aspects in designing a manufacturing enterprise. Covers problems unique to developing a new enterprise.

The theory of human work measurement and an examination of research in this field; systems for labor performance evaluation.

I.Sy.E. 6217. Work Center Design 2-3-3. Prerequisite: consent of department.
Advanced study of methods analysis and synthesis with emphasis upon sub-optimizing the work center and on quantitative techniques.

Advanced study of the design of work systems with emphasis on the human operator and his role in the work system.

Application of information on man's capabilities and limitations in the design process. Design problems are used to aid understanding of application of human factors data.

An evaluation of the various factors affecting human physical performance in the industrial environment. Topics: anthropometry, biomechanics, energy expenditure, heat stress, fatigue, training, strength.

An introduction to the application of systems theory and methodology to the analysis and design of man-machine control systems.

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.

Advanced engineering economy topics, including: measuring economic worth, economic optimization under constraints, analysis of economic risk and uncertainty, foundations of utility theory.

Topics include applications of multivariable production functions, optimum size inputs and outputs, analysis of dynamic fluctuations through the use of transforms.

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.

An introductory course in inventory theory. Deterministic lot size models, probabilistic models of continuous and periodic review policies, dynamic models, and multiechelon systems.

Analysis of sequencing and scheduling activities. Static scheduling problems, dynamic scheduling systems, simulation studies of priority dispatching rules, priority queuing models.

Mathematical models for production planning. Applications of mathematical programming, dynamic programming, network theory, and heuristic methods to problems of planning production, inventories, and capacity.

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.

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.

Introduction to response surface methodology. Topics include canonical analysis, steepest ascent, first and second order response surface designs, concepts of rotatable and uniform precision designs.

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.

Survey sampling techniques. Topics include simple random and stratified random sampling, ratio estimation, regression techniques, systematic, cluster, and multistage sampling, and sources of error.

An intermediate-level course in statistical decision theory and its application to problems in operations research, industrial and systems engineering.

The planning, operation and maintenance of industrial facilities to control accident, fire and health hazards. Special reference is made to occupational health and safety legislation.
I.Sy.E. 6515. Analysis of Distribution Systems
3-0-3. Prerequisite: I.Sy.E. 4044, I.Sy.E. 4080, or equivalent. Study of the various types of transportation systems available to enterprises for distribution services. Analysis of distribution alternatives stressed, emphasizing design of economic and control systems encountered.

3-0-3. Prerequisite: I.Sy.E. 4070 and I.Sy.E. 4080, or consent of department. Methodology useful in analysis and design of in-plant material flow systems and their interfaces with transportation and distribution systems emphasizing quantitative and simulation techniques.

3-0-3. Prerequisite: Math. 4222 or equivalent. Applications of probability and stochastic processes in operations research. Topics include applications of the Poisson process, birth-and-death process and Markov processes.

I.Sy.E. 6656. Queueing Theory
3-0-3. Prerequisite: Math. 4215 or equivalent. Text: At the level of Cooper, *Introduction to Queueing Theory.*

I.Sy.E. 6751-52. Complex Systems Design
2-4-3. Prerequisite: graduate standing. This two-quarter sequence permits students from all schools to meet, form an interdisciplinary team, and carry out a preliminary design of a significant, complex system.

I.Sy.E. 6802-6803. Advanced Systems Theory I and II
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 or Math. 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: large social systems with intangible variables. Student project.

I.Sy.E. 6807. Feedback Dynamics Principles

I.Sy.E. 6808. Feedback Dynamics Applications

I.Sy.E. 6830. Simulation Techniques

I.Sy.E. 7000. Master's Thesis
Required of degree candidates.

I.Sy.E. 7441. Linear Statistical Models I
9-0-3. 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

I.Sy.E. 6656. Advanced Queueing Theory
3-0-3. Prerequisite: I.Sy.E. 7441. A continuation of I.Sy.E. 7441 stressing nonlinear 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. 6669. Optimization Techniques
4-0-4. Prerequisite: I.Sy.E. 3033 or equivalent. Optimization of linear models, including the revised, dual, and primal-dual simplex methods; duality theorems; decomposition; cutting plane algorithms; some network algorithms.

I.Sy.E. 6670. Nonlinear Optimization Techniques
4-0-4. Prerequisite: I.Sy.E. 3033 or equivalent. Algorithms for solving nonlinear constrained and unconstrained problems at the levels of Ackoff, introduction to optimization techniques. Quadratic programming, dynamic programming and enumerative methods.

I.Sy.E. 6734. Systems Research and Application I
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. 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 queueing models, waiting times under various queue disciplines, and current research problems. Text: At the level of Cooper, *Introduction to Queueing Theory.*

I.Sy.E. 7671. Foundations of Optimization
3-0-3. Prerequisite: Math. 4311. An introduction to the application of optimization techniques including probability, analysis, and current research problems. Text: At the level of Mangesar, *Nonlinear Programming.*
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 con­
vexity, solution 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 the elements of modern dynamic programming via the state space formalism. 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, multicmodity flows, disconnecting 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.

I.Sy.E. 7678. Decomposition Methods for Large Systems
3-0-3. Prerequisite: I.Sy.E. 6669.
Solution strategies, illustrated with examples, for handling complex systems with large number of variables and/or restrictions, linear and nonlinear.

I.Sy.E. 7765. Projects in Health Care Delivery Systems
Credit to be arranged. Prerequisite: I.Sy.E. 6765 or consent of department.
Research projects addressed at real-life problems confronting operational health care institutions and employing modern principles and approaches health systems analysis. Project report.

I.Sy.E. 8001. Seminar in Operations Research
1-0-0.
Credit to be arranged. Prerequisite: consent of department.
Topics within the area of operations research of a special interest to the faculty and graduate students, and which are not included in regularly offered courses.

I.Sy.E. 8081-82-83. Seminar in Systems 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. 8100. Topics
3-0-3. Prerequisite: consent of department.
Special topic offerings not included in regular courses.

I.Sy.E. 8120-21-22. Topics in Safety Engineering
3-0-3. Prerequisite: consent of department.
This course will be devoted to special topic offerings in the field of safety engineering.

I.Sy.E. 8601. Projects in Operations Research
Credit to be arranged. Prerequisite: consent of department.
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 department.

I.Sy.E. 9000. Doctor's Thesis

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 (1xxx - 4xxx undergraduate; 6xxx - 9xxx graduate). The second digit designates the subject orientation of the course; theory and foundations (1xxx); professional milieu (2xxx); computing applications (3xxx); computer software (4xxx); numeric computing and mathematics (5xxx); computer hardware and systems (6xxx); service courses (7xxx); and special problems (8xxx). The last three digits in the range x00 through x99 are identical with the subject codes of Computing Reviews, thus facilitating the student's access to the current literature related to these courses.

An orientation to the discipline and professions of information, computer and systems science, and to their functions in science and society. Visits to selected installations.

Elementary survey of the function of signs in thought and action, problem recognition, beliefs, language, meaning, information, inference, formalization, logic, programs and computation.

First course on problem solving using computers. The concept, properties, and notation of algorithms. Problem analysis, development of algorithms, and their implementation in BASIC.

Algorithmic processes and 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.)

Introduction to the literature and information services of science, engineering and management. Effective uses of the Georgia Tech Library.

In-depth, parallel description of the syntax and semantics of FORTRAN and ALGOL; their effective use in the solution of problems.

Introduction to computer organization, machine-language programming, and assembly systems. Internal data structures; selected programming techniques.

Introduction to digital computer systems, computer organization, assembly language programming, and the structuring and processing of information. (No credit for I.C.S. majors.)

Basic concepts of signs relevant to natural and artificial sign processing systems. The representation relation; classification of signs. Analysis of sign systems. Examples and exercises.
I.C.S. 3113. Information Structures and Processes 
3-0-3. Prerequisite: I.C.S. 2400 or I.C.S. 2700.

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. 3116. Philosophy of Grammar 
3-0-3. Prerequisite Ling. 4002.

Study of the philosophical foundations of prominent linguistic theories in history. Emphasis is on Indian, Greek, Latin, medieval, and rationalistic contributions to language theory.

I.C.S. 3146. Introduction to Cybernetics 
3-0-3.

Concepts of system, structure, behavior, modeling, information, communication, self-organization and control are treated with respect to natural and artificial systems.

I.C.S. 3150. Introduction to Mathematical Logic 

Introduction to formal systems for the logical appraisal of inferences, including quantification and identity theory, referential interpretation, first order languages, soundness and completeness.

I.C.S. 3151. Proof Theory 
3-0-3. Prerequisite: I.C.S. 3150.

Introduction to various facets of modern proof theory, including mechanical theorem proving and its application in computer science.

I.C.S. 3342. Introduction to Computational Linguistics 
3-0-3. Prerequisite: I.C.S. 3113, Ling. 4002.

Approaches to natural language processing by computer. Concordance construction; syntactic analysis; question-answering systems; mechanical translation; and computer programs for linguistic research.

I.C.S. 3400. Automatic Data Processing 
2-3-3. Prerequisite: I.C.S. 2400 or I.C.S. 2700.

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. 2400 or I.C.S. 2700.

Contrastive description of the linguistic constructs and implementation characteristics of widely used, representative programming languages such as ALGOL, FORTRAN, COBOL, SNOBOL4, LISP, PL/I and APL.

I.C.S. 3510. Computer-Oriented Numerical Methods 

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: I.C.S. 3113.

Basic hardware and software components of computer systems. Topic include input/output, interrupts, storage devices, elements of operating systems, and microprogramming.

I.C.S. 3601. Computer Systems II 
3-0-3. Prerequisite: I.C.S. 3600, Math. 3215 or equivalent.

Study of hardware and software components of multiprogrammed computer systems including system architecture, virtual memory, segmentation and paging, and parallel processing.

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. 4112. Formal Semantics 
3-0-3. Prerequisite: I.C.S. 3150.

Introduction to the relationship between formal languages and their possible interpretations, the latter being treated as abstract mathematical structures.

I.C.S. 4117. Introduction to Mathematical Linguistics 
3-0-3. Prerequisite: I.C.S. 3150.

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. 1110, Math. 2020, Math. 3215 or equivalent.

Explication of the information concept; its properties; information processes; content analysis and control; 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. 4120.

Perception, cognition, classification; data structures; choice of measurements; classification and clustering techniques; classification schemata in documentation; indexing; evaluation of classification and indexing. Pattern recognition.

I.C.S. 4136. Problem Solving 
3-0-3. Prerequisite: I.C.S. 3150.

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.

I.C.S. 4150. Logistics Systems 
3-0-3. Prerequisite: I.C.S. 3150.

An intermediate-level course dealing with formal systems for the logical appraisal of inferences. Introduction to the logic of programs.

I.C.S. 4153. Computing Languages 
3-0-3. Prerequisite: I.C.S. 3150, I.C.S. 3422.

Introduction to the formal study of programming languages, including languages construction based on Markov algorithms, complex languages features, data structures, embedding and extensibility.

I.C.S. 4156. Theory of Abstract Machines 

Study of fundamental concepts in the formal theory of automata emphasizing finite state machines, Turing machines, and computational power of machines.

I.C.S. 4157. Theory of Computability 
3-0-3. Prerequisite: I.C.S. 3150, I.C.S. 4156.

Introduction to formalizations of the notion of effective computability, with application to logic and automata. Turing computable and recursive functions; Godel's theorems.

I.C.S. 4250. Literature of Science and Engineering 
2-3-3.

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. 2400 or I.C.S. 2700.

Major categories of information systems. Empirical methodology of analysis and design of computer-based systems. Definition of objectives; planning; analysis; design; implementation; evaluation. Case studies.

I.C.S. 4305. Science Information Systems 
3-0-3. Prerequisite: I.C.S. 4300.

Information and communication in science. Design of science data banks, document repositories, information transfer services. Science information control at national and international levels.

I.C.S. 4334. Health Information Processing 
3-0-3. Prerequisite: I.C.S. 4300.

Information processing applications in
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<tr>
<th>Course Code</th>
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<tr>
<td>I.C.S. 4350</td>
<td>Data Management Systems</td>
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<td>3-0-3</td>
<td>Prerequisite: I.C.S. 3422, I.C.S. 3601.</td>
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<td>I.C.S. 4360</td>
<td>Artificial Intelligence and Heuristics</td>
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<td>3-0-3</td>
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<td>I.C.S. 4370</td>
<td>Information Storage and Retrieval</td>
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<td>3-0-3</td>
<td>Prerequisite: I.C.S. 3113, Math. 3215, Ling. 3003.</td>
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<tr>
<td>I.C.S. 4380</td>
<td>Data Communications</td>
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<td>3-0-3</td>
<td>Prerequisite: I.C.S. 3601.</td>
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<tr>
<td>I.C.S. 4390</td>
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<td>Prerequisite: I.C.S. 3113.</td>
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<td>I.C.S. 4410</td>
<td>Introduction to Compilers</td>
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<td>3-0-3</td>
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<td>I.C.S. 4430</td>
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<tr>
<td>I.C.S. 4500</td>
<td>Mathematical Techniques for Information Science</td>
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<td>3-0-3</td>
<td>Prerequisite: Math. 4215</td>
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<td>I.C.S. 4560</td>
<td>Elements of Information Theory</td>
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<td>3-0-3</td>
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<td>I.C.S. 4600</td>
<td>Computer Systems Laboratory</td>
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<tr>
<td>2-12-6</td>
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<tr>
<td>I.C.S. 4610</td>
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<tr>
<td>I.C.S. 4611</td>
<td>Computer Systems</td>
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<tr>
<td>I.C.S. 4800</td>
<td>Selected Topics in Information and Computer Science</td>
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<td>3-0-3</td>
<td>Prerequisite: permission of department.</td>
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<tr>
<td>I.C.S. 4810, 4811, 4812</td>
<td>Design Project I, II, III</td>
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<td>0-6-2</td>
<td>Prerequisite: permission of department.</td>
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<tr>
<td>I.C.S. 4811</td>
<td>Advanced Semiotics</td>
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<td>3-0-3</td>
<td>Prerequisite: I.C.S. 4112.</td>
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<tr>
<td>I.C.S. 4814</td>
<td>Syntax of Natural Languages</td>
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<td>3-0-3</td>
<td>Prerequisite: I.C.S. 4110 or Ling. 4002.</td>
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<tr>
<td>I.C.S. 4815</td>
<td>Information Systems</td>
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<td>3-0-3</td>
<td>Prerequisite: I.C.S. 4145.</td>
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<tr>
<td>I.C.S. 4911</td>
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<td>3-0-3</td>
<td>Prerequisite: I.C.S. 4910.</td>
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<tr>
<td>I.C.S. 6135</td>
<td>Theory of Communication</td>
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<td>Prerequisite: I.C.S. 6130.</td>
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<td>I.C.S. 6140</td>
<td>Systems Theory I</td>
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<td>Prerequisite: Math. 2020.</td>
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<tr>
<td>I.C.S. 6141</td>
<td>Systems Theory II</td>
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<td>Prerequisite: I.C.S. 6140.</td>
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<tr>
<td>I.C.S. 6164</td>
<td>Information Systems Design I</td>
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<td>Prerequisite: I.C.S. 4300.</td>
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<tr>
<td>I.C.S. 6166</td>
<td>Syntax of Natural Languages</td>
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<td>3-0-3</td>
<td>Prerequisite: I.C.S. 4110 or Ling. 4002.</td>
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<tr>
<td>I.C.S. 6171</td>
<td>Mathematical Linguistics</td>
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<tr>
<td>3-0-3</td>
<td>Prerequisite: I.C.S. 6171.</td>
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</tbody>
</table>

Study of the mathematical structure of natural language, primarily from an algebraic viewpoint.

I.C.S. 6130. Philosophy of Mind
3-0-3. Prerequisite: graduate standing.

Higher mental processes including learning, concept formation, problem solving and production, considered in relation to artificial intelligence. Linguistic and physiological models of human information processes.

I.C.S. 6135. Theory of Communication
3-0-3. Prerequisite: I.C.S. 6130.

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


I.C.S. 6141. Systems Theory II
3-0-3. Prerequisite: I.C.S. 6140.

Discrete dynamical processes, recurrence equations, and difference equations. Stability and convergence. Linearity, realizations, controllability and observability, response separation, and transfer functions. Sensitivity, control, and optimization.

I.C.S. 6144, 6145. Information Systems Design I, II
3-0-3 each. Prerequisite: I.C.S. 4300.

Analysis and synthesis of information systems, emphasizing mathematical modeling. Study of selected systems in areas such as data processing, management, command and control systems.

I.C.S. 6146. Cybernetics
3-0-3.

Roles of various functions in living systems and their actual or potential realization in computers.
Courses of Instruction

I.C.S. 6147. Theory of Models
3-0-3. Prerequisite: I.C.S. 6140.

I.C.S. 6152. Theory of Automata
3-0-3. Prerequisite: I.C.S. 4156.
Study of the significant results concerning finite automata, pushdown automata, linear bounded automata, and Turing machines; recognizers of the four Chomsky phrase-structure languages.

I.C.S. 6157. Advanced Logic
3-0-3. Prerequisite: I.C.S. 4157.
Advanced treatment of the theory of recursive functions. Topics include recursively enumerable sets and relations, the recursion theorem, and degrees of unsolvability.

I.C.S. 6210. Communication and Control of Information
3-0-3.
Effects of information control on human activities are analyzed at the individual, group and societal levels. Methodological issues are illustrated in the interpretation of empirical studies.

I.C.S. 6240. Organization and Management of Information Industry
3-0-3. Prerequisite: Mgt. 6160.
Principles of organization, operation and management of the information industry; computing services and centers, software companies, information brokers. Vendor relationship. Functions of government, professional associations.

I.C.S. 6300. Advanced Systems Design
3-0-3. Prerequisite: I.C.S. 4300 or equivalent experience.
Study of techniques useful in the empirical design of information-processing systems, emphasizing quantitative methods of systems analysis, modeling, simulation, synthesis and evaluation.

I.C.S. 6301. Problems in Systems Design
0-6-2. Prerequisite: permission of department.
Advanced practice in the analysis, synthesis, modeling, simulation, or evaluation of information processing systems or their components. Small-group or individual student projects.

I.C.S. 6350. Computer Techniques for Information Storage and Retrieval
2-3-0. Prerequisite: I.C.S. 4350.
Study of the state of the art in data base design. Approaches to data base formalisms and standardization. Term project.

I.C.S. 6360. Artificial Intelligence
3-0-3. Prerequisite: I.C.S. 3515, I.C.S. 4360.
Advanced study of topics from heuristic search, automatic theorem proving, semantic information processing, representation theory, and robot research.

I.C.S. 6363. Pattern Recognition
3-0-3. Prerequisite: Math. 3215 or equivalent.
Selected topics from statistical pattern recognition. Examination of the problems of extracting useful information from pictures by automatic means.

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, abstracting, and classification; evaluation and performance.

I.C.S. 6410. Computer Language Design
3-0-3. Prerequisite: I.C.S. 3601.
Detailed study of the basic techniques of compiler implementation. Information: lexical scan, translation to intermediate language, object code generation and optimization.

I.C.S. 6412. Syntax Directed Compilation
3-0-3. Prerequisite: I.C.S. 6410.
Techniques for automating compiler construction, given appropriate descriptions of the syntax and the desired object code for the language being compiled.

I.C.S. 6430. Computer Operating Systems
3-0-3. Prerequisite: I.C.S. 3601.
Comprehensive study of the structure and implementation of computer operating systems for a spectrum varying from mini-computers to large timesharing systems.

