

# *Georgia Tech*

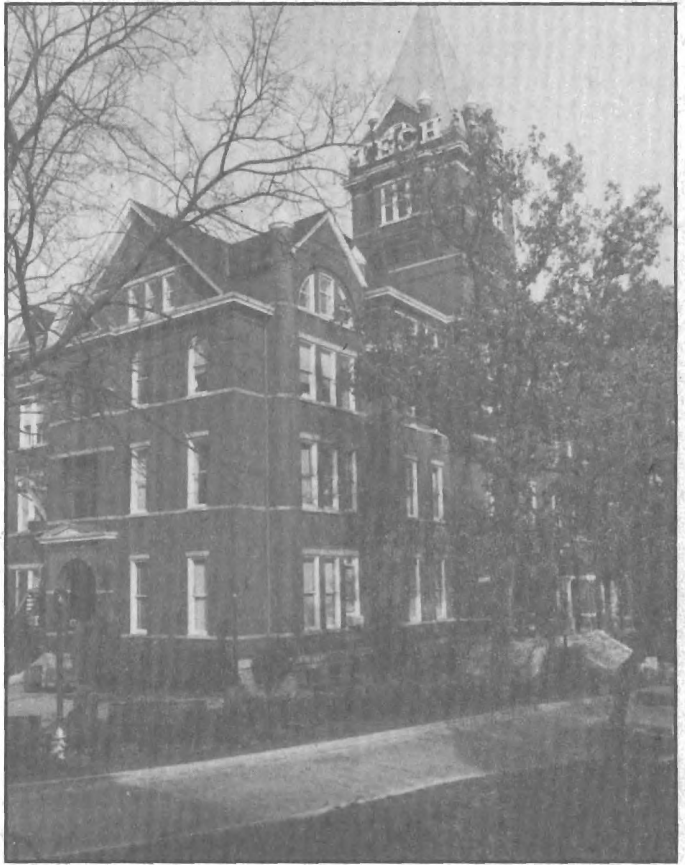


**experience  
the future**

general catalog 1995-96

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# *Georgia Institute of Technology*



General Catalog 1995-96  
Georgia Institute of Technology  
Atlanta, Georgia  
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**Georgia Tech: A Statement of  
Purpose**

The Georgia Institute of Technology is preparing leaders for the twenty-first century by building on traditional strengths and transcending disciplinary boundaries. This interdisciplinary interaction among traditionally unrelated fields serves as a catalyst for innovation. As a whole, our unique curricular configuration instills a greater understanding of the scientific, social, environmental, political, and international factors that will shape all technological development and, therefore, economic growth. In doing so, our students learn to think, analyze, and act. Equipped with these skills, they synthesize technological concepts and meet rigorous challenges imposed by industry and government. Through dedication to public service and educational value, we serve to enhance the state's greatest resource — its people.

**Statement on Human  
Relations**

Georgia Tech is a diverse community, composed of individuals and groups with a variety of religious, racial, national, cultural, sexual, and educational identities. The continuing need to deal constructively with this diversity is one of the great challenges facing us over the next two decades.

The challenge is both professional and personal. Professionally, we increase the opportunities in our lives if we are able to constructively manage and guide such diversity with tolerance. The challenge is also personal because each of us has a legacy of religious, racial, national, cultural, sexual, and educational prejudices which influence our lives.

Each member of our community must be committed to the creation of a harmonious climate because one cannot be neutral to this challenge. Those who are committed to it strengthen Georgia Tech and themselves.

Individuals who choose not to commit to the challenge, via acts of intolerance, jeopardize their continued affiliation with the Institute. Those acts may be defined as attempts to injure, harm, malign, or harass a person because of race, religious belief, color, sexual orientation, national origin, disability, age, or gender.

To belong to a global society, Georgia Tech must be a pluralistic institution. Only by



embracing diversity, multiformity, and variety can we gain stature, strength, and influence in that global society.

The Institute is committed to maintaining academic and working environments free of objectionable conduct and communication that would be construed as sexual harassment. The determination of what constitutes sexual harassment will vary with particular circumstances, but it can be described as unwanted sexual behavior, such as physical contact or verbal comments which adversely affect the environment of an individual.

## Academic Calendar 1995-96

Georgia Tech operates on the quarter plan, with the fall, winter, and spring quarters normally constituting the academic year. A full summer quarter schedule offers students the opportunity to accelerate their programs by attending four quarters per year. Students may enter a course of study or complete their degree requirements and attend a commencement ceremony in any one of the four quarters.

The Office of the Registrar prepares and distributes an official Institute calendar for each quarter. Dates, filing times, deadlines, and other information contained in the official calendar supersede previously published information, including notices in this catalog. Adherence to the requirements set by the official calendar is the responsibility of the student.

### Summer Quarter 1995

June 19	Registration
June 20	Classes begin
July 4	Holiday
August 25	Last day of classes
August 28	Final exams begin
September 1	Commencement
September 2	End of term

### Fall Quarter 1995

September 18-19	Registration
September 20	Classes begin
November 23	Begin Thanksgiving recess
November 26	Last day of Thanksgiving recess
December 1	Last day of classes
December 4	Final exams begin
December 9	End of term; Commencement
December 10	Begin Christmas recess

### Winter Quarter 1996

January 3	Registration
January 4	Classes begin
January 15	Holiday
March 8	Last day of classes
March 11	Final exams begin
March 16	End of term; Commencement
March 17	Begin spring recess

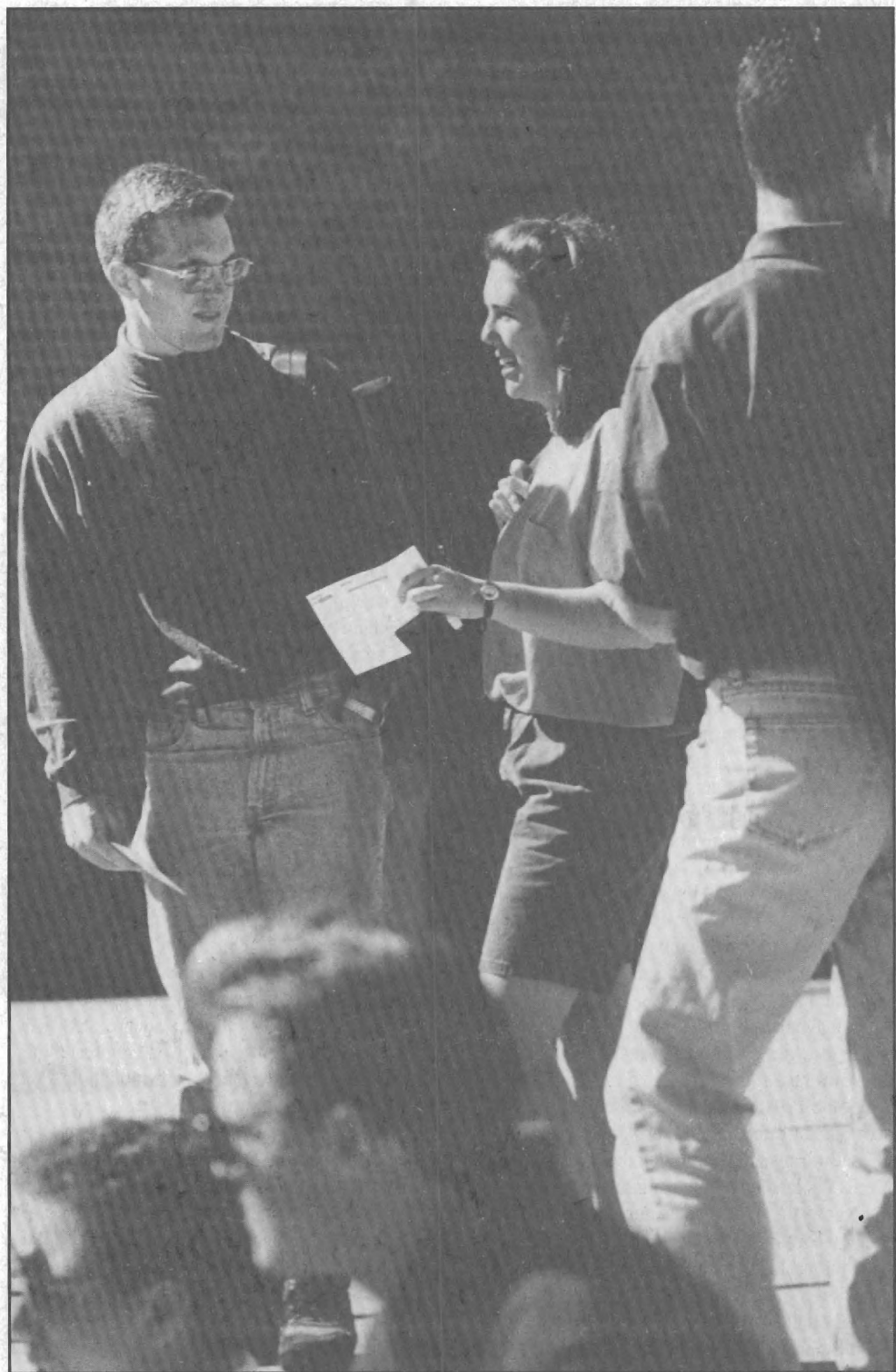
### Spring Quarter 1996

March 25	Registration
March 26	Classes begin
May 27	Holiday
May 31	Last day of classes
June 3	Final exams begin
June 8	End of term; Commencement

### \*Summer Quarter 1996

June 24	Registration
June 25	Classes begin
July 4	Holiday
August 26	Final exams begin
August 30	Last day of classes
September 2	Final exams begin
September 6	End of term

\* Note: Classes held during Summer Quarter 1996 will take place on the campus of the Southern College of Technology in Marietta, Georgia.



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# EXPERIENCE THE FUTURE AT GEORGIA TECH

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From the past through the present, the future has always been a top consideration at Georgia Tech. The first day of Tech classes in 1888 signified the beginning of technological education and economic transformation in the agrarian South. Despite opposition from those entrenched in the status quo, the foresighted founders of Georgia Tech laid the foundation for a prosperous future for the region.

Tech's economic, scientific, and technological leadership continues today. The Institute's renaissance graduates leave Georgia Tech with an understanding of the needs of the world and the demands of a global economy. They are prepared to be significant catalysts for the U.S. in the international market of the twenty-first century. In addition, our world-class multidisciplinary research centers provide leadership, guidance, and innovation to business, industry, and government.

In 1994 Tech alumnus Gerald Wayne Clough was named the tenth president of the Institute. President Clough is the first alumnus ever selected to lead the university. His commitment to a "shared vision" for the future has already been felt on campus. Due to Dr. Clough's leadership, coordinated strategic planning initiatives have been undertaken by students, faculty, staff, and administration.

Strengthening the foundation of success for the future includes continuing to recruit and retain above average students. With an average score of 1233, the 1994 freshman class has the highest SAT score of any public university in the country. This class also ranks first in the number of National Merit Scholars attending a public university. Current total undergraduate enrollment is 9,213, and total graduate enrollment is 3,688. Tech not only attracts high quality undergraduates, but superior graduate students as well. In 1994 we graduated the highest number of Ph.D. and M.S. degree students in Tech's history.

To become even more effective in a rapidly diversifying world, Tech is aggressively recruiting underrepresented populations. Each year the number of minority students continues to grow. More than 25 percent of our students are women, and we are ranked first in the country for the total number of degrees in engineering awarded to women. We also rank first in the number of master's degrees in engineering awarded to African Americans and second in the total number of engineering degrees awarded to African Americans.

Alongside their academic achievements, Georgia Tech students are also active in the community. More than 1,000 Tech students give of their time in community service activities.

Tech prepares students for future success. Many forward-thinking students choose to participate in the Cooperative Plan at Tech, an alternating work/study program that is the largest voluntary program of its kind in the U.S. More than 3,000 students (approximately one-third of Tech's student population) participate in this program. Tech's Placement Center is also one of the nation's most successful. In 1994 more than 550 employers interacted with that office.

The continued recruitment and job placement of high-quality students can also be attributed to the excellence of Tech's faculty. More than 90 percent of our faculty hold Ph.D. degrees and 40 of our young faculty have received the prestigious Presidential or National Science Foundation Young Investigator Awards.

Tech's administration and staff emphasize student services as well as academics. Centralized student services, the Student Success Center, and renovated and new residence halls are some of the efforts to improve the quality of life on campus. The strong work ethic at Tech is balanced by a collegiate atmosphere incorporating sports, campus traditions, and more than 170 extracurricular activities.



Georgia Tech is ranked among the top U.S. universities. *U.S. News & World Report* ranked Tech as the third best buy in education, as well as in tier one of the nation's best universities. It also ranked Tech's graduate industrial and manufacturing programs number one in the nation and our graduate school of business 26th in the nation.