I.C.S. 6431. Design of Computer Operating Systems
1-6-3. Prerequisite: I.C.S. 6430 or permission of department.
Laboratory project in operating system design. Typically, students design, test and merge independent modules to form the nucleus of an operating system.

I.C.S. 6530. Graph Theory
3-0-3.
Algorithmic combinatorics, including topics in permutations, combinations, enumeration, graphs and trees, with applications in information, computer and systems science.

I.C.S. 6620. Advanced Computer Organization
3-0-3. Prerequisite: I.C.S. 4610.
Study of formal transition from a given algorithm to the corresponding hardware structure, its timing, control, and optimization.

I.C.S. 6621. Equipment of Information Systems
1-3-3. Prerequisite or corequisite: I.C.S. 6620.
Laboratory component of the professional graduate programs principally related to I.C.S. 6620 and emphasizing the hardware/software interface at the logic level of digital computers.

I.C.S. 7000. Master's Thesis
Credit to be arranged: Prerequisite: permission of department.

I.C.S. 7115. Philosophy of Language
3-0-3. Prerequisite: I.C.S. 6160.
Study of selected topics in linguistics arising from philosophic discussion of language. Emphasis on contributions of Russell, Carnap, Quine, and Stevens to modern linguistic thought.

I.C.S. 7120, 7130. Information Processes I, II
3-0-3 each: Prerequisite: permission of department.
Advanced seminars in the theory and formalization of complex semiotic processes (e.g., classification, communication, problem solving, decision making), treated from the viewpoint of artificial intelligence.

I.C.S. 7145. Information Systems Optimization
3-0-3. Prerequisite: I.C.S. 6145.
Study of structures and behavior patterns which optimize information systems performance relative to selected efficiency criteria. Applications of queueing theory, network theory, and mathematical programming.

I.C.S. 7430. Evaluation of Computer Systems
2-3-3. Prerequisite: I.C.S. 6430, Math. 3215.
Methods of evaluating performance of large-scale computer systems, with emphasis on performance analysis through simulation and queuing models.

I.C.S. 8001, 8002, 8003. Seminar
1-0-0 each: Prerequisite: permission of department.

I.C.S. 8501, 8502, 8503. Special Problems
Credit to be arranged: Prerequisite: permission of department.
Small-group or individual investigation of advanced topics in information, computer, and systems science. Guided study and research.

Credit to be arranged: Prerequisite: permission of department.
Credit to be arranged. Prerequisite: permission of department.

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.
Inequalities; absolute values; conic sections; functions, continuity and limits;
derivatives of rational and trigonometric functions; mean value theorem; intro­duction to antiderivatives; applications of derivatives.
Text: At the level of Wilcox, Buck, Jacob,
Bailey, Introduction to Calculus 1 and 2.

Math. 1317, 1318, 1319. Honors
Calculus I, II, III
5-0-5. Prerequisite: invitation of School of Mathematics.
The topics covered parallel those of Math. 1307, 1308, 1309, with a treatment
somewhat more intensive and rigorous.
Text: At the level of Wilcox, Buck, Jacob,
Bailey, Introduction to Calculus 1 and 2.

Math. 1700. Developmental Algebra
5-0-0.
A non-credit course for students who
are not prepared to take Math. 1701 or
Math. 1710.

Math. 1701. College Algebra
5-0-5. Prerequisite: Entrance algebra.
The real number system, the concept
of function, theory of equations, systems
of equations, permutations, combi­nations, the binomial theorem, sequences,
mathematical induction, progressions.

Math. 1702. Trigonometry
5-0-5. Prerequisite: Math. 1701.
Exponential and logarithmic functions,
trigonometric functions, complex
numbers, inverse functions, trigonometric equations.

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 Johnson, Lendsey,
Slesnick, Bates, Algebra and Elementary
Functions.

Math. 1721. Calculus for
Management I
5-0-5. Prerequisite: Math. 1710.
Background for calculus; the limit concept;
the derivative; techniques and applications of the derivative.
Text: At the level of Ceder and Outcalt, A
Short Course in Calculus.

Math. 1722. Calculus for Man­agement II
5-0-5. Prerequisite: Math. 1721 or Math.
1307.
The definite integral; calculus of
trigonometric functions; the partial
derivative functions.
Text: At the level of Ceder and Outcalt, A
Short Course in Calculus.

Math. 2010. Finite Mathematics
5-0-5. Prerequisite: Math. 1721 or 1307.
Elements of logic, set theory, probability, and linear algebra, with an
introduction to convex sets and linear
programming.
Text: At the level of Lipschutz, Theory
and Problems of Finite Mathematics.

Math. 2020. Introduction to Set-Theoretic Concepts
3-0-3. Prerequisite: Math. 1308.
Algebra of sets; cartesian products, relations, equivalence relations; func­tions, sequences, mathematical induc­tion; equipotence of sets; partially
ordered sets.
Text: At the level of Ramanujan and
Thomas, Intermediate Analysis.

Math. 2205. Elementary Statistical
Analysis I
3-0-3. Prerequisite: entrance algebra.
Probability in finite sample spaces; inde­pendent trials, random variables and
moments, random sampling; statistical
estimation and hypothesis testing;
distribution-free tests of association.
Text: At the level of Kurtz, Basic
Statistics.

Math. 2206. Elementary Statistical
Analysis II
3-0-3. Prerequisite: Math. 2205; Math.
1308 or concurrently.
Random variables with continuous
distributions; normal distribution and
central limit theorem; statistical inference
for normal populations; distribution-free
methods; elementary regression and
correlation.
Text: At the level of Kurtz, Basic
Statistics.

Math. 2307. Calculus IV
5-0-5. Prerequisite: Math. 1309.
Linear algebra; vectors in n-space;
vector functions and their derivatives.

Math. 2308. Calculus V
5-0-5. Prerequisite: Math. 2307.
Partial differentiation; multiple inte­grals; vector analysis; line integrals.
Text: At the level of Flanigan and Kazdan,
Calculus Two.

Math. 2309. Differential Equations
5-0-5. Prerequisite: Math. 2308.
Linear differential equations, and
applications in the engineering and the
natural sciences; systems of linear
differential equations; series solutions;
simple nonlinear equations.
Text: At the level of Spiegel, Applied
Differential Equations.

Math. 2317, 2318. Honors Calculus
IV, V
5-0-5.
A continuation of Math. 1317, 1318,
1319. The coverage parallels that of
Math. 2307-2308.

Math. 3110. Introduction to Higher
Algebra
3-0-3. Prerequisite: Math. 2307.
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.

Math. 3215. Problems in Probability
and Statistics
5-0-5. Prerequisite: Math. 1309 or consent of department.
Basic concepts of probability as in
Math. 4215; introduction to statistical
inference; a problem-oriented course in­volving mathematical models in various
areas of application.
Text: At the level of Meyer, Introductory
Probability and Statistical Applications.

Math. 3308. Differential Equations
5-0-5. Prerequisite: Math. 2308.
Differential equations with linear
algebra; matrix treatment of linear
systems; characteristic roots, expo­nential matrix function; series method
solving equations of Bessel and Legendre.
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. 4038. Mathematical Logic
3-0-3. Prerequisite: Math. 2308 or consent of department.
The propositional and predicate calculi, developed as formal systems of symbol manipulation, with attention to the related decision problems, recursive functions and automata.
Text: At the level of Stoll, Introduction to Set Theory and Logic.

Math. 4110. Introduction to Linear Algebra
3-2-4. Prerequisite: Math. 3110.
Vector spaces; linear transformations; decomposition of spaces; various canonical forms; algebras; inner product spaces.
Text: At the level of Halmos, Finite Dimensional Vector Spaces.

Math. 4120. Introduction to Modern Algebra
3-2-4. Prerequisite: Math. 3110 or consent of department.
Basic properties of sets, relations, and maps; elementary theory of groups, including homomorphisms, quotient groups, direct products; elementary theory of rings, integral domains, fields.
Text: At the level of Ames, An Introduction to Abstract Algebra.

Math. 4130. Rings and Modules
3-0-3. Prerequisite: Math. 4120.
Embeddings, polynomial rings, principal ideal domains; unique factorization; introduction to modules, direct sums, free modules, modules over a principal ideal domain; applications.
Text: To be selected.

Math. 4140. Theory of Groups
3-0-3. Prerequisite: Math. 3110.
An introductory course in group theory suitable for students of mathematics, chemistry, and physics.
Text: At the level of Barnes, Introduction to Abstract Algebra.

Math. 4215. Introduction to Probability
3-0-3. Prerequisite: Math. 2308 or concurrently.
Introduction to probability theory with applications; discrete and non-discrete distributions; moments; laws of large numbers; central limit theorem with applications.
Text: At the level of Hoel, Port, and Stone, Introduction to Probability Theory.

Math. 4221. Probability with Applications
3-0-3. Prerequisite: Math. 3215 or 4215.
Continuation of probability theory from Math. 4215 (3215); random walks, probability generating functions, Markov chain processes, central limit theorem.
Text: At the level of Hoel, Port, and Stone, Introduction to Probability Theory and Introduction to Stochastic Processes.

Math. 4222. Probability with Applications
3-0-3. Prerequisite: Math. 4221, Math. 3110 or concurrently.
Continuation of Math. 4221. Topics in probability, including random walks and diffusion, branching processes, and stochastic processes with continuous time parameter.
Text: At the level of Hoel, Port, and Stone, Introduction to Stochastic Processes.

Math. 4241. Mathematical Statistics
3-0-3. Prerequisite: Math. 2308, Math. 3215 or 4215.
Introduction to the theory of statistical estimation and hypothesis testing. Exact and asymptotic sampling distributions with applications. Brief treatment of Bayesian inference.
Text: At the level of Hoel, Port, and Stone, Introduction to Statistical Theory.

Math. 4242. Mathematical Statistics
3-0-3. Prerequisite: Math. 4241.
Regression theory, analysis of variance, design of experiments, distribution-free methods of inference.
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.
A mathematical approach to information theory, primarily through probability in finite sample spaces. Coding theorem for discrete memoryless channels. Decision schemes; Shannon's theorem.
Text: At the level of Ash, Information Theory.

Math. 4281. Elementary Decision Theory
3-0-3. Prerequisite: Math. 4241.
Mathematical approach to decision theory; Bayesian and minimax strategies in response to statistical uncertainty; applications to mathematical statistics.
Text: At the level of Ferguson, Mathematical Statistics: A Decision Theoretic Approach.

Math. 4282. Introduction to Stochastic Processes
3-0-3. Prerequisite: Math. 4222.
Probabilistic description of continuous parameter stochastic processes, especially Markov, stationary and weakly stationary; normal processes; spectral analysis of time series, and ergodic theory.

Math. 4283. Introduction to Game Theory
3-0-3. Prerequisite: One of Math. 2301, 2306, 3215, or Math. 4312; 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.

Math. 4308. Ordinary Differential Equations
4-0-4. Prerequisite: Math. 2309 or 3308; Math. 3110, Math. 4311 or 4391.
Systems of differential equations; linear systems and phase space 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; differentiation and Riemann integration.
Text: At the level of Rossi, Advanced Calculus.

Math. 4312. Introduction to Analysis II
3-2-4. Prerequisite: Math. 4311.
Series of functions, uniform convergence; differentiation of functions from R^n to R^m; inverse and implicit function theorems; Lagrange multipliers; curves in R^n.
Text: At the level of Rossi, Advanced Calculus, and Spivak, Calculus on Manifolds.

Math. 4313. Introduction to Analysis III
3-2-4. Prerequisite: Math. 4312; Math. 4110 or concurrently.
Riemann multiple integrals; improper integrals; line and surface integrals; divergence theorem and theorem of Stokes; introduction to differential forms, change of variables in integrals.
Text: At the level of Rossi, Advanced Calculus, and Spivak, Calculus on Manifolds.

Math. 4321. Advanced Engineering Mathematics
3-0-3. Prerequisite: Math. 2309 or 3308.
Topics from complex function theory, including contour integration and conformal mapping.
Text: At the level of Levinson and Redheffer, Complex Variables.

Math. 4347. Introduction to Partial Differential Equations
3-0-3. Prerequisite: Math. 2309 or 3308.
Second-order linear differential
equations, including the wave equation; properties of parabolic and elliptic equations; the method of separation of variables; Fourier series; Green's function.

Text: At the level of Weinberger, *A First Course in Partial Differential Equations*.

Math. 4348. 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.

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 from Advanced Calculus I

3-0-3. Prerequisite: Math. 2308.

Partial differentiation; applications of partial differentiation; limits and indeterminate forms; infinite series; improper integrals; uniform convergence.


Math. 4392. Topics from 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.


Math. 4343. Introductory Topology

3-0-3. Prerequisite: Math. 4311 or consent of department.

This course provides background for use of topological methods in analysis; metric spaces; continuous transformation; nonplanar spaces.

Text: At the level of Kasriel, *Undergraduate Topology*.

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 topics related to them.

Text: To be selected.

Math. 4580. Linear Programming

3-0-3. Prerequisite: Math. 2308 or concurrently.

Mathematical structure of the linear programming problem. Requisite 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; gradient, divergence, curl; theorems of Green, Gauss, and Stokes; curvilinear coordinate systems; introduction to tensors.

Text: At the level of Davis, *Introduction to Vector Analysis*.


3-0-3. Prerequisite: Math. 2308.

An elementary tensorial treatment of various geometric 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 spaces; mathematical properties of the objective function will be examined and appropriate algorithms developed.

Text: At the level of Cooper and Steinberg, *Introduction to Methods of Optimization*.


3-0-3. Prerequisite: Math. 2308.

Organization and characteristics of digital computers; development of algorithms for elementary numerical methods; natural language and problem oriented language programming.

Text: To be selected.

Math. 4626. Computer Programming and Coding

3-0-3. Prerequisite: Math. 4625, 4643, Math. 4644 or concurrently or consent of department.

Application of the digital computing equipment currently available at the Rich Electronic Computer Center to implement and investigate methods studied in numerical analysis.

Text: To be selected.

Math. 4643. Numerical Analysis I

3-0-3. Prerequisite: Math. 2308.

Numerical solutions of linear and nonlinear equations; interpolation and approximation of functions; finite difference calculus.

Text: At the level of Conte and de Boor, *Elementary Numerical Analysis*, 2nd Ed.

Math. 4644. Numerical Analysis II

3-0-3. Prerequisite: Math. 2309 or 3308; Math. 4643 or consent of department.

Numerical differentiation, numerical integration, difference equations; numerical solution of ordinary differential equations.

Text: At the level of Conte and de Boor, *Elementary Numerical Analysis*, 2nd Ed.

Math. 4645. Numerical Analysis III

3-0-3. Prerequisite: Math. 4644 or consent of department.

Numerical approximation of solutions of integral equations and partial differential equations; eigenvalue problems; selected topics of current interest.


Math. 4790. Intensive Review of the Elementary Calculus

10-6-9 (audit basis only) Prerequisite: consent of School of Mathematics and student's academic work for considerable time.

Text: At the level of Protter and Morrey, *College Calculus with Analytic Geometry*.

Math. 4800. Special Topics

3-0-3. Prerequisite: consent of department.

This course enables the School of Mathematics to comply with requests for courses in special topics. Given upon sufficient demand.

Math. 4999. Reading or Research

1 to 3 credits. Prerequisite: junior standing or above, consent of department. Pass/fail basis only. Not more than 7 hours can be counted toward bachelor's degree. At most 3 hours can be counted as mathematics elective.

Math. 6121. Modern Abstract Algebra I

3-0-3. Prerequisite: Math. 4120.

An introduction to algebraic systems with emphasis on group theory.

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*. 
Concept of the total matrix algebra. Introduction to linear associative algebras.
Text: At the level of Lang, Algebra.

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.


Math. 6311-6312-6313. Functions of a Real Variable I, II, and III 3-0-3. Prerequisite: Math. 4312 or consent of department.
Applications in functional analysis. Text: At the level of Royden, Real Analysis, 2nd edition.

Point sets, continuity and differentiability, Cauchy-Reimann differential equations, integral of a continuous function, Cauchy's integral theorem and formula, series with variable terms, expression of analytic functions in power series, analytic continuation, conformal mapping, contour integration. Text: At the level of Deppere and Oehring, Elements of Complex Analysis.

Banach and Hilbert spaces, projections on convex sets, Riesz's representation theorem, Hahn-Banach theorems, duality, open mapping and closed graph theorems, uniform boundedness principle. Text: At the level of Schechter, Principles of Functional Analysis.

Compact operators, unbounded Fredholm operators, closed range theorem. Spectral theory and operational methods, integral transforms. Elements of Complex Analysis. Text: At the level of Wiensky, Topology for Analysis.


Classification of partial differential equations, canonical forms, wellposed problems, wave equation in R^n. Huygen's principle, potential equation, heat equation, strong maximum principle, fundamental solutions. Text: At the level of Stakgold, Boundary Value Problems of Mathematical Physics.

Existence theory for elliptic equations, single and double layer potentials, Schwarz's integral formula, subharmonic functions, weak solutions in a Sobolev space, regularity of weak solutions. Text: At the level of Sagan, Boundary Value Problems of Elliptic Equations.

Bases and subbases; filters, nets, and convergence concepts; continuous functions; separation axioms; connectedness; separability; 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 Milner, Topology for Analysis.

Introduction to homological algebra. Cech and singular homology and cohomology theories. Applications to fixed points of maps, invariance of domain, etc. homotopy, the fundamental group, covering spaces. Text: At the level of Spanier, Algebraic Topology.

A variety of mathematical methods including Green's function, Stewart-Liouville problems, linear integral equations, calculus of variations. Text: At the level of Stakgold, Boundary Value Problems of Mathematical Physics.

Math. 6511. Mathematical Methods of Applied Science I 5-0-5. Prerequisites: Math 2309 and 3110 or consent of department.
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.


Math. 6513. Mathematical Methods of Applied Science III 5-0-5. Prerequisite: Math 6512 or consent of department.
Approximate methods, nonlinear problems, variational techniques.

Math. 6581. Calculus of Variations 3-0-3. Prerequisites: Math. 2309 or 3308; 3110 and 4391; or consent of department.
The calculus of variations, vibration and eigenvalue problems, Sturm-Liouville Theory. Text: At the level of Sagan, Introduction to Calculus of Variations and Control Theory.

Math. 6582. Integral Transforms 3-0-3. Prerequisites: Math. 4582, 4321, 4391; or consent of department.
Selected topics from classical transform theory including Fourier, Laplace, Mellin and Hankel transforms, with applications to boundary-value problems. Text: At the level of Sneddon, Fourier Transforms.

Math. 6583. Integral Equations 3-0-3. Prerequisites: Math. 2309 or 3308; and 3110, 4391; or consent of department.
Linear integral equations and corresponding topics in linear algebra.
Text: At the level of Tricomi, *Integral Equations*. Math. 6584. Special Functions of Higher Mathematics 3-0-3. Prerequisites: Math. 4321 and 4391; or consent of department.

Selected functions of particular interest in relation to problems occurring in the physical sciences will be discussed.
Text: At the level of Lebedev, *Special Functions and their Applications*. Math. 6586. Tensor Analysis 3-0-3. Prerequisites: Math. 3110, 4583, 4391; or consent of department.

Tensor algebra, covariant differentiation, Cartesian tensors, curvilinear coordinates, introduction to differential forms.
Math. 6587. Field Theory with Applications 3-0-3. Prerequisites: Math. 4582 and 4391; or consent of department.

Solution of field equations of mathematical physics by Fourier's method in curvilinear coordinate systems. Applications with particular attention to advantageous choice of coordinates.
Math. 7000. Master's Thesis


Courses directed toward research in algebra. Areas of current research interests include homological algebra, finite groups, semi-groups, loop theory.