Georgia Tech's influence has become far-reaching. As a leading technological university with state-of-the-art facilities, Georgia Tech will host Olympic athletes and coaches from all over the world in our role as the 1996 Olympic Village. Tech's more than 50 interdisciplinary research centers consistently contribute vital research and innovation to America's government, industry, and business. For example, through research aimed at creating smaller electronic devices that cost less, Tech's newest multidisciplinary research center, the Packaging Research Center is expected to revolutionize the electronics industry in the United States. In Georgia specifically, the Institute plays a leading role in the Georgia Research Alliance (GRA), a centerpiece of the state's economic development strategy. Likewise the Manufacturing Research Center at Tech is regarded as the leading such organization in the country.

By insisting that the Institute's major interdisciplinary centers — focusing on topics from architectural conservation to biotechnology, microelectronics, and transportation research — also develop distinct undergraduate and graduate educational programs, Tech intends to keep its educational programs on the leading edge of discoveries and developments. Students have access to Tech's marine research facility at Skidaway Island off the Georgia coast, the Oak Ridge Nuclear Laboratories in Tennessee, and the global telecommunications activities at Georgia Tech's campus in Lorraine, France.

The Institute's commitment to excellence extends to athletics. During the past five years, Tech has won national championships in football, the ACC tournament in basketball, sent its basketball team to the Sweet Sixteen and the Final Four of the NCAA tournament, and won the ACC title in both golf and baseball. Tech's 1994 baseball team went on to win the NCAA Western Division, ending their quest just one game short in the finals of the Collegiate World Series. In 1994 our women's volleyball team had their best year

yet, tying for the top spot in the ACC during regular season play. Year after year, the NCAA ranks Tech in its list of the top 12 schools in the U.S. for football player graduation and our total rate of student athlete graduates in the top 25 of NCAA Division I.

As the modern research university continues to evolve, Georgia Tech is dedicated to remaining one step ahead of the status quo. Equipped with the extremely rich resources of an outstanding student body and faculty, strong partnerships with business, industry, and government, and support from alumni and friends, Georgia Tech is poised to meet and exceed the challenges of the next century.

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## Academic Offerings

Through the Colleges of Engineering, Sciences, Computing, Architecture, and Management, Policy, and International Affairs, Georgia Tech offers curricula leading to degrees in 31 undergraduate majors, 36 master's programs, and 24 doctoral programs as well as preparatory programs for law and medical schools. The "Information for Undergraduate Students" and the "Information for Graduate Students" sections of this book contain general information about these degree programs. For more specific information, see the "Curricula and Courses of Instruction" section in this catalog.

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## Accreditation

The Georgia Institute of Technology is an accredited member of the Southern Association of Colleges and Schools, and many programs within the Institute are specifically accredited by appropriate national certifying agencies. The Accreditation Board for Engineering and Technology (formerly the Engineers' Council for Professional Development) has awarded accreditation to the four-year engineering curricula leading to bachelor's degrees in the following fields: aerospace engineering, ceramic engineering, chemical engineering, civil engineering, computer engineering, electrical engineering, industrial engineering, materials engineering, mechanical engineering, nuclear engineering, and textile engineering and to the graduate programs leading to the master's degree in environmental engineering. The American

Chemical Society has certified the curriculum leading to the bachelor's degree in chemistry; the Computer Science Accreditation Board has certified the curriculum leading to the bachelor's degree in computer science; the National Architecture Accrediting Board has certified the curriculum leading to the Master of Architecture; and the American Assembly of Collegiate Schools of Business has accredited the curricula leading to the Bachelor of Science in Management and the Bachelor of Science in Management Science. The Counseling and Career Planning Center is accredited by the International Association of Counseling Services.

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## Student Life

The vice president of Student Services and his staff coordinate and administer extracurricular student services and activities. For complete information concerning these services, see the *Guide to Student Life*, available to all students from the Division of Student Services.

## Community Services

Georgia Tech applies its resources through community services to the needs of the community and provides an outlet for creative individual responses to social problems.

## Counseling and Career Planning Center

Students encountering almost any concern may find help at the Counseling Center. Psychologists and professional counselors assist in a completely confidential manner with academic, career, and personal concerns whenever students request their services. The Center also provides information on careers; other colleges, pre-law advising, business and graduate schools; and a number of tests for determining interests, abilities, and personality traits.

## Fraternities and Sororities

The 40 social fraternities and sororities are coordinated by Student Services. The groups offer a variety of activities, opportunities, and services to the Georgia Tech community.

## Student Publications and Radio

The student publications and radio communications boards oversee the budgeting and operation of the *Technique*, the official student newspaper; the *Blueprint*, the student yearbook; and other student publications, in addition to the operation of the student radio station, WREK 91.1 FM.

Other student publications include the *North Avenue Review*, an open forum magazine, and *Erato*, the student literary magazine.

## Women's Programs

Students' services and programs provide opportunities to involve female students in all phases of campus life and provide resources to fulfill the Institute's commitment to accept and encourage all qualified female students who apply.

## Housing Office

The Housing Office supervises the assignment of rooms for 5,400 single students and 300 married students. Additionally, a Graduate Living Center for single graduate students and apartment complexes for single undergraduates have been opened. A residence hall program provides counseling services and organized activities for residence hall and family housing residents. For further information, refer to the residence hall or the *Living on Campus* brochure available at the Housing Office.

## Student Health Center

The mission of the Student Health Center is to provide eligible students and spouses with quality and cost-effective ambulatory health care; to educate students and promote an environment that fosters positive personal and community health habits; to provide for practical learning experiences in numerous clinical settings; and to participate in the development of both a discriminating consumer and a responsive provider of health care.

The Student Health Center is located in the Joseph B. Whitehead building, 275 Fifth Street, N.W., (immediately west of the Russ Chandler Baseball Stadium). The Student Health Center cares for ill or injured students in its Primary Care Center and helps students remain well in its Wellness Center. The Primary Care Center is comprised of full-time staff physicians, visiting

physician consultants in gynecology, orthopedics, psychiatry, and radiology; and nurse practitioners, nurses, pharmacists, and laboratory and radiology technologists. The staff physicians have training in family medicine, internal medicine, and emergency medicine. They have experience in all areas of primary care medicine, including care of medical, orthopedic, gynecological, psychiatric, and minor surgical problems. A gynecology nurse practitioner is available for gynecological problems and preventive care (i.e., pap smears). All clinical staff are available for contraceptive counseling and sexually transmitted disease prevention and treatment.

The Wellness Center is available to all Tech students and offers computer-assisted health and nutrition assessments, wellness seminars and events, an information resources center, and personal consultations for wellness planning.