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 theory, limit laws of probability, statistical decision theory, theories of estimation and hypothesis testing, etc.


Courses directed toward research in differential equations, the content varying from year to year. Representative topics include singular boundary-value problems, asymptotic solutions of differential equations, differential equations containing a large parameter, Poincare-Liapounov stability theory, and differential equations in the large.

Math. 7311-7312-7313. Advanced Topics in Real Analysis 3-0-3. Prerequisites: Math. 6311, 6312, 6313 and consent of department.

Courses directed toward research in real analysis and related areas, the topics varying from year to year. Topics will be selected from such areas as Hilbert space theory, theory of distributions, abstract harmonic analysis, ergodic theory, Denjoy and Perron integrals.

Courses directed toward research in complex variables. Representative topics include topics from functions of several complex variables, conformal mapping.


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.


Courses extending and deepening the work of Math. 6501-6502-6503. Topics in a particular year may include some or all of the following: variational techniques, asymptotic methods, differential operators of mathematical physics, Fourier transforms, nonlinear and singular integral equations.


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 functions, problems of stability and convergence of difference methods, optimum seeking methods, etc.

Math. 8001-8002-8003. Seminar 1-0-0.

Math. 8100. Special Topics 3-0-3. Prerequisites: consent of department.

The purpose here is to enable the School of Mathematics to comply with requests for courses in selected topics.
Math. 8504-8505-8506. Special Problems Credit to be arranged.


MECHANICAL ENGINEERING


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.


Basic concepts for creative decisions in engineering problem solving and design. Exposure to practicing engineers, their industries and their problems and accomplishments -- with field trips. The course E.Gr. 1171. is the alternative offering to M.E. 1110, and both carry freely transferable credit within the Engineering College.

M.E. 2212. Materials Science 3-0-3. Prerequisites: Math. 2309 or concurrently, Physics 2123 or concurrently.

Mechanical behavior, elastic and plastic properties, annealing of cold-worked materials leading from atomic concepts; crystallography and relation of crystal defects to properties.


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.

M.E. 3055. Experimental Methodology 1-3-2. Prerequisites: Math. 2309 and M.E. 3322.

Presentation of experimental methodology; basic instrumentation used in mechanical engineering and its calibration and use; accuracy, error and uncertainty in experimental measurements; engineering report writing.

M.E. 3113. Mechanisms; Analysis and Synthesis 3-0-3. Prerequisite: ESM 3201.

Analysis and synthesis of the motion of linkages, cams and gears by graphical and analytical methods.
Text: At the level of Shigley, *Kinematic Analysis of Mechanisms*.

M.E. 3114. Dynamics of Machinery 3-0-3. Prerequisites: M.E. 3113 and Math. 2309.

Mechanism analysis with emphasis on inertia forces and balancing of rotating and reciprocating systems. Vibrations of linear systems. Text: At the level of Phelan, *Dynamics of Machinery*.

An elementary treatment of 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 physical properties of metallic and non-metallic materials related to behavior under service conditions. Phase equilibria, microstructure, steels, heat treatment, annealing, fracture, fatigue, creep.

M.E. 3322. Thermodynamics 3-0-3. Prerequisite: Physics 2123 or concurrently, Math. 2308 or concurrently.
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. 3342. Transport Phenomena I 3-0-3. Prerequisite: M.E. 3342.
Introduction to one-dimensional heat, momentum, and mass transport, developing rate equations and applying conservation principles; fundamentals of steady and transient heat conduction, including two and three dimensions; sources and extended surfaces; electrical analogies; practical applications.

Basic conservation concepts in integral form for real fluids, fluid properties and flow characteristics, fluid statics, ideal flows, Euler Bernoulli and Navier Stokes equations; practical examples.

M.E. 3344. Transport Phenomena III 3-3-4. Prerequisite: M.E. 3343; concurrently M.E. 3324 and M.E. 3055.
Compressible and incompressible flows, ducted flows, nozzles and shock waves, Radiative transport. Applications.

M.E. 3720. Thermodynamics 4-0-4. Prerequisite: Physics 2123 or concurrently, Math. 2308 or concurrently.
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 and M.E. 3727. Thermodynamics 4-0-4, 3-0-3. Prerequisite: Physics 2123 or concurrently, Math. 2309 or concurrently.
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: Physics 2113 or 2123.

M.E. 3735. Environmental Technology in Architecture II 2-3-3. Prerequisite: M.E. 3734.

M.E. 3753. Materials Laboratory 0-3-1. Prerequisite: E.S.M. 3301 or concurrently.
Basic test methods of determining and evaluating phenomenological properties of engineering materials. Stress analysis instrumentation is introduced. Text: Course notes.

M.E. 4023. 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 fields in large and small rooms, noise legislation.

M.E. 4024. Engineering Acoustics and Noise Control II 3-0-3. Prerequisite: M.E. 4023 or equivalent.
Continuation of M.E. 4023 emphasizing techniques for the solution of noise problems. Vibration isolation, energy absorption, dissipative and reactive mufflers enclosures, barriers, properties of materials, panel damping.

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. (Winter quarter only)
Civic and professional responsibilities and opportunities are brought to students by leaders in engineering, business and community affairs.

M.E. 4181. Design of Machine Elements 3-3-4. Prerequisite: E.S.M. 3301 and M.E. 3212.
Methodology and practice in designing machine components by means of integrating the general principles and empirical solids of mechanics, materials, metal fatigue, and other disciplines.

M.E. 4183. Design Theory 3-0-3. Prerequisite: M.E. 4181 or concurrently.
The design process including the topics of creativity, probability, the use of statistical methods, reliability theory, decision theory, optimization and the patient system.

M.E. 4184. Design Engineering 0-6-2. Prerequisite: final quarter standing.
The design process is applied to real multidisciplinary 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 and Math. 2309.
Continuation of M.E. 3114 with emphasis on the analysis of complex machines. Instrumentation and analog computer simulation of mechanisms.

M.E. 4186. Biomechanical Design 3-3-4. Prerequisite: M.E. 4445 or equivalent.
Design 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 3-3-3. Prerequisite: M.E. 3113 or equivalent. The design of mechanisms to generate specified point paths or analytical functions. Graphical and analytical design methods are shown. Text: At the level of Hartenberg and Denavit, The Kinematic Synthesis of Mechanisms.

M.E. 4188. Cams and Gears 3-4-4. Prerequisite: M.E. 3113 or equivalent. Selection and design of gears. Spur, bevel, helical and worm gearing are treated. Cam design with applications including high speed systems.

M.E. 4203. Material Removal Principles 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. 4212. Material Processes 3-3-4. Prerequisite: M.E. 3212. Fundamentals of various techniques for solidification, working and shaping materials. Machining, casting, joining and metal forming are major topics. Laboratory practice supplements classroom treatment.


M.E. 4263. Mechanical Testing of Materials 3-3-4. Prerequisite: Met. 3301 or M.E. 3212, or consent of school. Destructive and non-destructive test methods for metallic and non-metallic materials. Emphasis on the significance of results and the choice of materials based on test data.


M.E. 4316. Thermal Systems Design I 3-0-3. Prerequisite: M.E. 3324 and M.E. 4344, or concurrently. 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 II 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.


Text: At the level of Skrotzki and Vopat: Power Station Engineering and Economics

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 systems. Design of impellers and casings for various types of compressors, turbines, and pumps.


M.E. 4328. Elements of Rocket Systems 3-0-3. Prerequisite: M.E. 4344 or concurrently. 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: M.E. 4344 or concurrently. Fundamentals of one-dimensional steady and unsteady compressible flows. Isentropic flows, flows with friction and heat transfer and with shocks are examined.


M.E. 4339. Gas Turbines 3-0-3. Prerequisite: M.E. 3324 and M.E. 3344. Applications of gas turbines including limitations and advantages as compared with other prime movers. Design of compressor, combustor, and turbine components.


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. 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 magnetohydrodynamics; MHD waves; channel flow; application to electric arcs, MHD energy conversion and fusion.


M.E. 4448. Fluidics 3-3-4. Prerequisite: M.E. 3344 and M.E. 4445 or equivalent. Analysis and design of analog and digital fluidic devices and systems. Line
M.E. 4449. Numerical Control of Machine Tools
3-0-3. Prerequisite: M.E. 4445 or concurrently.
Study of design and operation of typical digital control systems for machine tools, including the flow of signals through the system.

M.E. 4714. Heat Transfer
3-0-3. Prerequisite: M.E. 3720 and M.E. 3016, or equivalent.
Transport processes; concepts of conduction, convection and radiation. Boundary layer analysis in convective heat transfer, hydrodynamic stability and automatic control.

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 these devices for power generation; environmental effects; cost factors.
Text: At the level of Angrist, *Direct Energy Conversion*.

M.E. 4801-4805. Special Topics, Mechanical Engineering 1-0-0 to 5-0-5 respectively.
Special topic offerings of current interest and not included in regular courses.

M.E. 4901-4912. 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
3-3-4. Prerequisite: M.E. 3055 or equivalent, or graduate standing.
Methods and techniques of modern instrumentation in engineering research.

M.E. 6024-6025. Variational Methods in Engineering
3-0-3. Prerequisite: M.E. 4344 and E.S.M. 3302, or equivalent.
Variational methods applied to the optimization of engineering systems; the formulation and approximate solution of differential equations with application to nonlinear vibration, fluid mechanics, heat transfer, hydrodynamic stability, and automatic control.

M.E. 6027. High Vacuum Science and Technology
3-0-3. Prerequisite: M.E. 6323 or consent of school.
Gas kinetics in the free molecular flow region and the design of pumping systems. Material selection, sorption of gases and total and partial pressure measurement.

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.

M.E. 6122. Machine Vibration
3-0-3. Prerequisite: consent of school.
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.
A continuation of M.E. 4187. Advanced topics in mechanism theory, finite displacement of a plane: Burmester theory. Current developments in kinematical and analytical design methods.
Text: At the level of Hartenberg and Denavit, *The Kinematic Synthesis of Mechanisms*.

M.E. 6126. Mechanism Synthesis II; Computer Methods
2-3-3. Prerequisite: M.E. 6125.

M.E. 6127. Spatial Mechanisms
3-0-3. Prerequisite: M.E. 6125.
The analysis and synthesis of three-dimensional linkages in general. Extension of the Gruber theory, number theory, special mechanisms.

M.E. 6133. Elastic Yield Designs of Machine Members
3-0-3. Prerequisite: consent of school.
The methods of strain-energy, virtual work, area-moment, and Castiglione's theorem are applied to the design of machine members against excessive deformation.

M.E. 6170. Engineering Design
3-0-5. Prerequisite: consent of school.
Design concepts, life design, fatigue and failure, thermal stress, and the elements of optimum design are studied.

M.E. 6221. Deformation of Metals
3-0-3. Prerequisite: M.E. 4212.
Advanced study of atomic structure and imperfections in crystalline solids. Topics include plastic deformation, strain hardening, annealing processes, creep, fatigue, and ductile and brittle fracture.

M.E. 6239. Materials for Design
3-0-3. Prerequisite: M.E. 4212.
Properties, behavior and selection of materials for practical design applications. Topics include effects of elastic and plastic deformation, brittle fracture, fatigue, creep, and corrosion.

M.E. 6272-6273. Fabrication of Metals
3-0-3. Prerequisite: M.E. 6221.
Fabrication processes of metals including forging, rolling, extrusion, drawing, deep drawing, and pressing. Frictional phenomena, slip line fields, upper bound forces, material properties and characteristics.

M.E. 6276. Low Temperature Design
3-0-3. Prerequisite: undergraduate materials.
Advanced design studies as affected by material properties unique to low temperatures. Cryogenic, arctic, stratospheric and outer space environments considered from theoretical and practical standpoints.

M.E. 6277-6278. Elevated Temperature Design
3-0-3. Prerequisite: undergraduate materials.
Materials for design at elevated temperatures. Emphasis on advanced treatment of creep, thermal shock, thermal stress, fatigue, fracture, strength and ductility, resistance to hostile environments. Practical applications.

M.E. 6322. Thermodynamics I
3-0-3. Prerequisite: undergraduate thermodynamics.
Thorough study of the principles and macroscopic formalism of thermodynamics. Thermodynamic systems, pure substances, multi-phase mixtures, reactive systems.

M.E. 6323. Thermodynamics II
3-0-3. Prerequisite: M.E. 6323 or consent of school.
Thermodynamic calculation of properties of ideal gases, real gases, solids and gas mixtures. Kinetic theory and transport properties. Thermodynamics of special systems.

M.E. 6324. Thermodynamics III
3-0-3. Prerequisite: M.E. 6323 or equivalent.
Statistical thermodynamic calculation of properties of ideal gases, real gases, solids and gas mixtures. Kinetic theory and transport properties. Thermodynamics of special systems.

M.E. 6325. Information Theory
2-3-3. Prerequisite: M.E. 6323 or consent of school.
A derivation from information theory of the fundamentals of thermodynamics.
M.E. 6330. Heat Transfer I
3-0-3. Prerequisite: M.E. 3343 or consent of school.

Conduction — steady state and transient, one and multi-dimensional geometries. Emphasis on analytical methods — exact and approximate, on numerical and graphical techniques.

M.E. 6332. Heat Transfer II
3-0-3. Prerequisite: M.E. 6330 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: M.E. 6332 or consent of school.

Radiation — radiodynamics, radiative transfer phenomena, black body radiation, surface characteristic. Exchange in enclosures, radiation through continua, experimental methods.

M.E. 6335. Advanced Theory of Heat Transfer
3-0-3. Prerequisite: M.E. 6332 or consent of school.

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, ablation.

M.E. 6341. 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. 6342. Fluid Flow II
3-0-3. Prerequisite: M.E. 6341 or consent of school.

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. 6349. Theory of Jets
3-0-3. Prerequisite: M.E. 6343 and M.E. 6434 or equivalent.

Laminar and turbulent jet flows in free and confined spaces.

M.E. 6351. Direct Energy Conversion
3-0-3. Prerequisite: M.E. 3720 or equivalent.

Analysis of performance characteristics, based on thermodynamics and fluid flow principles, of direct energy conversion devices such as thermionic, thermoelectrics, photovoltaic, magnetohydrodynamic, electrohydraulic, diesel, and fuel cells.

Text: At the level of Kettani, Direct Energy Conversion.

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. Review of relevant physical phenomena: Spectroscopic, interferometric, laser, and probe techniques. Treatment includes latest techniques and procedures.

M.E. 6355. Combustion I
3-0-3. Prerequisite: M.E. 6342 or equivalent.

A study of the performance characteristics and the mathematical modeling of control system components, including transient and frequency response tests, is conducted.

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. 6363. Internal Combustion Engine Design
3-0-3. Prerequisite: M.E. 4320 or equivalent.

Fuel systems, geometrical considerations, air supply, fuel injection, manifold. Heat transfer, cycle analysis.

M.E. 6368. Lubrication Systems
3-0-3. Prerequisite: M.E. 6383 or 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: M.E. 4445 or M.E. 6424 or equivalent.

Digital control. Linear systems, integration of classical (root locus, frequency response) and modern (state feedback, observers) techniques. Mechanical, thermal, fluid, chemical and nuclear examples.

M.E. 6426. Feedback Control Systems II
3-0-3. Prerequisite: M.E. 4445 or M.E. 6424 or equivalent.

Discrete time and non-linear systems. Sampled data and digital control. Phase plane, describing functions and Lyapunov methods.

M.E. 6437-6438. Digital Control Systems I and II
3-0-3.3-3-4. Prerequisite: M.E. 6437 or consent of school (M.E. 6437 is prerequisite for M.E. 6438).

A study of the basic theory and techniques employed in the design of control systems for numerically- controlled machine tools and digital computers is conducted.

M.E. 6439. Control System Components
2-1-3. Prerequisite: M.E. 4445 or equivalent.

A study of the performance characteristics and the mathematical modeling of control system components, including transient and frequency response tests, is conducted.
M.E. 6440. Fluid-Power Control Systems 3-0-3. Prerequisite: M.E. 445 or equivalent.
Analysis and synthesis of control systems using liquids and gases. Dynamic characteristics and specifications of control system components; closed-loop fluid-power control systems.

M.E. 6471. Control of Engineering Processes 3-0-3. Prerequisite: M.E. 6424 or equivalent.
Large-scale computer solutions and simulation. Distributed parameter system modeling and analysis. Current interest topics of practical significance not in M.E. 6424-6-6.

M.E. 6750. Systems Design Methodology 2-3-3. 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. (Cross listed with A.E., E.E., C.E., C.P., ISyE)

M.E. 6751-6752. Complex Systems Design 2-4-3. Prerequisite: graduate standing of any school at Georgia Tech or undergraduate 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 non-university resource persons and faculty. Grades based on oral and written reports. (Cross listed with A.E., E.E., C.E., C.P., ISyE)


Methods of noise reduction and control applied to systems in industry. Measurement of sound power, material acoustic properties, barriers, enclosures, mufflers, vibration reduction and damping methods.

M.E. 6999. M.S. Thesis Topic Selection Non-credit. Prerequisite: consent of school.

M.E. 7000. Master's Thesis


M.E. 7122. Advanced Machine Vibrations 3-0-3. Prerequisite: M.E. 6122, or consent of school.

M.E. 7136. Design of Resilient Machine Members 3-0-3. Prerequisite: M.E. 6122, or equivalent.

M.E. 7140. Decision Theory for Engineering Design 3-0-3. Prerequisite: Math. 4215 or consent of school.
Use of information-theory decision analysis in solving practice problems in engineering design and reliability which cannot be effectively treated by any other methods.

M.E. 7220. High Temperature Environment-Material Interactions 3-0-3. Prerequisite: consent of school.
Thermal behavior of materials exposed to high temperature environment considered. Surface melting, vaporization, charring, surface chemical reaction, and reaction in depth included. Methods of simulation considered.


M.E. 7322. Thermodynamics of Irreversible Processes I 3-0-3. Prerequisite: graduate standing.
Principles and formalism of thermodynamics of near-equilibrium states. Phenomenological equations and the Onsager-Casimir reciprocal relations. Coupled linear processes and cross-effects.

M.E. 7323. Thermodynamics of Irreversible Processes II 3-0-3. Prerequisite: M.E. 7322 or equivalent.
Further study of the application of irreversible thermodynamics in linear processes. Variational formulation for nonequilibrium thermodynamics; current contributions towards the solution of nonlinear problems.

Theory of forced convection heat exchange in recuperators, regenerators and devices with simultaneous heat and mass transfer, with emphasis on performance and thermal design. Text: At the level of Jakob, Heat Transfer, Vol. II.

Latest advances in heat transfer; boiling and two-phase flows, liquid metal heat transfer, influence of main stream turbulence, separated flows, porous media, radiation and conduction.

M.E. 7341. Transport Phenomena in Two-Phase Flow I 3-0-3. Prerequisites: consent of school.
Dispersed and separated flows - field and constitutive equations, jump conditions, interfacial phenomena, nucleation. Two-fluid and drift models, similarity criteria. Dynamics, propagation phenomena, kinematic waves.

M.E. 7342. Transport Phenomena in Two-Phase Flow II 3-0-3. Prerequisite: consent of school.

M.E. 7760. Magnetogasdynamics I 3-0-3. Prerequisite: Graduate standing.

M.E. 7761. Magnetogasdynamics II 3-0-3. Prerequisite: M.E. 7760 or equivalent.

M.E. 7762. Magnetogasdynamics III 3-0-3. Prerequisite: M.E. 7760 or equivalent.

M.E. 7763. Methods of Experimental Magnetogasdynamics 2-3-3. Prerequisite: M.E. 7761 or equivalent.
Laboratory plasma sources and flow facilities. Discussion of various arc configurations. Topics in plasma diagnostics. Field trip to representative facilities.

M.E. 7999. Preparation for Ph.D Qualifying Exam Non-credit. Prerequisite: consent of school.

Two presentations by each student of current research activities: thesis work and special problems, presentation of thesis proposals. Attendance in curriculum-related seminars.

M.E. 8041-8045. Fluid Mechanics Seminar 1, 2, 3, 4, 5 credit hours respectfully. Prerequisite: consent of school.
Advanced current topics in fluid mechanics and fluid engineering including applications of interest to mechanical engineering.

M.E. 8101-8105. Special Topics in Design 1, 2, 3, 4, 5 credit hours respectfully. Prerequisite: consent of school.
Special topic offerings of current interest and not included in regular courses.

M.E. 8201-8205. Special Topics in Materials 1, 2, 3, 4, 5 credit hours respectfully. Prerequisite: consent of school.
Special topic offerings of current interest and not included in regular courses.

M.E. 8301-8305. Special Topics in Energetics 1, 2, 3, 4, 5 credit hours respectfully. Prerequisite: consent of school.
Special topic offerings of current interest and not included in regular courses.

M.E. 8401-8405. Special Topics in Systems and Controls 1, 2, 3, 4, 5 credit hours respectfully. Prerequisite: consent of school.
Special topic offerings of current interest and not included in regular courses.

M.E. 8501-8517. Special Problems in Mechanical Engineering Credit to be arranged. Prerequisite: consent of school.
Individual studies in certain specialized areas, and mathematical analyses and/or experimental investigations of problems of current interest in mechanical engineering.

M.E. 8999. Preparation for Ph.D. Dissertation Non-credit. Prerequisite: consent of school.

M.E. 9000. Doctor's Thesis

METALLURGY
(See Chemical Engineering)

MILITARY SCIENCE

BASIC COURSES

M.S. 1040. Leadership Development 0-1-0.
A weekly period devoted to furtherance of basic military skills, leadership, drill and command. Command voice and individual execution are stressed.

Detailed orientation on the Georgia Tech ROTC Program: the role of the military officer; the national security organization; Department of the Army mission and organization.

A study of military maps and general photographs for terrain analysis and land navigation. A study of military symbology in operational planning.

A study of group dynamics, individual motivation, and the function of leadership at the small unit level. An examination of peer group relations.

M.S. 2200. Seminar on Communications and Instructional Methods 2-1-2.
Studies in fundamental techniques and methods of instruction with emphasis on individual presentation, group conferences, and critiques.

M.S. 2300. Military History 3-1-3.
A study of U.S. military history, emphasizing the principles of war and the effects of underlying political, economic, social and technological factors.

REQUIRED ADVANCED COURSES

M.S. 3040. Leadership Development 0-1-0. Prerequisite: Advanced ROTC standing.
A weekly period devoted to furtherance of intermediate leadership and management skills, stressing effective oral communications and instructions.

M.S. 3100. Tactical Decision-making 3-1-3. Prerequisite: Advanced ROTC standing.
Application of tactical decision-making at the small unit level. Practical experience in planning tactical operations.

M.S. 4010. World Change and Military Implications; Military Functions 4-1-3. Prerequisite: Advanced ROTC standing and consent of department.

A study of the social, economic, political and military factors influencing international relations; basic concepts of military administration and justice. Course designed for cross-enrolled cadets.

M.S. 4040. Leadership Development 0-1-0. Prerequisite: Advanced ROTC standing.
A weekly period devoted to furtherance of advanced leadership and management skills. Cadets plan, organize, and execute the entire leadership development program.

M.S. 4100. Military Administrative Operations 2-1-1. Prerequisite: Advanced ROTC standing.
A study of the basic concepts and fundamentals of military administration and military justice.

BRANCH MATERIAL COURSES

Air Defense Artillery

M.S. 3130. Forward Area Air Defense 3-1-3. Prerequisite: Advanced ROTC standing.
An introduction to the Army Air Defense forces with emphasis on the forward area air defense weapons employed with the Army in the field.

A study of the Army Air Defense missile systems utilized to protect military and civilian assets both in the United States and overseas.

Corps of Engineers

M.S. 3330. Combat Engineering 3-1-3. Prerequisite: Advanced ROTC standing.
A study of military engineering in a combat environment. Emphasis is placed on combat engineer units, equipment
and methods of employment in a combat situation.

M.S. 4330. Military Construction Management
3-1-3. Prerequisite: Advanced ROTC standing.
A study of construction management as applied to military construction to support combat operations. Emphasis is placed on construction project planning and control techniques.

Infantry

M.S. 3430. Tactics and Techniques of Small Unit Operations
3-1-3. Prerequisite: Advanced ROTC standing.
A study of the fundamentals and principles of infantry tactics at the small unit level, including the organization of Infantry, Armored, Airmobile, and Airborne Divisions.

M.S. 4430. Advanced Infantry Tactics and Techniques
3-1-3. Prerequisite: Advanced ROTC standing.
A study of staff and command actions, estimates, and orders in the employment of infantry units and supporting elements from other branches and services.

Ordnance Corps

M.S. 3530. Ordnance Tactics and Techniques
3-1-3. Prerequisite: Advanced ROTC standing.
An analysis of the characteristics, capabilities and trends in Army material and their impact on logistics management. Proven Ordnance tactics and techniques are discussed.

M.S. 4530. Ordnance Management
3-1-3. Prerequisite: Advanced ROTC standing.
An analysis of management theories, concepts and practices. Emphasis is on management functions, human relations and interpersonal communications as they relate to the Ordnance officer.

Signal Corps

M.S. 3630. Tactical Communications—Electronic Systems
3-1-3. Prerequisite: Advanced ROTC standing.
A study of Signal field communications system engineering and communications control in units below Division level, including wire, radio and multichannel communications systems.

M.S. 4360. Strategic Communications—Electronic Systems
3-1-3. Prerequisite: Advanced ROTC standing.
An analysis of Division, Corps and Field Army Communications. A study of U.S. Army Strategic Communications Command communications requirements and facilities, to include satellite communications.

MODERN LANGUAGES

CHINESE

Chin. 1001. Introduction to Mandarin Chinese
3-2-4. Prerequisite: One year college-level foreign-language study or equivalent and consent of department. Intensive study of patterns of expression in spoken Chinese.

Chin. 1002. Introduction to Mandarin Chinese
3-2-4. Prerequisite: Chin. 1001 or equivalent. Continuation of Chin. 1001; introduction to Chinese writing system.

Chin. 1003. Introduction to Mandarin Chinese
3-2-4. Prerequisite: Chin. 1002 or equivalent. Continuation of Chin. 1002; proportionately more emphasis on written Chinese.

FRENCH

Fren. 1001. Elementary French

3-0-3. Prerequisite: None.
Essential principles of French grammar; acquisition of vocabulary through simple conversational exercises and the reading of simple selections.

Fren. 1002. Elementary French
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
3-0-3. Prerequisite: Fren. 1002 or equivalent. Reading of selected texts; composition; completion of the survey of French grammar.


French 2001. Period: The Beginning to 1700
3-0-3. Prerequisite: Fren. 2001 or equivalent. Social evolution and the psychology which engendered France's artistic contributions to civilization in numerous areas.

Fren. 2002. Period 1700 to 1800
3-0-3. Prerequisite: Fren. 2001 or equivalent. France's contribution to the democratic ideal and the fine arts. Readings from Montesquieu, Voltaire, Rousseau and others.

Fren. 2003. Period: 1800 to the Present
3-0-3. Prerequisite: Fren. 2002 or equivalent. Readings from authors identified with the progress of democratic ideas and the scientific awakening.

Fren. 3001-3002-3003. Class and collateral study of prose, drama, and lyric poetry by representative authors through indicated literary movements.

Courses conducted in French.

Fren. 3001. Period: c. 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.

Fren. 3002. Period c. 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.

Fren. 3003. Period: c. 1900-1930
3-0-3. Prerequisite: Fren. 2003 or equivalent. Exploration of currents in modern prose, poetry, and drama.

Fren. 3011. France Today I
3-0-3. Prerequisite: Fren. 2003 or consent of department. Culture, history, and geography of modern France in lectures and class discussions; short papers on assigned topics; series conducted in French.

Fren. 3012. France Today II
3-0-3. Prerequisite: Fren. 3011 or consent of department. Continuation of Fren. 3011.

Fren. 3013. France Today III
3-0-3. Prerequisite: Fren. 3011-3012 or consent of department. Continuation of Fren. 3012.

Fren. 4001. Introduction to French Stylistics
3-0-3. Prerequisite: Fren. 2003 or equivalent. Advanced study of grammar and usage; aimed at development of stylistic sensitivity. Compositions in French.

Fren. 4002. Classic French Literature
3-0-3. Prerequisite: Fren. 3003 or equivalent. Survey of French classic literature;
readings in Malherbe, Descartes, Pascal, La Rochefoucauld, La Fontaine, La Bruyère, in Corneille, Molière, and Racine. Lectures on the Classic Age; term report.

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.

Fren. 4075. Intensive Readings in French I 3-0-3. Prerequisite: FREN 4075.
Intensive study of selected readings in French on the cultural, historical, and intellectual development of France. Class discussion of reading material.

*Ger. 1003. Elementary German 3-0-3. Prerequisite: GER. 1002 or equivalent.
Reading of general German material and the acquisition of a large vocabulary; continued study of German grammar, composition.

*Ger. 2001. Introduction to Modern German Culture I 3-0-3. Prerequisite: GER. 1003, or equivalent.
Selected readings in German on the cultural, historical, and intellectual development of Germany. Class discussion of reading material.

Continuation of GER. 2001.

*Ger. 2003. Introduction to Modern German Culture III 3-0-3. Prerequisite: GER. 2002 or equivalent.
Continuation of GER. 2002.

*Ger. 2008. Intermediate German (Scientific) 3-0-3. Prerequisite: GER. 1003 or equivalent.
Reading of German scientific and technical material; individual problems to conform, whenever possible, with the student's special field of study.

*Ger. 2011 Intermediate German (Scientific) 3-0-3. Prerequisite: GER. 1003 or equivalent.
Continuation of GER. 2008.

*Ger. 2012 Intermediate German (Scientific) 3-0-3. Prerequisite: GER. 2011 or equivalent.
Continuation of training given in GER. 2011.

GERMAN

Ger. 1001. Elementary German 3-0-3. Prerequisite: None.
Pronunciation; essential principles of German grammar; rapid acquisition of vocabulary by the reading of simple selections; elementary composition.

Ger. 1002. Elementary German 3-0-3. Prerequisite: GER. 1001 or equivalent.
Continuation of GER. 1001.

Ger. 1003. Elementary German 3-0-3. Prerequisite: GER. 1002 or equivalent.
Reading of general German material and the acquisition of a large vocabulary; continued study of German grammar, composition.

*Ger. 2001. Introduction to Modern German Culture I 3-0-3. Prerequisite: GER. 1003, or equivalent.
Selected readings in German on the cultural, historical, and intellectual development of Germany. Class discussion of reading material.

Continuation of GER. 2001.

*Ger. 2003. Introduction to Modern German Culture III 3-0-3. Prerequisite: GER. 2002 or equivalent.
Continuation of GER. 2002.

*Ger. 2011 Intermediate German (Scientific) 3-0-3. Prerequisite: GER. 1003 or equivalent.
Reading of German scientific and technical material; individual problems to conform, whenever possible, with the student's special field of study.

*Ger. 2012 Intermediate German (Scientific) 3-0-3. Prerequisite: GER. 2011 or equivalent.
Continuation of training given in GER. 2011.

*Ger. 2013 Intermediate German (Scientific) 3-0-3. Prerequisite: GER. 2012 or equivalent.
Continuation of GER. 2012.

Reading of German prose in support of the development achieved in GER. 2011 and 2012.

Ger. 3001. Introduction to German Literature I 3-0-3. Prerequisite: GER. 2003, GER. 2013 or equivalent.
Period: Medieval times – 1750.

Ger. 3002. Introduction to German Literature II 3-0-3. Prerequisite: GER. 2003, GER. 2013, or equivalent.
Period: 1750-1840.

Ger. 3003. Introduction to German Literature III 3-0-3. Prerequisite: GER. 2003, GER. 2013, or equivalent.
Period: 1840-1918.

Ger. 3011. Germany Today I 3-0-3. Prerequisite: GER. 2003 or consent of department.
German lectures and papers on and class discussions of German topics: history; urban and rural morphology; post-war social and economic development in East and West.

Ger. 3012. Germany Today II 3-0-3. Prerequisite: GER. 3011 or consent of department.
Continuation of GER. 3011 in treatment of additional topics; German family life, educational system, church and religion, development of the arts; the Hitler era.

Ger. 3013. Germany Today III 3-0-3. Prerequisite: GER. 3011-3012 or consent of department.
Continuation of GER. 3011-3012; In-depth treatment of contemporary issues. Supplementary instructional media: slides, recordings, journals, and panel discussions.

Ger. 3051. The German Folksong 3-0-3. Prerequisite: GER. 2003-2013, or equivalent.
Introduction to the wide range of human experience reflected in the German folksong; emphasis on the appreciation of musical forms and literary aspects.

Ger. 4001-4002. A study of the leading German authors from Naturalism to the present time. Collateral and class readings; lectures; class discussion. Both courses conducted in German.

Ger. 4001. German Writers of the 20th Century I 3-0-3. Prerequisite: GER. 2003, GER. 2013, or equivalent.

Ger. 4002. German Writers of the 20th Century II 3-0-3. Prerequisite: GER. 2003, GER. 2013, or equivalent.
Period: 1920–Present.

Ger. 4003. Modern German Drama 3-0-3. Prerequisite: GER. 2003, GER. 2013, or equivalent.
A study of the leading German dramatists from the period of Naturalism to the present time. Lectures: parallel readings; discussions. Course conducted in German.

Ger. 4021-4022. The rise of eighteenth-century German literature to the mature works of Goethe and Schiller. Collateral and class readings; lectures; discussion. Courses conducted in German.

Ger. 4021. The Age of Goethe I 3-0-3. Prerequisite: GER. 2003, GER. 2013, or equivalent.
Period: Eighteenth century to the time of Goethe and Schiller.
Ger. 4022. The Age of Goethe II
3-0-3. Prerequisite: Ger. 2003, Ger. 2013, or equivalent.

The mature works of Goethe and Schiller.

Ger. 4023. Selected Readings in German Literature
3-0-3. Prerequisite: Ger. 2003, Ger. 2013, or equivalent.

Study of selected authors, movements, genres, and forms in German literature. Selections vary from year to year. Parallel readings, reports, and papers.

Ger. 4051-4052-4053. Reading, in-depth analysis, and discussion of selected twentieth-century novels. All courses conducted in German.

Ger. 4051. Seminar in the Modern German Novel I
3-0-3. Prerequisite: Ger. 4001-4002-4003 or consent of department.

The novels of Franz Kafka.

Ger. 4052. Seminar in the Modern German Novel II
3-0-3. Prerequisite: Ger. 4051, or consent of department.

The major novels of Hermann Hesse (Demian, Narziß und Goldmund, Steppenwolf, Glaasperlenispiel).

Ger. 4053. Seminar in the Modern German Novel III
3-0-3. Prerequisite: Ger. 4052, or consent of department.

Selected novels of Gunter Grass, Max Frisch, and Christa Wolf.

Ger. 4075. Intensive Readings in German I
3-0-3. Prerequisite: Normally taken by students of at least junior standing — by others, with consent of department.

Acquisition, in one quarter, of as much German as is normally acquired in two.

Aim: Development of linguistic competence for reading and comprehension.

Ger. 4076. Intensive Readings in German II
3-0-3. Prerequisite: Ger. 4075.

Continuation of Ger. 4075, with comparable achievement as objective.

Ger. 4077. Intensive Readings in German III
3-0-3. Prerequisite: Ger. 4076.

Continuation of Ger. 4076, with comparable achievement as objective.

LINGUISTICS

Ling. 2001. Introduction to Language I
3-0-3. Prerequisite: None.

Survey of major language families of the world and relationships within language families; comparison of dialects and "standard" languages.

Ling. 2002. Introduction to Language II
3-0-3. Prerequisite: Ling. 2001 or consent of department.

Survey of the types of linguistic change and development; comparison of generic and genetic linguistic relationships; linguistic borrowing.

Ling. 2003. Introduction to Language III
3-0-3. Prerequisite: Ling. 2002 or consent of department.

Survey of universal structural units of language, major writing systems, and principles of graphophological representation of languages. Methodology of descriptive linguistics.

Ling. 3001. Introduction to Articulatory Phonetics
3-0-3. Prerequisite: None.

Introduction to articulatory and acoustic phonetics; methodology for analyzing sounds in various languages, with emphasis on recording sounds in phonetic script and reproduction of sounds.

Ling. 3002. Introduction to Structural Linguistics I
3-0-3. Prerequisite: Ling. 3001 or consent of department.

Methodology for phonological analysis of language; examination of phonological data from hypothetical and natural languages. Collateral readings; problems.

Ling. 3003. Introduction to Structural Linguistics II
3-0-3. Prerequisite: Ling. 3002 or consent of department.

Continuation of Ling. 3002 with emphasis on morphology and syntax; study of the works of Bloomfield, Pike, and Harris. Collateral readings; problems.

Ling. 4001. History of Linguistics
3-0-3. Prerequisite: Prior study of linguistics or consent of department.

Survey of the theoretical developments in linguistics, with major emphasis on the developments of the nineteenth and early twentieth centuries.

Ling. 4002. Current Developments in Linguistics
3-0-3. Prerequisite: Prior study of linguistics or consent of department.

Live issues in the field, and approaches favored by various contemporary schools.

Ling. 4003. Semantics and Linguistic Structure
3-0-3. Prerequisite: Prior study of linguistics or consent of department.

Various approaches to the problem of dealing with meaning in linguistic analysis.

Ling. 4021. Contrastive Language Systems
3-0-3. Prerequisite: Ling. 3001-3002-3003, or consent of department.

A comparison of the similarities and differences of selected major languages with English in respect to phonology, written representation, syntactic and semantic categories.

Ling. 4075-4076-4077. The study of the languages indicated, with emphasis on grammatical and semantical structures and their correspondences. English as the control language. Normally taken in any order by students of at least junior standing; by others, with consent of department.

Ling. 4075.Comparative Analysis of Major European Languages I
3-0-3.

The major Slavic languages.

Ling. 4076. Comparative Analysis of Major European Languages II
The major Germanic languages.

Ling. 4077. Comparative Analysis of Major European Languages III
The major Romance languages.

RUSSIAN

Russ. 1001. Elementary Russian
3-2-4. Prerequisite: Two years of high school training in any foreign language (s), ancient or modern — or equivalent; otherwise, consent of department.

Pronunciation; essential principles of Russian grammar; acquisition of vocabulary through illustrative readings; intensive familiarization with recorded material.

Russ. 1002. Elementary Russian
3-2-4. Prerequisite: Russ. 1001 or equivalent.

Continuation of Russ. 1001; introduction of additional reading material as progress of class permits.

Russ. 1003. Elementary Russian
3-2-4. Prerequisite: Russ. 1002 or equivalent.
Continuation of Russ. 1002; emphasis on the reading of simple prose.


Russ. 2001. History and Culture of Russia I 3-0-3. Prerequisite: Russ. 1003 or equivalent.
Period: Ninth century to eighteenth.