### **Medical Entrance Form**

Students will receive a Medical Entrance Form with the notice of their acceptance for enrollment. All students, graduate and undergraduate, should complete the form and mail it to the Student Health Center before registration. Incomplete forms will delay registration. Evidence of a tuberculosis screening and immunizations must accompany the Medical Entrance Form. Completed health forms and inquiries should be mailed to:

Student Health Services

Georgia Institute of Technology

Atlanta, Georgia 30332-0470

Attention: Medical Records Supervisor

### **Tuberculosis Screening**

In accordance with the recommendations of the Center for Disease Control (CDC), all students entering the Georgia Institute of Technology will be screened for tuberculosis. Students born in the United States should have their tuberculosis skin test done at their local health department or by their private physician within one (1) year prior to registration. Any student who has a positive tuberculosis skin test must have a chest X-ray. If the chest X-ray is positive for tuberculosis, the student will be treated and will not be permitted to attend classes until the possibility of transmitting tuberculosis is no longer present. Students with a positive skin test and a negative chest X-ray will be

offered treatment with Isoniazid (an anti-tuberculosis drug) for a period of at least six months. All international students (who were not born in the United States) must have a chest X-ray interpreted by a radiologist and taken in the United States within the past year. Students with abnormal chest X-rays or indications of tuberculosis infection will be referred to a local health department for treatment.

**DOCUMENTATION BY A PHYSICIAN OR HEALTH DEPARTMENT FOR THE ABOVE SCREENING PROCEDURES IS NECESSARY PRIOR TO REGISTRATION.**

### **Immunization Requirements**

Immunizations for measles, mumps, and rubella (MMR) are required of all students born on or after 1/1/57. Students should have received the first dose of MMR after 12 months of age, and a second dose at least three months after the first. If you have had only one measles shot, you are required to have another one before you start school. Students born before 1/1/57 are required to show proof of rubella immunization or immunity. **DOCUMENTATION OF THESE IMMUNIZATIONS IS REQUIRED FOR REGISTRATION.**

### **Eligibility for Treatment**

Students enrolled in classes, co-op students, spouses of students enrolled in classes or the co-op program (if both the student and spouse have paid their health fees), and continuing students with a current student I.D. are eligible for treatment if the health fee is paid.

### **Cost**

A quarterly health fee is automatically assessed to those students taking six hours or more. All others must pay the health fee at the health center or present the health center with proof that the health fee has been paid. A \$10 late penalty will be assessed if the health fee is paid after the second week of each quarter.

Services begin on the first day of class and expire on graduation day of each quarter. During the inter-quarter breaks, only those persons who were eligible for treatment the preceding quarter or those who have proof of enrollment and health fee payment for the upcoming quarter will be eligible to receive services.



## **Special Health Considerations**

It is the responsibility of all students to notify the director of Student Health Service and the Department of Health and Performance Sciences of any disability or handicap that would make participation in swimming, competitive sports, and aerobic training hazardous to their well-being. Any student requesting special consideration because of mental or physical disability should have his or her physician write an explanatory letter, giving full details of the disability and consequent limitations on physical activity, to the director of Student Health Service. This letter must accompany the Medical Entrance Form. Students wanting to continue to receive allergy injections or treatments started by a private physician, should enclose a detailed, signed instruction sheet from that physician.

## **Health and Accident Insurance**

Since the facilities of the Student Health Center are limited, supplemental insurance to cover major illnesses and surgeries, specialist consultations, and diagnostic procedures (not available at the Student Health Center) should be purchased by all students who are not included in their parents' or spouses' medical insurance plans. As a general rule, private hospitals in the community will not admit patients who do not have hospitalization insurance. Supplemental insurance plans and information are available at the Student Health Center for students and their spouses. These policies cover health services rendered away from campus, between quarter breaks, during vacations, during co-op quarters, or during terms not enrolled. **Please read each policy carefully. If a more comprehensive policy is desired, students should make arrangements with a private insurance company.**

## **International Student Services & Programs (ISSP) and Study Abroad**

The ISSP/Study Abroad Department provides services and programs for three groups: over 1,000 international students from approximately 90 countries; Georgia Tech students who study abroad; and international exchange visitors. These students and exchange visitors receive assistance

in maintaining status with the U.S. immigration and naturalization service, in adjusting to Georgia Tech and American society, or in adjusting to new cultures and societies. In return, many of the students and exchange visitors work with the ISSP staff to develop programs promoting intracultural understanding.

## **New Student/Parent Programs (FASET)**

The student/parent orientation program informs new students and their parents of academic programs and requirements, in addition to familiarizing them with Tech traditions and the activities and services available on campus.

## **Office of Minority Educational Development (OMED)**

OMED is an academic service organization that seeks to assist Georgia Tech in its development of the complete undergraduate student learner who is African-American, Native-American, or Hispanic. This complete development is intended to insure that when these students graduate or leave Tech their choice set is optimal and they, as well as their families, will have had a positive and gratifying experience.

## **Student Athletic Complex**

The Fuller E. Callaway III Student Athletic Complex (SAC) is the primary recreational sports facility on campus. Facilities include: a 25-meter indoor swimming pool; a 50-meter outdoor swimming pool; five multipurpose courts for basketball, volleyball, and badminton; eight indoor racquetball/handball courts; two squash courts; five outdoor racquetball/handball courts; aerobic/exercise fitness areas; lighted artificial turf fields; and an outdoor track.

## **Georgia Tech Center for the Arts**

The Georgia Tech Center for the Arts serves as a brilliant showcase for the presentation of concerts, recitals, lectures, dance, and theatre. Since opening its doors in the spring of 1992, the Center for the Arts has provided a once in a lifetime opportunity for the students of Georgia Tech to experience the finest entertainers in the world at truly affordable prices. Each year the Center for the Arts hosts memorable

performances and events such as the 1992 Vice Presidential debate; the former Secretaries of Defense Roundtable Discussion; violinist Itzhak Perlman; Marcel Marceau, the famous mime; the Tonight Show's band leader Branford Marsalis; and the beloved Canadian Brass.

The Center for the Arts not only houses the Robert Ferst Theatre but also the Richards and Westbrook Galleries, located in the foyer of the Center, which feature displays from local and traveling exhibits of fine arts and high technology. The newly dedicated James E. Dull Theatre, containing the student-run black box Theatre which is home to DramaTech, is also located within the Center.

The Center for the Arts is committed to exploring the links between the arts and technology and serves as a shining example of Georgia Tech's dedication to excellence and outstanding performance — both on campus and in the community.

### **DramaTech**

DramaTech, Georgia Tech's theater group, produces at least four plays a year, offering a unique aspect of Georgia Tech life. DramaTech attempts to uncover and nourish the creative talents of Tech's future engineers, managers, architects, scientists, and leaders; talents that might otherwise never develop in the world of calculators, computers, designs, and formulas.