Russ. 2002. History and Culture of Russia II 3-0-3. Prerequisite: Russ. 2001 or equivalent.
Period: Eighteenth century to 1917.

Russ. 2003. History and Culture of Russia III 3-0-3. Prerequisite: Russ. 2002 or equivalent.
Period: 1917 to the present.

Russ. 3001-3002-3003. Class and collateral study of prose, drama, and poetry by representative authors, according to the indicated time periods and literary movements; readings in Russian.


Russ. 3003. Period: c. 1900 to the present.Symbolism; Futurism; Soviet Literature.

3-0-3. Prerequisite: Russ. 2003 or equivalent.

Russ. 4075. Intensive Readings in Russian I 3-0-3. Prerequisite: normally taken by students of at least junior standing; by others, with consent of department. Acquisition, in one quarter, of as much Russian as is normally acquired in two. Aim: development of linguistic competence for reading and comprehension.

Russ. 4076. Intensive Readings in Russian II 3-0-3. Prerequisite: Russ. 4075. Continuation of Russ. 4075; with comparable achievement as objective.

Russ. 4077. Intensive Readings in Russian III 3-0-3. Prerequisite: Russ. 4076. Continuation of Russ. 4076, with comparable achievement as objective.

SPANISH

   Pronunciation; grammar; reading; composition, simple conversational exercises.

Span. 1002. Elementary Spanish 3-0-3. Prerequisite: Span. 1001 or equivalent.
   Continuation of Span. 1001; increased emphasis on reading and conversation.

Span. 1003. Elementary Spanish Continuation of Span. 1002; completion of fundamentals of Spanish grammar.

   Span. 2001. Cultural History of Spain I 3-0-3. Prerequisite: Span. 1003 or equivalent.
   Period: Prehistoric times through the Middle Ages.

   Period: 1450-1700.

   Period 1700-

Span. 3001-3002-3003. Spanish-American Civilization as reflected in representative literary works from the periods indicated. Introduction to literary criticism. Lectures; discussions. Both courses conducted in Spanish.

Span. 3001. Spanish-American Literature Before 1895 3-0-3. Prerequisite: Span. 2003 or equivalent.

Span. 3002. Spanish-American Literature Since 1895 3-0-3. Prerequisite: Span. 2003 or equivalent.

Span. 3003. Introduction to Spanish Literature. 3-0-3. Prerequisite: Span. 2003 or equivalent.
   The cultural heritage of Spain in the Americas as reflected in representative European and Spanish-American literary works. Conducted in Spanish.

Span. 3004. Cultural History of Mexico 3-0-3. Prerequisite: Span. 2003 or equivalent.
   Readings from representative authors. Vocabulary building; lectures, discussions; conversation and composition.

Span. 3005. Contemporary Latin America 3-0-3. Prerequisite: Span. 2003 or equivalent.

Selected contemporary essays, speeches, and diverse documents reflecting social, economic, and political problems. Conducted in Spanish.

   Grammar review through conversational drills in language laboratory; composition.

Span. 3007-3008-3009. Spanish civilization from prehistoric times to the present. Readings in representative authors from the periods indicated. Lectures, discussions, reports. All courses conducted in Spanish. Prerequisite: Native or near-native fluency.

Span. 3007. Cultural History of Spain 3-0-3.

Span. 3008. Cultural History of Spain 3-0-3.

Span. 3009. Cultural History of Spain 3-0-3.

Span. 4001-4002. Spanish drama from the periods indicated as the medium of contribution to Western literature by the writers listed and others. Both courses conducted in Spanish.

Span. 4001. Spanish Drama Before 1700 3-0-3. Prerequisite: Span. 3006 or
equivalent.
Lope de Vega and Calderon.

Span. 4002. Spanish Drama Since 1700.
3-0-3. Prerequisite: Span. 3006 or equivalent.
Lorca and Caso.

Span. 4003-4004. Spanish prose in the periods and the works indicated, with attention to the contributions to Western literature. Both courses conducted in Spanish.

Span. 4003. Spanish Prose Before 1700.
3-0-3. Prerequisite: Span. 3006 or equivalent.
The Celestine.

Span. 4004. Spanish Prose Since 1700.
3-0-3. Prerequisite: Span. 3006 or equivalent.
Works of the generation of 1898.

Span. 4007. Spanish Historical Linguistics.
3-0-3. Prerequisite: Span. 3006 or equivalent.

Span. 4008. Libro de buen amor.
3-0-3. Prerequisite: Span. 4007 or equivalent.
Detailed linguistic and literary analysis of the Ruiz masterpiece as the vortex of Spanish medieval literature. Conducted in Spanish.

Span. 4009. Don Quijote, Part I.
3-0-3. Prerequisite: Span. 3006 or equivalent.
Recommended achievement as objective.

Detailed study of Cervantes' masterpiece as the vortex of Spanish literature, the prototype of the modern novel, and the essence of Renaissance and Baroque literature. Conducted in Spanish.

Span. 4010. Don Quijote, Part II.
3-0-3. Prerequisite: Span. 3006 or equivalent.
Continuation of Span. 4009.

Span. 4075. Intensive Readings in Spanish.
3-0-3. Prerequisite: This course normally taken by students of at least junior standing.
Acquisition, in one quarter, of as much Spanish as is normally acquired in two.
Aim: development of linguistic competence for reading and comprehension.

Span. 4076. Intensive Readings in Spanish II.
3-0-3. Prerequisite: Span. 4075.
Continuation of Span. 4075, with comparable achievement as objective.

Span. 4077. Intensive Readings in Spanish III.
3-0-3. Prerequisite: Span. 4076.
Continuation of Span. 4076, with comparable achievement as objective.

Study Abroad Programs of the University System of Georgia.

These courses are catalog courses only and are never staffed or taught at Georgia Tech. Their only purpose is that of a bookkeeping device which facilitates the recording of credit earned by successful participation in the Study Abroad Programs of the University System of Georgia - fifteen (15) quarter-hours credit for each summer course.

Fren. 4091-4092-4093. FRENCH STUDY ABROAD.
5-0-5 each.

Ger. 4091-4092-4093. GERMAN STUDY ABROAD.
5-0-5 each.

Span. 4091-4092-4093. SPANISH STUDY ABROAD.
5-0-5 each.

MUSIC

Music 2001. Choral Music—History
1-2-1. Sophomore, junior or senior year, fall quarter. Prerequisite: satisfactory completion of three quarters in Glee Club; consent of department.
Practical and laboratory work, rehearsing and performing choral music; history and development of choral music from German chant through Palestrina and Bach to the present.

1-2-1. Sophomore, junior or senior year, winter quarter. Prerequisite: satisfactory completion of three quarters in Glee Club; consent of department.
Rehearsal or performance of choral music; practice conducting by the students.

1-2-1. Sophomore, junior or senior year, spring quarter. Prerequisite: satisfactory completion of three quarters in Glee Club; consent of department.
Study of operas presented during spring quarter in Atlanta by Metropolitan Opera Association, which can be attended free of charge by Glee Club members.

Music 2005 Marching Band
0-3-1. Sophomore, junior or senior year, fall quarter. Prerequisite: satisfactory completion of three quarters in band as freshman or sophomore; consent of department.
A continuation of the 2000 series music courses.

Music 2006. Concert Band
0-3-1. Sophomore, junior or senior year, winter quarter. Prerequisite: satisfactory completion of three quarters in band; consent of department.
Performance and appreciation of concert music, baton techniques and student conducting. Radio and television broadcasting techniques.

Music 2007. Concert and Marching Band
0-3-1. Sophomore, junior or senior year, spring quarter. Prerequisite: satisfactory completion of three quarters participation in band; consent of department.
Continuation of all procedures listed under Music 2006 plus a continuation of the marching drill and performance in Music 2005.

Music 3001. Marching Band
0-3-1. Junior or senior year, fall quarter. Prerequisite: satisfactory completion of three quarters participation in band as freshman or sophomore; consent of department.
A continuation of the 2000 series music courses.

Music 3002. Concert Band
0-3-1. Junior or senior year, winter quarter. Prerequisite: satisfactory completion of three quarters participation in band as freshman or sophomore; consent of department.
A continuation of the 2000 series music courses.

Music 3003. Concert and Marching Band
0-3-1. Junior or senior year, spring quarter. Prerequisite: satisfactory completion of three quarters participation in band as freshman or sophomore; consent of department.
A continuation of the 2000 series music courses.

Music 4001. Marching Band
0-3-1. Senior year, fall quarter. Prerequisite: satisfactory completion of Music 3001; consent of department.
A continuation of the 3000 series music courses.

Music 4002. Concert Band
0-3-1. Senior year, winter quarter. Prerequisite: Satisfactory completion of Music 3002, consent of department.
A continuation of the 3000 series music courses.

Music 4003. Concert and Marching Band
0-3-1. Senior year, spring quarter. Prerequisite: satisfactory completion of
Music 3003; consent of department.
A continuation of the 3000 series music courses.

NAVAL SCIENCE

NAVY OPTION

N.S. 1001. Naval Organization and Sea Power
2-1-2.

Introduction to structure and principles of Naval organization, terminology, customs and uniforms, missions of the Navy as they relate to sea power and maritime affairs.
Text: At the level of Naval Orientation; Blue Jackets Manual

N.S. 1002. Naval Ship Systems I
2-1-2.

Discussion of naval ship design and construction. Examination of concepts and calculations of ship stability characteristics. Introduction to shipboard damage control.
Text: At the level of Principles of Naval Engineering; Modern Ship Design

N.S. 1003. Naval Ship Systems II
2-1-2. Prerequisite: N.S. 1002 or consent of department.

Shipboard propulsion, electrical, and auxiliary engineering systems are examined. Nuclear propulsion, gas turbines, and other developments in naval engineering are presented.
Text: At the level of Principles of Naval Engineering.

2-1-1.

Relationships between fundamental principles of organization and management and the naval organization are explored. Topics include human relations, management functions, supervision and subordinate evaluation.

N.S. 2002. Naval Administration
2-1-1.

The broad area of naval administration is considered with emphasis on correspondence format, directives and enlisted personnel matters. Knowledge for effective officer performance is stressed.

N.S. 2003. Military law
2-1-1.

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.

N.S. 3001. Navigation I
3-2-3. Prerequisite: N.S. 3001 or consent of department.

Determination of position at sea using the marine sextant to observe heavenly bodies, principles/applications. Utilization of advanced electronic navigation systems is also introduced.

N.S. 3002. Navigation II
3-2-3. Prerequisite: N.S. 3001 or consent of department.

Theory and technique of navigation at sea. Areas of emphasis: dead reckoning, piloting, rules governing waterborne traffic. Practical applications utilizing nautical charts, tables, and instruments.

N.S. 3003. Naval Operations
3-2-3. Prerequisite: N.S. 3002 or consent of department.

Elements and principles of naval operations. Command responsibility, tactical doctrine, communication procedures, and relative movement problems introduced. Practical applications include review of basic navigation techniques.

N.S. 4001. Naval Weapons Systems I
3-1-3. Prerequisite: calculus, college physics.

A fundamental working knowledge of weapon system components and their contribution to the overall system is provided. The relationships of systems and subsystems are explored.
Text: At the level of Principles of Naval Ordnance and Gunnery; Principles of Guided Missiles and Nuclear Weapons; Weapons Systems Fundamentals (three volumes).

N.S. 4002. Naval Weapons Systems II
3-1-3. Prerequisite: N.S. 4001.

Employment and utilization of naval weapons systems are studied. An understanding of the capabilities of weapon systems and their role in the Navy's strategic mission.
Text: At the level of Principles of Naval Ordnance and Gunnery; Principles of Guided Missiles and Nuclear Weapons; Weapons Systems Fundamentals (three volumes).

N.S. 4003. Naval Personnel Administration

Broad areas of personnel administration and management are covered using the case method. Topics include promotion policy, evaluation of personnel performance, training and leadership requirements.

MARINE CORPS OPTION

N.S. 3004. Naval Science Laboratory
0-2-0.

Marine Corps leadership laboratory.
No preparation required. Grade of "S" given for satisfactory completion. Taken by all junior Marine option Midshipmen during spring quarter.

N.S. 3005, 3006. Evolution of Warfare I and II
3-1-3.

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, 4005. Amphibious Warfare I and II
3-2-3.

Two-quarter sequence designed to study projection of seaware ashore, emphasis on evolution of amphibious warfare in 20th century. Strategic concepts, current doctrine discussed.

N.S. 4006. Naval Science Laboratory 0-2-0.

Marine Corps leadership laboratory to prepare senior Marine option for commissioning. Grade of "S" given satisfactory completion.

N.S. 4901, 4902, 4903. Special Problems in Naval Science
Credit to be arranged. Prerequisite: Submission of a 500-word statement detailing the expected area of study to the professor of naval science; permission from the professor of naval science to enroll.

Selected students pursue creative research in specialized areas of naval science under the supervision of a staff officer whose career specialty is in that field. Professional papers of publishable quality and depth will be sought. Students have the option of studying for 1, 2, or 3 credit hours per quarter, and for 1, 2, or 3 quarters of the academic year.

NUCLEAR ENGINEERING

N.E. 1100. Energy and Engineers in Society
2-3-3.

Deals with the concept of energy, society's requirements and the sources of supply, power generation methods, and related environmental influences.

N.E. 2401, 2, 3. Introduction to Health Physics
1-0-1. Prerequisite: sophomore standing.

A course designed to familiarize the student with the health physics profession and the role of the health physicist in industry, medicine, and public health.

N.E. 3110. Nuclear Radiation Detection
2-6-4. Prerequisite: Phys. 3001.

An introductory laboratory course to the principles and characteristics of basic detectors for nuclear radiations
and the electronic systems associated with them.


Computer programming with emphasis on solution of problems relevant to nuclear engineering. FORTRAN V for the UNIVAC 1108 is used.

N.E. 4201. Nuclear Reactor Physics I 3-0-3. Prerequisite: Phys. 3001. The course covers the physical principles of nuclear reactors. Major topics include the diffusion equation, neutron moderation, neutron thermalization, and criticality conditions.

N.E. 4202. Nuclear Reactor Physics II 3-0-3. Prerequisite: N.E. 4201. Topics include the multigroup diffusion method, heterogeneity effects, reactor kinetics, and reactivity changes.

N.E. 4205. Reactor Laboratory 1-6-3. Prerequisite: N.E. 4002. Reactor principles and operational parameters. Approach to criticality, measurements of control rod worth, power distribution, void and temperature coefficients, importance function, absolute flux, and the thermal spectrum.

N.E. 4211. Reactor Engineering I 3-0-3. Prerequisite: N.E. 3544 or Ch.E. 3305 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. 4230. Nuclear Engineering Design 2-6-4. Prerequisite: N.E. 4212 and N.E. 4202. A complete design project of a nuclear power station. Nuclear computer codes will be used to aid in the design.

N.E. 4260. Radiation Transport and Shielding 3-0-3. Prerequisite: N.E. 4202 or equivalent. Transport theory as applied to radiation transport in homogeneous and heterogeneous bulk media. Emphasis on neutron and gamma-ray transport, both theoretical and applied.

N.E. 4261. Boiling Water Reactor Systems and Operations 3-0-3. Prerequisite: N.E. 4701 or 4201 or consent of school. An analysis of operating characteristics of boiling water reactors.

N.E. 4401,2,3. Health Physics Seminar 1-0-1. Prerequisite: consent of school. Intended primarily for students who plan a career in health physics. Review of current literature and current activities in the profession with class discussions.

N.E. 4411. Radiation Physics 3-3-4. Prerequisite: Math. 2309 Phys. 2123. This course provides the physical basis for understanding the effects of ionizing radiation on matter, for developing a philosophy of radiation protection for individuals and the environment.


N.E. 4413. Applied Health Physics 3-3-4. Prerequisite: N.E. 4412 or consent of school. Topics covered include personnel monitoring, bioassay, air sampling and respiratory protection, radiation surveys of nuclear reactors, accelerators, and X-ray installations.

N.E. 4440. Effects of Nonionizing Radiation and Protection Standards 3-0-3. Prerequisite: Consent of school; 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 of the radiation protection standards.

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. 4630. 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. 2307. N.E. 4701-02-03 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. 4780. Energy Conversion Engineering 3-0-3. Prerequisite: thermodynamics. Topics include energy sources, basic principles of energy conversion, semiconductors, thermoelectric converters, photovoltaic generators, thermionic systems, magnetohydrodynamics, and fuel cells.

N.E. 4801-02-03. Special Topics 3-0-3. Prerequisite: consent of school. The purpose of this course is to permit the student of Nuclear Engineering to offer formal courses on topics of special interest on an ad hoc basis.

N.E. 4901-02-03-04. Special Problems Credit to be arranged. Prerequisite: consent of school. Special engineering problems will be assigned to the student according to his 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. 6110. Radiation Detection I 2-6-4. Prerequisite: Phys. 6011 or equivalent. Principles of radiation detection systems in common use. Included are interaction mechanisms, detector
response, design and selection criteria for detectors and indicating circuits.


N.E. 6125. Nuclear Engineering Calculations with Digital Computers II 3-0-3. Prerequisite: N.E. 4115 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. 6205. Nuclear Engineering Laboratory 1-6-3. Prerequisite: N.E. 4202. Sequence of experiments elucidating reactor physics principles. Nuclear reactors, subcritical assembly, pulsed neutron generators and isotopic neutron sources are used. Second course includes design of experiments by students.

N.E. 6211. Nuclear Reactor Technology I 3-0-3. Prerequisite: M.E. 3720 or equivalent. A study of current and proposed nuclear reactor power plants with emphasis on thermodynamic and single-phase fluid flows of reactor system design.

N.E. 6212. Nuclear Reactor Technology II 3-0-3. Prerequisite: N.E. 6211 or N.E. 4211. A continuation of the study of fluid flow in reactor systems; magnetohydrodynamic energy conversion; heat generation in nuclear systems due to fission and gamma rays, conduction heat transfer, single-phase convection heat transfer, and temperature distributions in reactor components.


N.E. 6220. Advanced Engineering Design 3-0-3. Prerequisite: N.E. 4202 and 4212 or N.E. 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. 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. Equations describing reactor time-dependent behavior; elementary control theory for stability analysis; analog simulation of kinetics and control problems; measurement of reactor control parameters.

N.E. 6232. Nuclear Fuel Management 3-0-3. Prerequisite: N.E. 4710 and N.E. 6760 or equivalent. Nuclear fuel procurement options will be examined with regard to financing, scheduling guarantees, risk, and cost. Calculational emphasis will be on in-core fuel management.

N.E. 6235. Nuclear Reactor Safety 3-0-3. Prerequisite: consent of school. Licensing procedures, sources of potential hazard, accident transients, engineered safeguards, incipient failure, diagnostic techniques, and safety analysis reports are discussed.

N.E. 6237. Fast Reactor Physics and Technology 3-0-3. Prerequisite: N.E. 4202. The course covers reactor physics and design topics of importance for fast breeder reactors.


N.E. 6401. Principles of Health Physics for Reactor Specialists 3-0-3. Prerequisite: consent of school; Phys. 6011 concurrently or equivalent. An evaluation 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 1-5-3. Prerequisite: N.E. 4413, 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 N.E. 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. 6412. Radiation Dosimetry Systems 1-6-3. Prerequisite: consent of school. Deals with calibration of ionizing radiation sources and 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 aspects of radioisotope
applications, tracer technology, radiation chemistry, and activation analysis, as applied in health physics.

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 3-3-3. Prerequisite: N.E. 6405 or N.E. 4413, 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 1-6-3. Prerequisite: N.E. 6430 (concurrent).