DramaTech is unique among area college theaters in that it is student run. Although Georgia Tech has no theater department, the director is part of the faculty of the School of Literature, Communication, and Culture. Participation in the theater is open to all students, faculty, staff, and community members. Students may earn credit for participation in DramaTech through the School of Literature, Communication, and Culture.

For more information, call DramaTech at 894-2745.

### **Career Services Office**

The Career Services Office (formerly known as the Placement Office) is located in the Student Success Center on the west side of Bobby Dodd stadium. Annually, about 550 employers, representing a substantial number of the Fortune 500 corporations, interact directly with the Office. National and regional salary information is maintained by the Career Services Office.

Services and assistance from the Career Services Office are available to all Georgia Tech students, from freshmen to seniors to graduate students. This office offers the Georgia Tech student community a variety of services designed to help them find employment. Campus recruiting takes place each quarter, and opportunities for full-time, part-time, temporary, and summer employment are advertised through the office. The Career Services employer information library is housed in the Center and includes information on specific employers, including government services. Students may review special publications related to employment search strategies. Seminars on job search strategies, resume preparation, interviewing, etc., are held throughout the year and students may schedule individual sessions for career assistance. In addition, the office issues to employers a compilation of resumes of graduating seniors that is available in hard copy or on disk.

New services available to students include a computerized interview scheduling system that makes Career Services available 24 hours a day, seven days a week. Video teleconferenced interviews are available for the convenience of employers. A weekly *Job Tracker* bulletin is published listing full-time, part-time, summer, and campus job postings. Career Services information is available to students on Internet and the World Wide Web Mosaic.

The Office also provides assistance to corporate university relations officials in the planning, implementation, and administration of effective corporate-university relations programs.

### **Student Center**

The Fred B. Wenn Student Center is located in the heart of the Georgia Tech campus and services Tech students' many service needs. Governed and run by students, the Student Center Program Council consists of student-run planning committees that organize and coordinate campuswide activities and events. The Student Center houses a post office, a recreation area, a crafts center, the Community Service Office, a music listening room, a ballroom, several smaller meeting rooms, a credit union, a Mac lab, and three dining options. Vans, a cellular phone, and audio/visual equipment are available for use by student organizations through the Student Center Administrative Office. Also located in the Student Center is the Center for the Arts Box Office,

offering students discounted tickets to a variety of entertainment options.

The hours of operation for many of the Student Center services vary, however, the Student Center building is open 24 hours to provide students with a place to meet and study at any hour.

### **Student Government**

The Georgia Tech Undergraduate and Graduate Student Government Associations enable students to maintain responsible and respected self-government and official institutional involvement in academic and nonacademic affairs.

### **Assistance for Persons with Disabilities**

Through the Division of Student Services, Access Disabled Assistance Program for Tech Students (A.D.A.P.T.S.), Georgia Tech offers self-identified students with disabilities assistance with registration, academic advisement, accessibility, transportation, parking, housing, counseling, tutoring, taped textbooks, advocacy, test proctoring, referral services, and other needs. The office sponsors a student advisory club and promotes disability awareness programs for departmental faculty and staff, and student organizations. Interpreting services for deaf and hard of hearing students are available through the interpreter coordinator. Faculty and staff with disabilities are served through the Office of Equal Opportunity/Affirmative Action.

For further information, contact the coordinator in the Student Services Building, Room 221, at (404) 894-2564. Information regarding faculty and staff may be obtained from the affirmative action officer in the Human Resources Building at 894-3245.

### **Nontraditional Student Services (NTSS)**

Through the NTSS office, Georgia Tech offers information pertinent to undergraduate students over age 25, graduate students over age 30, and financially independent students whose lifestyles vary significantly from those of younger students.

NTSS also offers services in conjunction with other campus offices including campus orientation, individual and group support services, advocacy, and referral services. The Nontraditional Student Services Group serves as

the student advisory committee to the office. For further information, contact the Nontraditional Student Services coordinator in the Student Services Building, Room 221, at (404) 894-2564.

### **Annual Notice of Privacy Rights**

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

A written policy detailing how Georgia Tech will comply with the provisions of the Act is printed in the *Guide to Student Life*, available in the Division of Student Affairs. The registrar has the institutional responsibility for interpreting (a) the Family Educational Rights and Privacy Act of 1974, as amended, (b) rules and regulations issued by the Department of Education, to enforce this Act, and (c) the written policy of the institution.

Students who believe the institution has violated the written policy and/or the provisions of FERPA should send a written complaint to the registrar, specifying the nature of the possible violation. The registrar shall investigate the complaint and initiate corrective action if it appears the institution is in violation. The registrar shall notify the complainant of the results of the review within a reasonable period of time, not to exceed 30 calendar days. Students also have the right to file complaints with the FERPA Office of the Department of Education, Family Policy Compliance Office, 400 Maryland Ave., S.W., Washington, D.C. 20202, regarding alleged violations of the Act.

### **Policy on Sexual Harassment**

Sexual harassment of employees or students in the University System is prohibited and shall subject the offender to dismissal or other sanctions after compliance with procedural due process



requirements. Unwelcome sexual advances, requests for sexual favors, and other conduct of a sexual nature can constitute sexual harassment. For more information, contact the Affirmative Action Office, Senior Vice President, Administration and Finance, at either (404) 894-9410 or 894-3249.

## **Intellectual Property Policy**

The Institute's Intellectual Property Policy, concerning inventions, copyright, and computer software, applies to students as well as to faculty and staff. Adherence thereto is a condition of continued enrollment at the Institute.

## **Special Support Facilities**

### **Library and Information Center**

The Georgia Tech Library and Information Center houses one of the nation's largest collections of scientific and technical information. Its holdings in management and architecture are also significant. The resources include over 2.7 million volumes, more than 700,000 government documents, over 170,000 maps, a complete collection of U.S. patents, and approximately 2 million technical reports. The Library receives more than 12,000 serials, about 75 percent in scientific and technical fields. It is an official depository of the U.S. Government Printing Office and the U.S. Patent and Trademark Office.

The catalog record of the Library is on line, as part of the Georgia Tech Electronic Library (GTEL)®, and is available to faculty, staff, and students through the campus computer network. GTEL® also contains data bases that index the contents of periodicals, conference proceedings, and research reports. Gateways to Internet resources are part of GTEL®.

Services provided by the Library include delivery of library materials to faculty and staff; computer searches of more than 500 commercial and government produced data bases; copying facilities; fee-based services to sponsored research users on campus and to individuals and businesses outside the Georgia Tech campus; access to and delivery of materials from 11 other libraries in the Atlanta area and Athens; and borrower cards for major U.S. research libraries and the libraries of all institutions in the University System.