A laboratory course covering practical aspects of monitoring problems in nuclear facilities and environmental surveillance analyses.

N.E. 6601. Radioisotopes Engineering I 3-0-3. Prerequisite: Phys. 6011 or equivalent.

Production and handling of radioisotope sources. Industrial applications of tracer methods and radiation sources. Design procedures for radiation gauges and high-level irradiation facilities.


Production and economics of large-scale radiation sources for process systems and power sources. Analysis and design of practical systems and case studies.

N.E. 6620. Thermonuclear Engineering I 3-0-3.

An introduction to controlled thermonuclear fusion with emphasis on the production, confinement, and heating of thermonuclear plasmas.


Covers engineering problems related to development of controlled thermonuclear fusion. Included are energy removal systems, radiation damage, tritium breeding, magnetic field generation, direct conversion, environmental effects.


Advanced course on environmental radioactivity and environmental aspects of nuclear power. Radioactive waste treatment, reactor effluents, and waste disposal. (Identical with N.E. 6783 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 preparation 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 with Econ. 6760.

N.E. 6770. Small Computer Interface Engineering and Applications 2-6-4.

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.

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 with N.E. 6641.)

N.E. 7999. Master's Thesis Preparation for Ph.D. Qualifying Examination Noncredit Prerequisite: consent of director.

N.E. 8001-02-03. Seminar 1-0-0.

Regularly scheduled, noncredit course required of all N.E. majors. Various topics presented by graduate students, faculty members, and guest speakers.

N.E. 8110-11-12-13. Special Topics 3-0-3. Prerequisite: consent of school.

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.

N.E. 8501-02-03-04. Special Problems Credit to be arranged. Prerequisite: consent of school.

The student is encouraged to exercise his resourcefulness and originality in attacking a problem of special interest to himself and a member of the N.E. faculty.

N.E. 8999. Thesis Preparation (Ph.D. level)

N.E. 9000. Thesis

PHILOSOPHY AND HISTORY OF SCIENCE

(See Social Science)

PHYSICAL TRAINING

P.T. 1010. Swimming 0-4-1.

Each Student strives for maximum safety by thoughtful experimentation with simulated water emergencies. "Drowning-proofing" evolves as the basic method for survival.

P.T. 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.


Guest lecturers from the medical profession acquaint the student with contemporary personal health problems including drugs, nutrition, emotional health, and sex education.

P.T. 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.
Electives Physical Training

P.T. 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.T. 2120. Touch Football
Game rules and team strategy will be covered, followed by competition. P.T. 2040. Softball
0-4-1.
Basic fundamentals will be demonstrated and practiced. Teams will be organized for competition.

P.T. 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.T. 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.T. 2070. Paddleball
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.T. 2080. Bowling
0-4-1
Team and league bowling competition follows a comprehensive instructional program utilizing both live and filmed demonstration of basic skills and techniques.

P.T. 2090. Advanced Physical Conditioning
0-4-1
An individually tailored physical fitness program with emphasis on proper techniques of weight training. Total body development is stressed, with flexibility and aerobic conditioning included.

P.T. 2110. Basketball
0-4-1
The basic fundamentals of the game will be practiced. Team competition will then be organized.

P.T. 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.T. 2140. Athletic Officiating
2-2-1
Study of rules with laboratory experience. Instruction, demonstration and practical application of mechanics of officiating athletic games. Will help meet entrance requirements for professional officiating.

PHYSICS

Phys. 1000. Physics Orientation
1-0-1
Guest lectures will describe career opportunities in physics, the role physicists play in government and industrial laboratories and in education, and programs available to physics major.

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
Prerequisite: Phys. 2021 or consent of the department.
The nature and behavior of the stars and galaxies will be examined. Text: At the level of Abell, Exploration of the Universe.

Phys. 2111, 2112, 2113. Elementary College Physics
4-0-4
Courses should be taken in sequence. 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 Beeche, Principles of Physics.

Phys. 2121. Particle Dynamics
4-3-5
Corequisite: Math. 1309
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, Math. 1309
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 1309

Phys. 2141, 2142, 2143. General Physics
5-3-6
Corequisite: Math. 1309, courses to be taken in sequence.
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 competence in mathematics and who desire a more rigorous foundation in physics. Text: At the level of Resnick and Halliday, Physics.

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. At the level of Weidner and Sells, Elementary Modern Physics.

Phys. 3002. The Solid State
3-0-3
Prerequisite: Phys. 2123
Introductory solid state physics for engineers and aspiring scientists, using seven exemplary materials to illustrate the important properties of solids based on their atomic structure. Text: At the level of Moore, Seven Solid States.

Phys. 3021. Nuclear Astrophysics and Stellar Evolution
3-0-3
Prerequisite: Phys. 2123
Nucleosynthesis and energy generation in stars, stellar models, and stellar evolution. Formation of elements, supernovae, quasars, neutron stars, "black holes" and radio sources. All majors. Text: At the level of Fowler, Nuclear Astrophysics.
Phys. 3121, 3122, 3123. 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; resistance, 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; Lorrain and Corson, Introduction to Electromagnetic Fields and Waves.

Phys. 3132. Intermediate Mechanics
3-0-3. 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 Jackson, Classical Electrodynamics (Mechanics).

Phys. 3136. Intermediate Electricity and Magnetism
3-0-3. Prerequisite: Phys. 2123.
Maxwell's equations and applications. Electrostatics, dielectrics, magnetostatics, magnetic substances, Ampère's and Faraday's laws, electrical circuits. Text: At the level of Duckworth, Electricity and Magnetism.

Phys. 3141, Thermal Physics
5-0-5. Prerequisite: Phys. 2123 and Math 2308.

Phys. 3143, Quantum Mechanics I
5-0-5. Prerequisite: Phys. 3121 or 3132 and Math. 2309.
Historical approach to wave mechanics. Operator, eigenfunction-eigenvalue problem solutions to Schrödinger'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.

Phys. 3145. Introductory Statistical Physics
3-0-3. Prerequisite: Phys. 2123.
Introduction to the concepts and principles of statistical physics necessary for a microscopically 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 devices. Text: At the level of Mitchell, Essentials of Electronics.

Phys. 3223. Geometrical Optics
3-0-3. Prerequisite: Phys. 2123 and Math. 2308.
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 Blaker, Geometric Optics.

Phys. 3224. Optical Instruments Laboratory
1-3-2. Corequisite: Phys. 3223.
Use of optical instruments for purposes of observation and measurement. Instrumentation includes spectrometers, interferometers, polariscopes, microscopes and telescopes.

Phys. 3225. Fourier Optics
3-0-3. Prerequisite: Phys. 2123 and Math 2308.

Phys. 3226. Advanced Optical Physics Laboratory
1-3-2. Corequisite: Phys. 3225.
Optional laboratory taken with Physics 3225. A small number of experiments designed to exemplify the material presented in lecture course.

Phys. 3229. Vacuum Ultraviolet Optics
1-3-2. 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 Sampson, Techniques of Vacuum Ultraviolet Spectroscopy.

Phys. 3241. Elementary Biophysics I
3-0-3. Prerequisite: Phys. 2123.
Applications of the principles and techniques of the physical sciences to areas of the life sciences. Text: At the level of Ackerman, Biophysical Science.

Phys. 3243. Elementary Biophysics II
3-0-3. Prerequisite: Phys. 3241.
A continuation of topics from Physics 3241. Physics of viruses, the central nervous system and biophysical instrumentation. Text: At the level of Ackerman, Biophysical Science.

Phys. 3244. Introductory Biophysics Laboratory
0-3-1. Corequisite: Phys. 3243.
This laboratory is taken at the student's option with Phys. 3243. Selected exercises exemplifying and reinforcing material presented in the lecture course.

Phys. 3251, Biophysics I
3-0-3. Prerequisite: Phys. 2123 and Bio. 2211.
An introduction to biophysical systems, first through the study of physical properties of biological macromolecules, and then through selected studies of sensory systems in animals. Text: At the level of Lehniger, Bioenergetics.

Phys. 3252, Biophysics II
3-3-4. Prerequisite: Phys. 3251.
Selected topics that stress the application of the measurement and analytical techniques of the physical sciences to studies of living systems.

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. Text: At the level of Perkins, Introduction to High Energy Physics.

Phys. 3263. Selected Problems in Physics
1-6-3. Prerequisite: Phys. 2123.
Studies of realistic problems illustrating various physical principles with detailed numerical applications pursued through the aid of computer facilities.

Phys. 3265. Introduction to Acoustics
3-0-3. Prerequisite: Phys. 2122 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 Kinsler, Fundamentals of Acoustics.

Phys. 3751. Laser Physics
3-0-3. Prerequisite: Physics 2123 and 2308.
Principles of laser operation. Types of lasers. Survey lectures on the application of lasers to various fields. Course intended for both physics and non-physics majors. (Phys. 3751 is the same as E.E. 4751).

Phys. 3800. Special Problems. (Credit to be arranged) Prerequisite: consent of department.
Content of course will vary to allow offering of courses in special topics on demand or on experimental basis. Individual problems arranged with consent of faculty member.
Phys. 4141. Vibrations and Wave Motion
3-0-3. Prerequisite: Phys. 3123 or 3136.
Oscillations and wave motion of discrete and continuous mechanical systems. The course emphasizes those aspects of wave motion common to many areas of physics.
Text: At the level of Morse, Vibration and Sound.

Phys. 4143. Quantum Mechanics II
5-0-5. Prerequisite: Phys. 3143 or equivalent.
Introduction to perturbation theory, identical particles, spin, and semiclassical radiation theory. Applications to atomic physics.
Text: At the level of Sard, Relativistic Mechanics.

Phys. 4145. Special Relativity
3-0-3. Prerequisite: Phys. 3123 or 3136.
Critique of Newtonian mechanics and Maxwell's equations. Postulates and development of Einstein's theory. Four-vector notation and relativistic mechanics.
Text: At the level of Park, Introduction to Quantum Theory.

Phys. 4211. Electronic Instruments for Scientific Research
2-3-3. Prerequisite: Physics 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
0-3-1. Prerequisite: Physics 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. 4213. Physical Measurements Laboratory
3-0-3. Prerequisite: Physics 3211 or equivalent.
Theoretical and experimental study of measuring techniques. Students are required to perform experiments in a laboratory using various measuring instruments.

Phys. 4214. Physical Measurements Laboratory
0-3-1. Corequisite: Phys. 4213.
Taken at student's option with Physics 4213. A set of laboratory exercises exemplifying and reinforcing material presented in the lecture course.

Phys. 4215. Interfacing Laboratory
1-6-3. Prerequisite: Physics 3211 or equivalent.
Introduction to the interfacing of computers with scientific apparatus. A PDP-11 computer and a variety of interfacing logic is available for the laboratory.

Phys. 4216. Interfacing Laboratory II
1-6-3. Prerequisite: Physics 4215 or consent of department.
A continuation of Phys. 4215. Emphasis on individual student design and construction of interfaces for on-line control of experiments.

Phys. 4261. Atomic Physics
5-0-5. Prerequisite: Physics 3143 or equivalent.
The structure and spectra of ordinary atoms, mesics atoms, and positronium. Atomic beams techniques, double resonance and level-crossing spectroscopy, Optical pumping. Properties of leptons.
Text: At the level of Woodgate, Elementary Atomic Structure.

Phys. 4262. Molecular and Solid State Physics
5-0-5. Prerequisite: Physics 3143; Physics 3141 or Chem. 1113.
Application of quantum mechanics to molecules and solids. Molecular bonding and spectra of diatomic molecules, Binding forces and bond theory is solids. Applications to solid state devices.
Text: At the level of Kittel, Introduction to Solid State Physics.

Phys. 4263. Nuclear Physics
5-0-5. Prerequisite: Physics 3143.
Basic properties of nuclei, interactions of radiation with matter, accelerators, radioactivity, nuclear reactions, nuclear models, elementary particles. Physics of nuclei, exposition of nuclear techniques.

Phys. 4264. Plasma Physics
5-0-5. Prerequisite: Physics 3123 or 3136.
Basic treatment of the plasma state via the Boltzmann equation, including collisions. Debye shielding length, diffusion, conductivity, oscillations, and propagation of EM waves.
Text: At the level of Holt and Haskell, Foundations of Plasma Dynamics.

Phys. 4265. Transport Phenomena
3-6-5. Prerequisite: Physics 3141 or equivalent.
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 department.
Introductory theory and practice of the most widely used 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. 4271. Stellar and Planetary Atmospheres
5-0-5. Prerequisite: Physics 2123.
Essentials of physics necessary for interpreting stellar and planetary atmospheres and other astrophysical plasmas. Solar radiation, chemical change, atmospheric temperatures and evolution of atmospheres.
Text: At the level of Aller, Astrophysics.

Phys. 4321, 4322, 4323. Advanced Laboratory I, II, III
5-0-5. Corequisite: Physics 3143.
May be scheduled in any order. Experiments of classical and contemporary importance selected from various fields of physics. Emphasis frequently deals with 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. 4980. Special Problems
(2-6 hours to be arranged) Prerequisite: consent of department.
Courses in special topics may be offered under this number. Individual student problems may be arranged with the consent of a faculty member.

Phys. 6011. Principles of Nuclear Physics
4-0-4.
Radioactive decay and decay processes, interaction of radiation, statistical considerations in interactions, nuclear structure, stability, and models; nuclear reactions and cross sections; properties of neutrons.
Text: At the level of Friedlander, Kennedy, and Miller, Nuclear and Radio Chemistry.

Phys. 6012. Radiation Attenuation
3-3-4.
Interaction of radiation with matter in bulk, adsorption scattering, and attenuation of nuclear radiations, radiation transport theory, geometrical considerations and transport solution methods.

Phys. 6121. Theoretical Mechanics
5-0-5.
Dynamics of particles and rigid bodies, including developments and applications of LaGrange's, Hamilton's and Euler's equations. Potential theory. Gyroscopic Motion. Poisson brackets, Hamilton-Jacobi theory.
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 Panofsky and Phillips, Classical Electricity and Magnetism.

Phys. 6123. Statistical Mechanics
5-0-5. Corequisite: Physics 6121.
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 Page, Introduction to Theoretical Physics.

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. Prerequisite: Phys. 4143 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.


A problem-solving course that applies principles of quantum mechanics to areas of physics such as 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. 4266 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.

Electron structure, calculation of potential energy curves, absorption parameters, emission parameters, rotational line strengths, vibrational band strengths, calculation of Franck-Condon factors.


Particle trajectories in electric and magnetic fields. Space charge and current sheaths. Plasma formation and confinement. Oscillations, waves and instabilities. Radiation from plasmas.

Phys. 6263. An Introduction to Collision Theory 3-0-3. Prerequisite: Phys. 4143 or equivalent.

Quantum theory of non-relativistic elastic and inelastic scattering; rearrangement collisions; central, non-local, 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.


An advanced course on the techniques by which atomic collisions phenomena are studied; includes scattering of ions and electrons in gases and scattering from solid surfaces.

Phys. 6300. Graduate Laboratory in Quantum Mechanics 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 (listed also as Ch.E. and Chem. 6753) 3-18-8. Prerequisite: consent of department.

A highly specialized laboratory course using modern analytical and research instrumentation to characterize and study the surface properties of materials.


An advanced course in statistical mechanics, including problems of biological significance.

Phys. 7125. Introduction to Relativity 5-0-5. Prerequisite: Phys. 6121 and 6122.

Reference frames and transformations; tensor calculus; review of special relativity; electrodynamics; the principle of equivalence; general relativity and gravitation; scalar-tensor theories.


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 structure.

Phys. 7147. Quantum Field Theory 5-0-5. Prerequisite: Phys. 6141 and 6122.


Use of nuclear models in computation of observable nuclear phenomena, including static and dynamic electromagnetic properties of nuclei.


Time-dependent correlation functions and dynamical structure factors. Coherent and incoherent, elastic and inelastic scattering cross sections. Applications to neutron scattering by phonons, magnetic interactions, fluids.

Phys. 7999 Preparation for the Comprehensive Examination 1-0-1.
PSYCHOLOGY

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. Emphasis will be placed upon the scientific approach to the study of behavior.

Psy. 3304. General Psychology B 3-0-3. Prerequisite: Psy. 3303.
A continuation of Psychology 3303. Such topics as individual differences, perception, and personality will be discussed.

Psy. 4400. Developmental Psychology 3-0-3. Prerequisite: Psy. 3303.
A comprehensive study of human behavior and 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 such topics 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. Principle 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. Prerequisites: Psy. 3303 and 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 issues.

Psy. 4406. Psychological Statistics 2-3-3. Prerequisite: consent of the department.
Application of statistical techniques to the design and analysis of psychological studies.

An introduction to psychological measurement and laboratory techniques used in the experimental study of topics such as sensory processes, perception, and psychomotor performance.

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.

Consideration of the behavior of the individual in relation to other individuals and groups.

Psy. 4411. Experimental Psychology II 3-3-4. Prerequisite: Psy. 3304 and 4407, and consent of the department.
Consideration of principles and research methods in the areas of learning and motivation with special emphasis on classical and operant conditioning of non-human animals.

Psy. 4412. Psychology of Learning 3-3-4. Prerequisite: Psy. 4411, and consent of the department.
An empirical and theoretical analysis of human learning, memory, and cognitive processes.

Psy. 4413. Applied Experimental Psychology 3-3-4. Prerequisite: Psy. 4406 and 4412, and consent of department.
Consideration of the application of the methods and data of experimental psychology.

Neurophysiological, endocrinological, and biochemical bases of sensory and motor functioning, learning, memory, motivation, and behavior disorders.

An introduction to psychological measurement and laboratory techniques used in the experimental study of topics such as sensory processes, perception, and psychomotor performance.

Psy. 4423. Introduction to Psycholinguistics 3-0-3. Prerequisite: consent of the department.
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 the department.
Introduction to and survey of major theories of personality.

Psy. 4750. (Soc. 4750). Social-Psychology—Sociology Measurement Seminar 3-0-3. Prerequisite: Psy. 4410 or equivalent, and consent of the department.
Problems, implications, and methodologies relating to the measurement of individual and group behavior in social situations. Students will receive supervised project experience.

Psy. 4751. (Arch. 4751). Psychology and Environmental Design I 3-0-3. Prerequisite: consent of the department.
Introduction to psychological concepts relevant to environmental design. Survey of selected methods for assessing man-made environment. Taught jointly by psychology and architecture faculty.

Psy. 4752. (Arch. 4752). Psychology and Environmental Design II 3-0-3. Prerequisite: Psy. 4751 and consent of the department.
Continuation of 4751 with greater emphasis on independent research and development of design solutions to selected problems. Taught jointly by psychology and architecture faculty.

Psy. 4753. (Arch. 4753). Special Problems in Psychological Aspects of Environmental Design Credit to be arranged. Prerequisite: Psy. 4751, 4752, and consent of the department.
Supervised individual study of a problem relating to the interaction of environmental design and behavior.

Psy. 4800. Special Topics 1-3-2. Prerequisite: Psy. 3304 and 4407, and consent of the department. Guided independent study in an area of psychology not represented in departmental course offerings.

Psy. 4900. Special Problems Credit to be arranged. Prerequisite: consent of the department. Students engage in individual and group projects under the direction of a faculty member.

Psy. 4814. Special Topics 0-3-1. Prerequisite: Psy. 4406 and 4411, and consent of the department. The student will, under the direction of a staff member, do semi-independent work in literature review and/or experimental design.

Psy. 4815. Special Topics 3-2. Prerequisite: consent of the department. Students will work, under the direction of the instructor, on projects adding to their development beyond the scope of existing courses.