## **Computing Facilities**

The Office of Information Technology is a service-oriented organization of Georgia Tech whose function is to provide computing services in support of education, research, and administration. Accounts issued to all students, faculty, and staff provide a universal access method for authorized computation, communication, and information. The office works closely with the academic and research units to provide specialized computer facilities in addition to strategic planning to bring Tech's facilities up to state-of-the-art levels. OIT consists of several units which are described below.

Except for official holidays, the computing facilities are open and attended 24 hours a day, seven days a week by staff from Technical Services. These facilities consist of 1 CDC Cyber 990, 1 IBM ES9000/260, 1 IBM SP2 (8 nodes), 1 KSR2 (64 cpus), 6 IBM RS/6000s (3 900 series machines, 3 500 series machines), 1 Sun SparcServer 2000 (12 cpus), 2 Sun SparcServer 1000s (6 cpus), 5 Sun 4/490s, 1 Cray YMP/EL, 1 Sequent S81 (18 cpus), and the Rich Computer Cluster, open whenever the building is attended, consists of 18 Sun IPXs and 24 Mac IIcxs.

Network Services provides interactive access to these machines via GTNet, the campuswide fiber optic based network. Direct connection plus remote dial-up connections are supported. Georgia Tech is the Network Operations Center South (NOCSouth) for the Southeastern Research Association Network (SURAnet) and is the primary node on the National Science Foundation Network (NSFnet) for the southeastern United States. Other network connections include PeachNet, the statewide educational network and Bitnet.

Client Services operates and supports 13 public clusters comprised of Apple, DOS/Windows, IBM, NeXT, and SUN microcomputers available to all students, faculty, and staff. This department also provides access and instruction for the use of high-performance computing facilities, operates the Helpdesk, supports basic and applied research in computer graphics, and operates the scientific visualization laboratory. Client Services also supports an Information Center, provides end user training, and administers software site licensing programs. The Field Services group provides microcomputer, networking, and hardware contract support.

Information Systems and Services develops and

maintains the traditional administrative software applications. A comprehensive development effort is underway to build an integrated Administrative Information Management System based on relational data base technologies in a distributed computing environment, including a Student Information System, Business Data Systems, Human Resources, and Departmental/Executive Information Systems. Planning and Programs provides centralized program management support to OIT. This office is developing a Strategic Plan for OIT, assists the OIT staff with full life cycle project support including requirement's analysis, specification development, bid preparation, acquisition support, scheduling, and project execution. Additionally, Planning and Programs, in coordination with Network Services, is managing the FutureNet program that will significantly enhance the campus telecommunications infrastructure.

## On-line Capabilities

Applying for admission to Georgia Tech is now as easy as ABC. The Apply By Computer (ABC) program allows anyone with access to a computer terminal and a modem to submit their undergraduate application for admission via the Georgia Tech computer network (GTNet). The application fee is waived for undergraduate applications submitted through ABC. Georgia Tech was the first university to develop a computer-prompted application procedure. The ABC system also enables prospective students to submit co-op applications, request data on the Institute, and monitor the status of their application. In addition, GTNet enables enrolled students to register for classes, check grades, request transcripts, change addresses, search library data bases, and apply for housing or financial aid.

GTNet may be accessed via the following phone lines and communications parameters. All are full duplex, one stop bit, and use XON/XOFF flow control.

### ABC - Apply by Computer Log-in Instructions

(Application fee is waived for applications submitted by ABC.)

To connect with the Georgia Tech computer network (GTNet), dial the following number: (404) 894-2195. (Supports line speeds

1200/2400 BPS, 8 Data Bits, no parity, 1 stop bit.)

Once your terminal is connected to GTNet, press the return (or enter) key until you get to a prompt with two "greater than" signs at the end (">>").

Then type: **telnet georgiatech**.

(Note: "georgiatech" is all lowercase letters and there is no space between the "a" and the "t.")

Always complete each input by pressing the return or enter key. The next prompt should be: **login**. At this point, type: **yellow**. Then you should see the prompt: **password: Type: jackets** (the password will not appear on the screen when you type it).

From this point, follow the instructions that appear on the screen; the program provides prompts at each step. If you need help, call the Office of Admissions at (404) 894-4154.

After completion of the application and the prompt with the ">>" reappears, type: **hangup**.

## Georgia Tech Research Institute

The Georgia Tech Research Institute (GTRI) is a nonprofit, client-oriented, applied research organization that is an integral part of the Georgia Institute of Technology. It was chartered by the Georgia General Assembly in 1919 and activated in 1934. GTRI plans and conducts focused programs of innovative research, education, and economic development that advance the global competitiveness of Georgia, the region, and the nation. Working closely with academic colleges and interdisciplinary centers in areas of research, education, and service, GTRI plays a vital role in helping Georgia Tech reach its goals.

Specific missions include:

- Conducting scientific, engineering, and industrial research;
- Participating in national programs of science, technology, and preparedness;
- Encouraging the development of Georgia's natural resources;
- Aiding industrial and economic development; and
- Furnishing technical advice and assistance to business and industry.

GTRI researchers have expertise in most important areas of science and technology.

Major GTRI research areas include:

- acoustics
- aerospace sciences
- communications
- economic development
- educational technology
- electromagnetic environmental effects
- electronic defense
- energy development
- environmental science and technology
- information technology
- infrared/electro-optics
- intelligence and national policy
- manufacturing technology
- materials science
- medical technology
- microelectronics and applications
- modeling and systems analysis
- photonic devices and materials
- radar
- sensors
- simulation systems
- technology transfer
- test and evaluation, and
- transportation

As of December 31, 1994, GTRI had 1,184 employees, including 488 full-time engineers and scientists and 255 full-time support staff members. Other employees include additional faculty, students, and consultants who work in the research program on a part-time basis. During fiscal 1994, GTRI research expenditures totaled \$94.6 million, accounting for approximately 60 percent of Georgia Tech's overall research volume.

GTRI is headquartered on the Georgia Tech campus in Atlanta. A major portion of the activity is also located at an off-campus facility in nearby Cobb County. For additional information, contact the Office of the Vice President and Director, Georgia Tech Research Institute, Centennial Research Building, Atlanta, Georgia 30332-0800, Telephone: (404) 894-3411.

## **Advanced Technology Development Center**

The Advanced Technology Development Center (ATDC), was formed in 1980 by the governor and General Assembly to increase the high technology business base of Georgia. ATDC fulfills this objective by providing business assistance to start-

up technology companies, supporting technology commercialization ventures, and assisting in economic development efforts in key technological areas around the state. Headquartered in Atlanta, the ATDC promotes the development of advanced technology-based companies.

ATDC offers technical and business management services to help entrepreneurs build and successfully operate a new business. ATDC's Technology Business Center, located on the Georgia Tech campus, provides a strong entrepreneurial working environment, contact with research faculty, and modern office and laboratory facilities with central support staff.

Companies locating in the ATDC have access to resources at Georgia Tech, including its \$144 million per year research program, over 2,000 faculty members, researchers and support staff, an extensive inventory of sophisticated equipment, a top-ranked research library, and approximately 13,000 of the nation's best science, engineering, and management students.

The ATDC assists in economic development efforts in key technological areas around Georgia. Georgia Tech's Economic Development Institute extends ATDC's services to 18 locations in the state of Georgia.

## **Department of Continuing Education**

The Department of Continuing Education coordinates the offering of short courses, video delivery of academic courses, and intensive English for professionals in industry, government, and private practice.

**Continuing Education.** Short courses varying in length from one-to-five days are offered throughout the year to assist professionals with acquiring knowledge of different fields and new technologies. Courses are offered on various topics in engineering, architecture, science, management, and computing. For quarterly calendar, write to Continuing Education, Georgia Institute of Technology, Atlanta, Georgia 30332-0385 or call (404) 894-2547, FAX (404) 853-0117, e-mail: [conted@gatech.edu](mailto:conted@gatech.edu).



**Language Institute.** The Language Institute offers classes to international students and business and professional people. An intensive English program provides six levels of instruction in English as a second language, quarterly, to participants from around the world. The program facilitates the assimilation of international students into campus life in the United States through orientation and assistance in the admissions process to American colleges and universities. The Language Institute also offers courses for business and professional people in English and other languages. For descriptive brochures, write to Director, Language Institute, Georgia Institute of Technology, Atlanta, Georgia 30332-0374, USA, or call (404) 894-2425, FAX (404) 894-8755.

**Video-based Instruction.** Graduate-level courses in the fields of engineering listed below are available throughout the state of Georgia and the nation by videotape. Selected courses are available at some locations by videoconferencing and satellite. A Master of Science degree also can be earned in these fields.

- Electrical engineering
- Environmental engineering
- Health physics/Radiological engineering
- Industrial engineering
- Mechanical engineering

Students at remote sites receive by mail class handouts and videotapes of campus class sessions, and communicate with the instructor by telephone, computer, FAX, and/or e-mail. Qualified candidates are enrolled as regular part-time graduate students. For quarterly calendar, write to Video Programs, Georgia Institute of Technology, Atlanta, GA 30332-0385, or call (404) 894-3379, FAX (404) 894-8924, e-mail: VBIS@conted.gatech.edu.

## **Oak Ridge Associated Universities**

Georgia Institute of Technology has been a sponsoring institution of Oak Ridge Associated Universities (ORAU) since 1946. ORAU is a private, not-for-profit consortium of 65 colleges and universities and a management and operating contractor for the U.S. Department of Energy

(DOE) with principal offices located in Oak Ridge, Tennessee. ORAU provides and develops capabilities critical to the nation's technology infrastructure, particularly in energy, education, health, and the environment. ORAU works with and for its member institutions to help faculty and students gain access to federal research facilities; to keep members informed about opportunities for fellowship, scholarship, and research appointments; and to organize research alliances among our members in areas where their collective strengths can be focused on issues of national importance.

ORAU manages the Oak Ridge Institute for Science and Education (ORISE) for DOE. ORISE is responsible for national and international programs in science and engineering education, training and management systems, energy and environment systems, and medical sciences. ORISE's competitive programs bring students at all levels, K-12 through postgraduate, and university faculty members into federal and private laboratories.

ORAU's office for University, Industry, and Government Alliances (UIGA) seeks out opportunities for collaborative alliances among its member universities, private industry, and federal laboratories. Current alliances include the Southern Association for High Energy Physics (SAHEP) and the Center for Bio-electromagnetic Interaction Research (CBEIR). Other UIGA activities include the sponsorship of conferences and workshops, the Visiting Scholars program, and the Junior Faculty Enhancement Awards.

More information is available from Georgia Institute of Technology's representative on the ORAU Council, Helen Grenga, or by writing to University Programs Division, P.O. Box 117, Oak Ridge, Tennessee 37831-0117.

## **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 either participate in established research activities or initiate research compatible with the facility's purpose.

The Institute maintains small boats and the R/V *Blue Fin*, a 72-foot vessel for research at

distances up to 100 miles offshore. Areas of research expertise at the Institute include chemical oceanography, physical oceanography, biological oceanography, and marine geology.

## **Georgia Tech Lorraine**

GT Lorraine is the European extension for Georgia Tech into the scientific, technological, and economic community in Europe. The first operational year of the campus was 1991. Located in Metz, capital of the Region of Lorraine, its student body is approximately 50 graduate students—one-third from the United States and two-thirds from other countries such as France, Spain, Switzerland, Turkey, Romania, Tunisia, and Pakistan. As a founding member, the Georgia Institute of Technology has full responsibility and control over all academic and research endeavors at GT Lorraine, and admission and graduation policies are the same as for the U.S.

GT Lorraine offers graduate academic programs, continuing education, and research activities. A graduate program in electrical engineering is currently the main subject offered until spring 1995, when programs will involve management and management of technology. Dual degree programs are open to students who desire a degree from Georgia Tech and from a European university or engineering school. Internships and co-op programs in European companies are at the core of the dual degree programs.

The campus, consists of an academic research and administrative state-of-the-art facility of about 50,000 square feet and residence for students and faculty. Government research laboratories, educational institutions, and technological companies are in close proximity. Research focuses on telecommunications.

## **Regents' Global Center (RGC), University System of Georgia**

The RGC identifies and organizes resources to serve the international education needs of the 34 units of the University System of Georgia. The RGC works with appointed liaison officers on each campus to insure effective transmission of and feedback on its faculty, student, and outreach programs and processes. For more information, please call the Regents' Global Center at (404) 651-2950.

## **Interdisciplinary Programs**

The Office of Interdisciplinary Programs coordinates interdisciplinary research centers at Georgia Tech. The office currently provides administrative coordination for more than 40 units. Each unit is listed below and a contact and telephone number supplied. For more information on each center, please call the number provided here or call the Office of Vice President for Interdisciplinary Programs.