Psy. 6601. Advanced Industrial Psychology 3-0-3. Prerequisite: Psy. 4401. A survey of the theoretical and pragmatic issues in industrial psychology. Recent developments and experimental findings will be discussed.

Psy. 6602. 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 his environment, emphasizing the engineering psychology approach.

Psy. 6603. Social Psychology 3-0-3. Prerequisite: six hours of psychology and consent of the department. 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 the department. A study of information processing theories and measurements 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 the department. A comprehensive, advanced consideration of general psychology including such topics as learning, motivation, and cognitive processes.

Psy. 6606. Proseminar in General Psychology 3-0-3. Prerequisite: graduate standing and consent of the department. A comprehensive, advanced 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 and 6606, or equivalent, and consent of the department. 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 the department. Examines theoretical and pragmatic issues in the description and prediction of motivated behavior. Includes the measurement problems, implications, and applications in a range of settings.

Psy. 6609. Social Psychology of Organizations 3-0-3. Prerequisite: Psy. 4410 or equivalent, and consent of the department. Selected topics from social psychology which are of particular significance to an understanding of individual behavior in an organizational context. Supervised readings and discussion.

Psy. 6610. Psychoacoustics 3-0-3. Prerequisite: Psy. 3304 or equivalent, and consent of the department. 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. 6621-6622. Foundations of Psychology 3-0-3. Prerequisite: graduate standing and consent of the department. A sequence involving historical and current points of view in psychology, emphasizing issues important for psychological theory.

Psy. 6623-6624. Design of Psychological Experiments 2-3-3. Prerequisite: graduate standing, Math. 2205 and Psy. 4406 or equivalent, and consent of the department. 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 the department. 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 the department. Intensive consideration of theoretical and pragmatic problems in the description and evaluation of human response 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 the department. 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 and 6606, or equivalent. Human capabilities and limitations for learning and performing psychomotor skills are studied. Emphasis is on performance measurement, and assessment of skill proficiency, prediction and control.

Psy. 6630. Psychometric Theory 3-0-3. Prerequisite: Psy. 4403 and 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. 6680. Multivariate Analysis 5-0-5. Prerequisite: Psy. 6624 or equivalent, and consent of the department. 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. Prerequisites: Psy. 6601, 6607, and consent of the department. Critical and comprehensive examination of current problems in a selected area of industrial psychology. The area to be covered may vary.

Psy. 7011. Seminar in Experimental Psychology 3-0-3. Prerequisite: Psy. 6607, 6625, and consent of the department. 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 the department. 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 the department. An advanced and systematic examination of selected topics dealing with the experimental analysis of learning. 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 the department. An examination of human interpretation of physical stimulation. The student studies in some detail the scientifically established 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 the department. Introduces the student to professional problems which he 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 or 6609, IM 6150 or 6105, and consent of the department. Preparation and discussion 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 problem involving investigation of some psychological aspect of management problems.

Psy. 8505. Special Problems in Experimental Psychology Credit to be arranged. Prerequisite: consent of the department. 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 the department. 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. 3012. History of Georgia 3-0-3. Prerequisite: Hist. 1001, 1002, 3010, 3011, or History Examination. Settlement and growth of the English colonies in North America with emphasis on the foundations of American political and economic institutions.

Hist. 3017. History of the Old South to 1865 3-0-3. Prerequisite: Hist. 1001, 1002, 3010, 3011, or History Examination. An analysis of the 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: Hist. 1001, 1002, 3010, 3011, or History Examination. Continues Hist. 3017. An examination of social, political, and economic developments from the Reconstruction period to the present.

Hist. 3020. American Diplomatic History 3-0-3. Prerequisite: History 1001, 1002, 3010, 3011, or History Examination. Historical analysis of diplomacy since the Revolutionary War. Emphasis upon political, economic, and social factors and upon role of the South in world affairs.

Hist. 3022. Afro-American History 3-0-3. Prerequisite: Hist. 1001, 1002, 3010, 3011, or History Examination. Historical analysis of the American Negro to the present. Special attention given to the Negro's contributions to American letters, music, and other performing arts.
Hist. 3024. The American Civil War
3-0-3. Prerequisite: Hist. 1001, 1002, 3010, 3011, or History Examination.
A survey of the major political, economic, and military events occurring in both the Union and the Confederacy during the American Civil War.

Hist. 3025. American Economic History
3-0-3. Prerequisite: Hist. 1001, 1002, 3010, 3011, or History Examination.
Special attention given to the rise of technology in 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: 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. 3040. Recent Latin American History
3-0-3.
Historical evolution of Latin America in recent times with particular attention to social change.

Hist. 4025. the United States Since 1917
3-0-3. Prerequisite: Hist. 1001, 1002, 3010, 3011, or History Examination.
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: History 1001, 1002, 3010, 3011, or History Examination.
The inequities and achievements of the period are dealt with through an analysis of selected topics.

Hist. 4075. The City in American History
3-0-3. Prerequisite: Hist. 1001, 1002, 3010, 3011, or History Examination.
Selected topics concerning the social, economic, and political history of American cities with emphasis on the role of technology in urban development.

Hist. 4925. Special Problems in History
Credit to be arranged.

PHILOSOPHY AND HISTORY OF SCIENCE

P.H.S. 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.H.S. 1127. Science, Technology, and Human Values
3-0-3.
An introductory study of the impact of science and technology on the religious, ethical, and social values in the Western tradition.

P.H.S. 1128. Introduction to the History of Science and Technology
3-0-3.
An interpretive study of development of science and technology to the present. Includes examination of historical details and the consequences of scientific, industrial and technological revolutions.

P.H.S. 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.H.S. 3102. History of Ancient Philosophy
3-0-3.
A study of the development of philosophy from the early scientific writings of pre-Socratics to Christian thought. The works of Plato and Aristotle stressed.

P.H.S. 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.H.S. 3104. Contemporary Philosophy
3-0-3.
A study of the diverse movements in philosophy from Hegel to Russell with emphasis on the philosophic response to the development of modern scientific inquiry.

P.H.S. 3105. Types of Ethical Theory
3-0-3.
Critical examination of ethical theories; consideration of theoretical problems of ethics; nature and presuppositions of ethical judgments; justification of ethical standards.

P.H.S. 3107. Contemporary Religious Thought
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.H.S. 3113. Symbolic Logic
3-0-3.
A first course in symbolic logic including the logic of statements and the logic of predicates.

P.H.S. 4106. Philosophy of the Behavioral and Social Sciences
3-0-3. 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.H.S. 4107. Philosophy of Technology
3-0-3. Senior standing or consent of the department.
Examination of selected problems such as interface between individual and technology, artificial intelligence, epistemology and metaphysics of technology.

P.H.S. 4108. History of Technology
3-0-3.
An introduction to the development of technology in the United States as interwoven with its economic and social background and influence.

P.H.S. 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.H.S. 4115. Philosophy of Science 
3-0-3.
Examination of selected problems such as causality, induction, scientific explanation, development of scientific knowledge, social and philosophical import of scientific theories.

P.H.S. 4116. History of Electrical Science and Technology
3-0-3.
Senior level or consent of department.
An interpretive study of the origins and evolution of electrical science and technology since the 17th century.

P.H.S. 4120. Semantics.
3-0-3. Normally taken by seniors.
The relations of formal logic and natural languages, sense and reference, semantical paradoxes, semantic criteria of truth.

P.H.S. 4948. Selected Problems in the History of Science
Credit to be arranged.

P.H.S. 4949. Special Problems
Credit to be arranged.

P.H.S. 8549. Special Topics
3-0-3.
Topics to be selected.

POLITICAL SCIENCE

Pol. 1251. Government of the United States
3-0-3.
Study of structure and function of governments of United States and Georgia. Gives exemption from United States and Georgia Constitution Examination.

Pol. 1252. 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—behavior and post-behavioral perspective. Explores basic concepts 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 thoughts which have shaped the American political system.

Pol. 3200. American Constitutional Problems
3-0-3.
Study of structure and function of United States and Georgia government, taught largely through medium of constitutional law.

3-0-3. Prerequisite: Pol. 1251 or consent of the department.
Analysis of security policies of United States in domestic and international situations.

Pol. 3204. United States Military Policies
3-0-3. Prerequisite: Pol. 1251 or consent of the department.
Critical examination of American military policies from the Revolution to present.

Pol. 3205. American Foreign Policy
3-0-3. Prerequisite: Pol. 1251 or consent of the department.
Study of formulation of foreign policy and structure and function of State Department.

Pol. 3207. 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 governments.

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, Pol. 2270, or consent of the department.
Source, nature, and use of presidential power, the roles of the president. Recent historical examples emphasized.

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. 3220. Urban Government and Political Problems
3-0-3. Prerequisite: Pol. 1251 or consent of the department.
Analysis 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 suburbia, and community power structures.

Pol. 3222. Urban Public Policy
3-0-3. Prerequisite: Pol. 3220, Pol. 3221, or consent of the department.
An empirical and systematic analysis of selected urban public policy areas, possibly including such policy areas as education, housing, and crime control.

Pol. 3265. Latin American Governments and Politics
3-0-3. Prerequisite: Pol. 1251 or consent of the department.
A survey of governmental and political processes in Latin American countries.

Pol. 3266. The Developing Nations
3-0-3. Prerequisite: Pol. 1251 or consent of the department.
Study of selected underdeveloped nations including economic and political development.

Pol. 3270. Western European Governments and Politics
3-0-3. Prerequisite: Pol. 1251 or consent of the department.
Comparative analysis of governmental and political processes in the nations of Western Europe.

Pol. 3275. Foundations of National Power and International Relations
3-0-3. Prerequisite: Pol. 1251 or consent of the department.
Study of U. S. power position in world affairs.

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. 3280. Communist Political Systems
3-0-3. Prerequisite: Pol. 1251 or consent of the department.
An analysis of governmental and political processes in the communist governments.

Pol. 3281. Soviet Foreign Policy
3-0-3. Prerequisite: Pol. 3280 or consent of the department.
Study of formulation and conduct of Soviet foreign policy. Consideration of ideological, geopolitical influences; development of relations with western world.

Pol. 4200. Political Theory I
3-0-3. Prerequisite: Pol. 1251 or consent of department.
A study of ancient, medieval, renaissance, and reformation political philosophy.

Pol. 4201. Political Theory II
3-0-3. Prerequisite: Pol. 1251, Pol. 4200, or consent of the department.
The development of political philosophy from the 17th century age of reason through the 19th century age of ideology.

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Pol. 4202. Political Theory III
3-0-3. Prerequisite: Pol. 1251, Pol. 4200. Pol. 4201, or consent of the department.
An analysis of contemporary political philosophy, emphasizing radical ideologies.

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. 4211. Science, Technology and World Politics
3-0-3. Prerequisite: Pol. 1251 or consent of the department.
Analysis of impact of science-technology on international system: role of science and technology in foreign policy process.

Pol. 4250. Georgia Internship Program
Credit to be arranged (15 hrs. max.) Junior or senior standing is normally required.
Work-study program assigning student to project in state or local government. Student prepares research paper under jurisdiction of faculty member.

Pol. 4950. Special Problems in Political Science
Credit to be arranged.

Pol. 6250. Governor's Intern Program
Credit to be arranged.
Directed reading and research for students selected to work as interns in departments of State Government.

Pol. 6251. Legislative Intern Program
Credit to be arranged.
Work-study program combining an academic study of the legislative process with internship at Georgia Legislature in winter quarter. Interns selected competitively each year.

Pol. 6255. Governmental Aspects of Planning
3-0-3.
Analysis and study of problems and solutions in the field of city planning.

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, and the foundations of personality; and analysis of social organization.

Soc. 1377. Social Institutions
3-0-3. Prerequisite: Soc. 1376.
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. 3310. Demographic Analysis
3-0-3. Prerequisite: Soc. 1376, Soc. 3308.
Factors affecting population problems; population growth, fertility, mortality, migration, distribution and composition.

Soc. 3330. Ethnic Minorities in American Society
3-0-3.
Analysis of social, economic and technological roles and contributions of various racial and cultural minorities in forming the American culture of today.

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 alienation 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. 3340. Urban Ecology and Demography
3-0-3. Prerequisite: Soc. 1376.
Involves application of ecological perspective to the study of urban phenomena; human spatial distribution theories of city location and patterns of city growth.

Soc. 3875, 3876, 3877. Special Topics

Soc. 4306. 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 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 sub-groups in urban societies; minorities, the aged, residents of the inner city, suburbanites. Impact of environment on individuals and families.

SOCIOLOGY

(See Social Science)

SPANISH

(See Modern Languages)
TEXTILE ENGINEERING

Text. 1100. Introduction to Textile Engineering 3-0-3.
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 cannot 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 department.
Alternate methods for producing yarns from continuous filament and staple fiber.

A course sequence giving the student hands-on experience in unit operations employed in textile manufacturing within a 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.


An introduction to the history, structure, properties, fabrication, and use of polymers in the textile and related industries.

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 cannot be obtained for both Text. 1100 and Text. 2701.

A survey of natural and man-made fibers used in the textile industry.

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. 3112. Knit Fabrics 3-0-3. Prerequisite: Text. 2100.
a study of warp and weft knit fabric production, properties and design. Description of knitting machines as related to fabric design and control of properties.

Text. 3113. Nonwoven Fabrics 3-0-3. Prerequisite: Text. 2100.
Chemically and mechanically bonded nonwoven fabrics, fabric formation processes, design, and properties.

Text. 3120. Introduction to Textile Chemistry 3-0-3. Prerequisite: Chem. 1102.
An introduction to the study of organic chemistry as it applies to fibers, dyes, finishes and polymers.

Text. 3121. Structures of Organic Polymers 3-0-3. Prerequisite: Text. 3120 or consent of department.
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: Physics 2113 or consent of department.
Computer techniques are applied to textile engineering problems. A calculator assembler language introduces Fortran. Application is made of digital and analog interfaces to textile processes.

Text. 3483-4-5. Problems in Textile Management I, II, and III 0-3-1. Prerequisite: Text. 3481 or concurrently.
Course sequence exposing the student to staff level problems of plant engineering, cost accounting, marketing, product development, and personnel administration within a 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. 3510. Materials Preparation, Pattern Analysis and Cutting in Garment Manufacture 3-0-3.
Methods, mechanics and analysis of materials preparation, pattern drafting and cutting in garment manufacture with emphasis on new methods and automation.

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.
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.

A survey course in yarn manufacturing covering principles of processing natural and synthetic fibers.

Text. 3701. Survey of Fabric Production 3-0-3. Prerequisite: Text. 2701 or Text. 2702; Not open to textile students.
A survey of fabric assemblies including woven, knit, nonwoven and flexible composite structures. Discussion includes processing, design and mechanical behavior.

Text. 3702. Survey of Dyeing and Finishing of Textile Materials 3-0-3. Prerequisite: Text. 2701 or Text. 2702; Not open to textile students.
Dyeing and finishing of textile materials made from natural and synthetic fibers.

Unit operations of chemical engineering emphasizing applications to fibers and textiles. (Also taught as Ch.E. 3700.)

Text. 4100. Textile Management Decision Making 2-3-3. Prerequisite: senior standing.
Students practice making management decisions using computer simulations of textile manufacturing operations in a competitive market.

Text. 4200. Fiber Science 3-0-3. Prerequisite: Physics 2121 or Physics 2111.
The physical structure and properties of fibers are examined and related to end-use performance.

Text. 4201. Mechanics of Fibrous Structures I 3-0-3. Prerequisite: Text. 4200 or consent of department.
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 department. Processes, properties and mechanics 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 department. Investigation of production processes, structures and properties of adhesive and mechanically bonded nonwoven fabrics and fiber reinforced materials.

Text. 4204. Chemical Processing of Textile Materials 3-0-3. Prerequisite: Text. 4751 or consent of department.
Chemical principles involved in the processing of textile materials.

Text. 4300. The Chemistry and Chemical Processing of Fibers and Textiles I 3-0-3. Prerequisite: Text. 3121 or 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 3-3-4. Prerequisite: Text. 3121 or Text 4751. The dyeing and finishing of textile materials with emphasis on the relationship of fiber structure and response of textiles to these chemical and mechanical processes.

Text. 4310. Textile Instrumental Analysis 2-3-3. Prerequisite: consent of department. 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. 4400. Seminar 1-0-1. Prerequisite: senior standing. Presentations by invited speakers on new developments in textiles, job opportunities and graduate education.

Text. 4401. Introduction to Textile Literature 1-0-1. Prerequisite: senior standing.
Sources of textile information and an introduction to search techniques for the textile information system.

The performance requirements of structural subsystems are examined and the relative merits of fibrous materials in these applications evaluated.

Text. 4420. Analysis of Textile Materials 3-3-4. Prerequisite: Text. 4200, Text. 3121 or consent of department.
The 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. 3485 or concurrently.
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: consent of department.
Supervision of one of the student operated enterprise's staff level departments.

Text. 4482. Product Innovation 0-3-1. Prerequisite: consent of department.
The student is part of a small entrepreneurial 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 department.
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, back-coating, and non-woven carpet manufacturing methods are examined.

The chemistry of pulp preparation, additives, and mechanical systems used in paper manufacture. Properties of paper, textiles, leather, and plastic film are contrasted.

Text. 4502. Fiber Reinforced Materials 3-0-3. Prerequisite: consent of department.
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 and Physics 2113 or consent of department.
The physical, chemical, and biological principles involved in perception, measurement, and specification of color.

Text. 4504. Fiber Spinning, Drawing and Texturing 3-0-3. Prerequisite: Text. 3121 or Text. 4751 or consent of department.
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 Mechanisms of Knit Fabrics 3-0-3. Prerequisite: Text. 3112 or consent of department.
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, Physics 2113, or consent of department.
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.
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. 4800-1-2. Special Topics 3-0-3. Prerequisite: consent of department.
Studies of topics of current interest and concern to the textile industry.

Text. 4900-1 Special Problems Credit to be arranged. Prerequisite: consent of department.
Special problems involving analytical and/or experimental investigations in the field of textiles.
Text. 6200. Physical Methods of Investigating Textiles 3-0-3. Prerequisite: Text. 3420 or consent of department. 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 department. 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: Text. 6200 or consent of department. 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, 6212. Dynamics of Fiber Processing Systems II, III 3-0-3. Prerequisite: Text. 6210 or consent of department. The dynamics of fabric forming mechanisms are examined. Weaving, knitting, sewing, heating, and drying are typical processes which are considered.

Text. 6220, 6221. Problems in Fiber Processing Systems I, II 0-6-2. Prerequisite: Text. 6210. Principles of forming various textile structures are demonstrated and verified in laboratory work.

Text. 6300. Preparation and Reactions of Polymers 3-0-3. Prerequisite: Text. 4750 and Text. 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, Text. 4751 or consent of department. Models required for the interpretation of the dyeing behavior of textile materials are examined in order to provide useful semi-quantitative descriptions of dye processes.

Text. 6321. Chemical Technology of Stabilization Processes 3-0-3. Prerequisite: Text. 4301 Text. 4751 or consent of department. A comprehensive treatment of finishing processes used in the textile industry to impart desirable end-use performance characteristics to textile materials.

Text. 6750. Polymer Structure and Physical Properties I 3-0-3. Prerequisite: Text. 4751 or Ch.E. 4751 or consent of department. 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 composite nature of all polymers and polymeric materials. Also taught as Ch.E. 6751.

Text. 7000. Master's Thesis

Text. 7200. Advanced Mechanics of Fibrous Structures I 3-0-3. Prerequisite: Text. 4203 or consent of department. The tensile, bending and torsional response of fibers, continuous filament, staple and blended yarns, and braided cords.


Text. 7210. Recent Advances in Textile Manufacturing 3-0-3. Prerequisite: consent of department. A detailed review of significant new processes, techniques, and machines in the textile industry.

Text. 7300. Energetics 3-0-3. Prerequisite: consent of department. 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.

Text. 7301. Kinetics 3-0-3. Prerequisite: consent of department. 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. 7311. Polymer Degradation 3-0-3. Prerequisite: Text. 4750 and 4751 or consent of department. A study of the physical and chemical changes in polymeric materials exposed to hostile environments during processing and use.

Text. 7312. Dye Synthesis 3-0-3. Prerequisite: consent of department. The industrial chemistry of dyes and their intermediates is covered. Structure is related to color, fastness, and affinity. Lapworth nomenclature and recent patents are surveyed.

Text. 7750. Surface and Solution Properties of Polymers 3-0-3. Prerequisite: consent of department. 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. 7760 Polymer Flow 3-0-3. Prerequisite: Text. 6750, C.E. 3054, Text. 3750 or consent of department. The fluid mechanics, heat transfer, and mixing of non-Newtonian fluids. Experimental methods for characterizing fluids and the extrusion of polymer melts are emphasized.

Text. 7999. Preparation for Ph.D. Qualifying Exams.

Text. 8000, 8001, 8002. Seminar 1-0-0.

Text. 8100, 8101, 8102. Special Topics in Textile Science and Engineering 3-0-3. Prerequisite: consent of department. Topics of current interest in textile science and engineering.

Text. 8500, 8501, 8502. Special Problems in Textiles and Textile Engineering Credit to be arranged.

Text. 9000. Doctor's Thesis
6. Student Rules and Regulations
STUDENT RULES AND REGULATIONS
The Committee on Student Rules and Regulations
H. R. Hunt, Chairman
S. L. Dickerson
James E. Dull
F. E. Roper
J. W. Walker

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 official address, and he 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 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 class, the students shall wait for him until twenty minutes after the hour. If the instructor has not arrived by that time, they may leave unless specifically notified to await his 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 the work missed during their absences. Approval of such activities will be granted by the Executive 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:

A—excellent (4 quality points)
B—good (3 quality points)
C—satisfactory (2 quality points)
D—passing (1 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:

S—satisfactory completion of a course taken under pass-fail or of a course in which no other letter grade may be assigned.

U—unsatisfactory completion of a course taken under pass-fail or of 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. If the student's record is so poor as to preclude his passing, the instructor shall assign the grade of F.

W—(with date)—out before the end of the fifth week, or out passing after the fifth week. The student must have officially dropped the course with all required approvals. After the fifth week of the quarter, approval will not ordinarily be given. Courses in which the grade "W" has been assigned will not be included in computing the scholastic average. The grade "W" is also assigned in cases where the student officially withdraws from school before the second week preceding the end of the quarter. Students who withdraw and receive grades of "W" will not ordinarily be permitted to re-enroll 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 or F in a course has a deficiency in the course.
2. A student whose final grade is F has a failure in that course. He must repeat and pass the course in class before 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 received the grade, nor in any quarters immediately following in which he 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 is in residence.
4. A senior who has a single deficiency between him 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 reexamination 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 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:
   For each quarter credit hour with a grade of:
   A ------------------ 4 points
   B ------------------ 3 points
   C ------------------ 2 points
   D ------------------ 1 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:
<table>
<thead>
<tr>
<th>Classification</th>
<th>0-50 credit hours</th>
<th>51-100 credit hours</th>
<th>101-150 credit hours</th>
<th>151-to graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
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<td>Sophomore</td>
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<td>Junior</td>
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<tr>
<td>Senior</td>
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</tbody>
</table>

   A student who has completed all requirements for a particular classification as defined by his major department may petition for reclassification through his major department.

2. Students scheduled for twelve 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 between schools during their first quarter at Georgia Tech. Thereafter, by filing the required form, free 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 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, and are not on academic warning or probation or subject to any disciplinary action.

3. Satisfactory scholarship
(a) A scholastic average of 2.0 is the minimum satisfactory scholastic average except for freshmen for whom the requirement is 1.7 and for sophomores for whom the requirement is 1.9.
(b) A student whose scholastic average for any quarter is 1.0 or below shall be referred to the Committee of Standing, which may place the student on academic probation or drop him regardless of his previous record if such action is deemed advisable.

4. Good academic standing
A student not on academic probation is in good academic standing.

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 load of 18 credit hours.

6. Academic probation
A student on academic probation 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 15 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 shall be reviewed by the Committee on Standing, which may dismiss the student or continue him 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 twelve credit hours. The academic standing of these students will be determined by the Committee on Standing 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 application for readmission be considered unless he has remained out of the institute for one regular quarter. (The summer session is considered here to be a regular quarter.) 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.
3. A student who has been dropped a second time for unsatisfactory scholarship will not be readmitted unless approved by the Executive Committee.

G. Exceptions
Exceptions to the scholastic regulations may be made by the Committee on Standing 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 course.
2. In dropping courses from his schedule, a student must retain back courses in preference to advanced courses, unless permission is otherwise obtained from his school director.
3. The scheduling of back courses is the responsibility of the student, and he will be held accountable therefor.
4. The normal load scheduled by a student in good standing may not exceed 21 credit hours. In exceptional cases a student may schedule up to 23 credit hours with permission of the Executive Committee.
5. Auditing of courses will be permitted to a regularly enrolled student who has obtained the approval of his 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 a W on the basis of the auditor's attendance in the course. The grade of 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 credit 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.

B. Examinations for advanced standing

1. A student who offers satisfactory evidence that he 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 may 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 examinations at the end of the quarter immediately preceding commencement.

D. Regulations covering final examinations

A student reporting to a final examination room more than fifteen minutes after the hour shall not be allowed to take the examination, unless he can present a satisfactory explanation to the instructor conducting the examination. If unable to present an explanation satisfactory to the instructor, he 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 final quarter in residence.

2. To be a candidate for a degree, a student must have passed all courses required for the degree, must have a scholastic average for his entire academic program of at least 2.0, and must have done creditable work in his departmental courses so as to merit the recommendation for the degree by the director and faculty of his school.

3. A student, with the approval of his 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 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. The diploma of a candidate for a degree shall bear the date of the commencement at which the degree is awarded.

6. 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.

7. No work may be counted toward a degree which has been completed more than ten 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 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 fifty credit hours in excess of the requirement for any previous degrees earned.

XI. CONDUCT

A. Student Conduct Code

A student enrolling in the Georgia Institute of Technology assumes an obligation to conduct himself 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 non-academic 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.

2. Non-Academic Misconduct

Non-academic 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, ad-

ministration, 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.

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 to the institute, or 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:

Violations, wherever they may occur of the conduct code, and/or the laws of the City of Atlanta, Fulton County, the state of Georgia or the United States, where the violative act creates a clear and present danger of material interference with the normal, or orderly processes of the institute or its requirements of appropriate discipline.

q. Violations of the “Student Motor Vehicle Regulations” (Violations fall within the jurisdiction of the Student Traffic Court.)

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 non-academic misconduct.

b. The dean of students shall cause to be investigated alleged acts of student misconduct reported to him. He 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 notify the accused student(s) in writing. Cases of academic misconduct are referred to the Student-Faculty Honor Committee through the hearing body chairman. Cases of non-academic misconduct are referred to the Graduate Judiciary or Undergraduate Judiciary Cabinet through the hearing body chairman.

c. When written notification is made by the dean of students to a student(s) for alleged violations of academic misconduct or non-academic 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 his 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 may request a hearing as specified in e, f, or g below.

e. Cases of academic misconduct will normally be referred to the Student-Faculty Honor Committee, which shall hear and try cases involving academic misconduct on the part of any student(s).

f. Cases of serious non-academic misconduct which may result in suspension or 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 agen-
cies in those cases of non-academic 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 shall at the request of the accused, or for good cause may, refer any case of non-academic misconduct to the Graduate Judiciary or Undergraduate Judiciary Cabinet.

h. A student(s) accused of an act of academic misconduct or non-academic misconduct is encouraged to notify his/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 measure, if applied, will be without reasonably avoidable prejudice to the student(s).

2. Student-Faculty Honor Committee

a. The Student-Faculty Honor Committee shall consist of four (4) faculty members (of staggered terms 4, 3, 2, and 1 years – the faculty member with the longest service on the committee shall be chairman) and three (3) students. The faculty members shall be members of the Academic Senate and shall be appointed by the president. In cases involving undergraduate students, the student members of the committee shall be currently enrolled, full-time, undergraduate students in good standing appointed by the student body president with the approval of the Student Council. In cases involving graduate students, the student members of the committee shall be currently enrolled, full-time graduate students in good standing who are appointed by the president of the Graduate Student Body and approved by the Graduate Student Senate.

b. The Student-Faculty Honor Committee shall hear all cases of alleged academic misconduct.

3. Student Judiciary

a. Graduate Judiciary

The Graduate Judiciary shall consist of a graduate student chairman and six (6) 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 non-academic misconduct in which there is the possibility of suspension or expulsion of the accused student. The Graduate Judiciary shall have appellate jurisdiction in cases from the Student Traffic Court involving graduate students.

b. The Undergraduate Judiciary Cabinet

The Undergraduate Judiciary Cabinet shall consist of an undergraduate student chairman and ten (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 non-academic misconduct in which there is a possibility of suspension or expulsion of the accused student. The Undergraduate Judiciary Cabinet shall have appellate jurisdiction in cases from the Student Traffic Court involving undergraduate students.

4. Procedural Rights of Accused

a. A student(s) accused of an act(s) of misconduct and summoned to a hearing before the Student-Faculty Honor Committee, Graduate Judiciary or Judiciary Cabinet shall have to right to:

   (1.) Be accompanied by an advisor of his choice.
   (2.) Remain silent with no inference of guilt drawn therefrom.
   (3.) Question the complainant.
   (4.) Present evidence in his behalf.
   (5.) Call pertinent witnesses in his behalf.
   (6.) Cross-examine witnesses.
   (7.) 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 (6) student justices and the chairman must remain.
   (8.) Right of appeal.

5. Hearing Procedures

a. The chairman of the hearing body shall set the date, time and place of the hearing, and 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-Faculty Honor Committee, Graduate Judiciary or Undergraduate Judiciary Cabinet, the chairman shall notify the accused student(s) in writing at least three (3) 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 is accused, with sufficient particularity to ensure opportunity to prepare for the hearing.

(3.) Names of witnesses scheduled to appear.

c. Decisions of the hearing body shall be by majority vote. A quorum for the Student-Faculty Honor Committee shall consist of five (5) members, three (3) faculty members, and two (2) students. A quorum for the Undergraduate Judiciary Cabinet shall consist of the chairman and six (6) justices. (In appeals involving violations of Student Motor Vehicle Regulations, three (3) student justices will constitute a quorum). A quorum for the Graduate Judiciary shall consist of the chairman and four (4) justices.

d. Any member of the hearing body shall disqualify himself if his personal involvement in the hearing is of such a nature as to prejudice the case.

e. The hearings of the Student-Faculty Honor Committee, Graduate Judiciary and Undergraduate Judiciary Cabinet shall ordinarily be closed except for the accused and his advisor and those directly involved; exceptions may be made at the discretion of the chairman. The hearing body may exclude anyone 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.

6. Disciplinary Measures

a. For violations of institute rules and regulations or for acts of student misconduct, academic or non-academic, 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 severances 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 restitution. A student on disciplinary probation is not in good stand-

ing, and shall not be permitted to hold any elective or appointive office in extracurricular activities, or to participate in any contest or 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 may appeal the case in writing to the president of Georgia Tech within five (5) days after the action about which there is a complaint.

b. The president, within five (5) days, shall:

(1.) Refer the appeal to the Student-Faculty Appeal Board to review all facts and circumstances connected with the case and report their findings to the president within five (5) days of the receipt of the appeal.

The Student-Faculty Appeal Board will consist of five (5) faculty members (of staggered terms of 5,4,3,2, and 1 years — the faculty member with the longest service on the Appeal Board shall be chairman (the faculty members will be selected and appointed by the Executive Committee of the Academic Senate) and four (4) currently enrolled, full-time students in good standing [two (2) undergraduate students of junior or senior standing and two (2) graduate students with at least 1 year's enrollment]. The graduate student members will be appointed by the Graduate Student Body president with the approval of the Graduate Student Senate. The undergraduate student members will be appointed by the Student Body president with the approval of the Student Council. A quorum will consist of three (3) faculty and two (2) students.

c. The president, within five (5) days from the receipt of the committee's recommendation, shall make a decision in the case which shall be final so far as the institute is concerned.

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. Appeals made to the Board of Regents by students who have been suspended or expelled may only be made after appealing to the president of Georgia Tech, and such appeal must be made in writing to the executive secretary of the Board of Regents within ten (10) days after the president's
decision: such shall recite all reasons for dissatisfaction with the previous decision.

C. Regents' 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 non-disruptive 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 actions 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 on occasion 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 the several 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 or disrupts, or attempts to obstruct or disrupt any teaching, research, administrative, disciplinary or 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. (Minutes, 1968-69, pp. 166-169).

XII. WITHDRAWAL FROM SCHOOL

A. General

1. No student under eighteen years of age will be allowed to withdraw from school before the official close of a quarter, unless he first presents, with his formal resignation, written permission to this effect from his parents or guardian. A student over eighteen 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. 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 Student Traffic Court and the Student 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 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 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 TRAINING
All freshman and sophomore students will be required to take physical training except the following who will be exempt: students not physically able; students twenty-one years of age or over on first admission to Georgia Tech; students who are over twenty-five years of age; veterans, who shall receive one quarter exemption for each quarter as a full-time student at another institution. The director of health shall determine physical ability. The registrar shall determine all other exemptions. The Executive Committee may grant exemptions in exceptional cases.

Students exempted from physical training are not required to make up the credit hours.

XVI. R.O.T.C. 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. If the student elects to take basic ROTC he may count six credit hours toward his degree.
2. If the student elects not to take basic ROTC he must substitute other courses totaling six credit hours.
3. If the student elects to take basic ROTC but drops it before completing six credit hours he must make up the difference between the credit hours he 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, in good standing, and carrying a schedule of at least six credit hours. (In addition, he 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 Executive 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 (6) 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 Faculty Committee.
on Student Activities, whose approval is also necessary. Faculty Senate approval will be granted by the acceptance of the minutes of the Faculty Committee on Student Activities. Subsequent revisions and amendments of the constitution must also be approved by the Student Council and the Faculty Committee on Student Activities.

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 Regulations; and its compliance with all other relevant school rules and regulations. The conclusions about each organization will be transmitted to the Faculty Committee on Student Activities 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 in good standing, 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 in good standing, 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 N.C.A.A. 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.
4. It is the policy of the Georgia Institute of Technology not to approve women students for competition on men’s athletic teams. This would not preclude the formation of women’s teams under the sponsorship of Georgia Tech. Nor would it preclude women representing Georgia Tech in meets or tournaments against other women.

XVIII. EXCEPTIONS

Where appeals are not otherwise specified in this document, exceptions to the regulations may be made by the Executive 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.
7. Administration, Faculty and Staff
ADMINISTRATION

Board of Regents

Georgia Institute of Technology is one of the educational institutions constituting the University System of Georgia. The University System is governed by a 15-man Board of Regents, the members of which are appointed to seven-year terms by the Governor of Georgia. The members of the Board of Regents are:

Jesse Hill, Atlanta ........................................ State-at-Large
John A. Bell, Jr., Dublin ................................... State-at-Large
Roy V. Harris, Augusta .................................. State-at-Large
*William S. Morris, III, Augusta ....................... State-at-Large
Sam A. Way, III, Hawkinsville ......................... State-at-Large
Mrs. Hugh Peterson, Sr., Ailey .......................... First District
John I. Spooner, Donalsonville .......................... Second District
John H. Robinson, III, Americus ......................... Third District
John R. Richardson, Conyers ................................ Fourth District
W. Lee Burge, Atlanta ................................... Fifth District
David H. Tisinger, Carrollton ............................ Sixth District
James D. Maddox, Rome ..................................... Seventh District
**Charles A. Harris, Ocilla .................................. Eight District
P. R. Smith, Winder ........................................ Ninth District
Carey Williams, Greensboro ................................ Tenth District

**Vice Chairman
*Chairman

Chancellor of University System and His Administrative Staff

Chancellor George L. Simpson, Jr. is the chief administrative officer of the University System and the chief executive officer of the Board of Regents. Members of his administrative staff are:

John O. Eidson, Vice Chancellor
John W. Hooper, Associate Vice Chancellor
Henry G. Neal, Executive Secretary
Shealy E. McCoy, Vice Chancellor-Fiscal Affairs and Treasurer
James E. Boyd, Vice Chancellor-Academic Development
Frank C. Dunham, Vice-Chancellor-Construction and Physical Plant
Mario J. Goglia, Vice Chancellor-Research
Howard Jordan, Jr., Vice Chancellor-Services

Harry B. O'Rear, Vice Chancellor-Health Affairs
James L. Carmon, Assistant Vice Chancellor-Computing Systems
Haskin R. Pounds, Assistant Vice Chancellor
Mrs. Hubert L. Harris, Assistant Vice Chancellor-Personnel
Robert M. Joiner, Assistant Vice Chancellor-Communications
Harry H. Murphy, Jr., Director of Public Information
C. C. Murray, Director, Interinstitutional Programs in International Affairs

INSTITUTIONAL ADMINISTRATION

Office of the President

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W. M. Sangster, Director, Civil Engineering
D. T. Paris, Director, Electrical Engineering
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Institution</th>
<th>Degree</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>James A. Anderson, Ph.D.</td>
<td>Assistant Professor, Biology</td>
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</tr>
<tr>
<td>Aristides F. Abril, D.C.S.</td>
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<td>University of Havana</td>
<td>D.C.S.</td>
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<tr>
<td>George H. Adams, B.S.</td>
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<td>Western Carolina University</td>
<td>B.S.</td>
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<tr>
<td>Henry W. Adams, M.A.</td>
<td>Professor Emeritus, English</td>
<td>Columbia University</td>
<td>M.A.</td>
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<tr>
<td>Philip Adler, Jr., Ph.D.</td>
<td>Professor, Industrial Management</td>
<td>Ohio State University</td>
<td>Ph.D.</td>
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<tr>
<td>R. Martin Ahrens, Ph.D.</td>
<td>Professor, Physics</td>
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<td>Ph.D.</td>
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<tr>
<td>Cecil O. Alford, Ph.D.</td>
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<td>Mississippi State University</td>
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<tr>
<td>Edgar R. Allingham, B.S.</td>
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<tr>
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<tr>
<td>Tom F. Almon, M.A.</td>
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<td>M.A.</td>
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<tr>
<td>Francis B. Alt, B.S.E.</td>
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<tr>
<td>Charles Anderson, Jr., B.S.</td>
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<td>B.S.</td>
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<tr>
<td>Gary L. Anderson, Ph.D.</td>
<td>Assistant Professor, Industrial and Systems Engineering</td>
<td>Purdue University</td>
<td>Ph.D.</td>
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<tr>
<td>Jerry M. Anderson, Ph.D.</td>
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<tr>
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<tr>
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<td></td>
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<tr>
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<td></td>
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<tr>
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<td></td>
</tr>
<tr>
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<tr>
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<tr>
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<td></td>
</tr>
<tr>
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<td>Georgia, Michigan</td>
</tr>
</tbody>
</table>
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(Lieutenant Colonel, USA)  
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