Advanced Technology Development Center  
Economic Development Institute  
Contact: Dwight Holter, 894-3575

Advanced Telecommunications Research Center  
Office of Interdisciplinary Programs  
Contact: John A. Copeland, 894-9211

Apparel Manufacturing Technology Center  
Economic Development Institute  
Contact: John C. Adams, 894-4138

Bioengineering Center  
OIP/School of Chemical Engineering  
Contacts: James C. Toler, 894-3964 or Ajit Yoganathan, 894-2849

Biosciences Center  
Office of Interdisciplinary Programs  
Contact: Roger M. Wartell, 894-3700

Center for Computational Materials Science  
Office of Interdisciplinary Programs  
Contact: Uzi Landman, 894-3368

Center for Dynamical Systems and Nonlinear Studies  
Office of Interdisciplinary Programs  
Contact: Jack K. Hale, 894-8766

Center for Enterprise Systems  
Georgia Tech Research Institute  
Contact: Gary S. Tjaden, 894-1303

Center for Excellence for Photovoltaics Research and Education  
Office of Interdisciplinary Programs  
Contact: Ajeet Rohatgi, 894-7692

Center for Excellence in Rotocraft Aircraft  
Technology

School of Aerospace Engineering  
Contact: Daniel P. Schrage, 894-6257

Center for High Yield Pulp Science  
School of Chemical Engineering  
Contact: Jeffrey S. Hsieh, 894-3556

Center for Information Management Research  
College of Computing  
Contact: W.M. McCracken, 894-6172

Computer Integrated Manufacturing Systems  
College of Engineering  
Contact: Leon F. McGinnis, 894-5562

Center for International Standards and Quality  
Office of Interdisciplinary Programs  
Contact: David S. Clifton, Jr., 853-0968

Center for International Strategy, Technology, and  
Policy  
Office of Interdisciplinary Programs  
Contact: John E. Endicott, 894-9451

Center for Optical Science and Engineering  
Office of Interdisciplinary Programs  
Contact: William T. Rhodes, 894-2929

Center for Public Buildings  
Economic Development Center  
Contact: John H. Myers, 894-3390

Center for Rehabilitation Technology  
OIP/ College of Architecture  
Contact: Carol Whitescarver, 894-4960

Center for Strategic Improvements  
Economic Development Institute  
Contact: Ken Charon, 894-6101

Center for Sustainable Technology  
College of Engineering  
Contact: John White, 894-3350

CALS Technology Center  
Office of Interdisciplinary Programs  
Contacts: Robert E. Fulton, 894-7409 (ME),

James Craig, 894-3042 (AE), or Randolph M.  
Case, 894-3523

China/ United States Professional Exchange  
Program  
Office of Interdisciplinary Programs  
Contact: John Heetderks, 894-7368

Composites Education and Research Center  
Office of Interdisciplinary Programs  
Contact: Charles Ueng, 894-2769

Composites Manufacturing Research Program  
OIP/CERC  
Contact: John D. Muzzy, 894-2882 or Jonathan S.  
Colton, 894-7407

Computational Mechanics Center  
Office of Interdisciplinary Programs  
Contact: Satya Atluri, 894-2758

Construction Research Center  
College of Architecture  
Contact: Louis J. Circeo, Jr., 894-2070

Economic Development Institute  
Georgia Tech Research Institute  
Contact: H.W. Hodges, 894-5240

Electronics Packaging Research Center  
Contact: Rao Tummala, 894-9097

Emory-Georgia Tech Biomedical Technology  
Research Center  
Office of Interdisciplinary Programs  
Contact: Ajit Yoganathan, 894-2849

Energy Analysis and Diagnostic Center  
Economic Development Institute  
Contacts: William A. Meffert, 894-3844 or Douglas  
Moore, 894-6115

Environmental Resources Center  
Office of Interdisciplinary Programs  
Contact: Bernd Kahn, 894-3776

Fluid Properties Research Institute School of  
Chemical Engineering  
Contact: Amyn S. Teja, 894-3098

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Fusion Research Center  
Office of Interdisciplinary Programs  
Contact: Weston M. Stacey, 894-3714

Geographic Information Systems Center  
OIP/ Georgia Tech Research Center  
Contact: Michael J. Rowan, 894-0020

GIT/MCG Biomedical Research and Education  
Office of Interdisciplinary Programs  
Contact: James C. Toler, 894-3964

Georgia Procurement Assistance Center  
Economic Development Institute  
Contacts: Charles Catlett, 894-6121 or Nadine Hinton, 894-6121

Georgia Tech Economic Development  
Administration's University Center  
Economic Development Institute  
Contact: Arthur L. Bown, 894-0051

Graphics, Visualization, & Usability Center  
College of Computing  
Contact: James D. Foley, 853-0671

Health Systems Research Center  
School of Industrial and Systems Engineering  
Contact: Justin Myrick, 894-4551

Indoor Environment Research Program  
Georgia Tech Research Institute  
Contact: Charlene W. Bayer, 894-3825

Institute for Bioengineering and Bioscience  
Office of Interdisciplinary Programs  
Contact: Robert M. Nerem, 894-2763

The Logistics Institute  
School of Industrial and Systems Engineering  
Contact: George L. Nemhauser, 894-7796

Manufacturing Research Center  
Office of Interdisciplinary Programs  
Contact: Steven Danyluk, 894-9687

Microelectronics Research Center  
Office of Interdisciplinary Programs  
Contact: Richard J. Higgins, 853-9400

Mechanical Properties Research Laboratory  
Office of Interdisciplinary Programs  
Contact: David L. McDowell, 894-5128

Multimedia Technology Laboratory  
Office of Interdisciplinary Programs  
Contact: Michael J. Sinclair, 894-4931

Neely Nuclear Research Center  
Office of Interdisciplinary Programs  
Contact: Ratib A. Karam, 894-3600

Office of Environmental Science, Technology, and Policy  
Office of Interdisciplinary Programs  
Contact: F.M. Saunders, 894-7693; 894-9725

Phosphor Technology Center of Excellence  
OIP/Georgia Tech Research Institute  
Contact: Chris Summer, 894-3420

Polymer Education and Research Center  
OIP/ College of Engineering  
Contact: A.S. Abhiraman, 894-2874

Southeastern Trade Adjustment Assistance  
Economic Development Institute  
Contact: Paul Lewis, 894-6789

Specialty Separations Center  
Office of Interdisciplinary Programs  
Contact: Charles A. Eckert, 853-9344; 894-2866

Software Technology Branch Army Research  
Laboratory ARL  
Contact: James Gantt, 894-3104

Technology, Policy, and Assessment Center  
Office of Interdisciplinary Programs  
Contact: Alan L. Porter, 894-2330

Transportation Research and Education Center  
Office of Interdisciplinary Programs  
Contact: Michael D. Meyer, 894-2236

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## Affiliated Organizations

### The Georgia Tech Athletic Association

This not-for-profit corporation administers intercollegiate sports at Georgia Tech through a board of trustees consisting of seven faculty members, three alumni, and three students, with the president of Tech serving as president of the board. The Association aims to secure cooperation of the faculty and students in athletic affairs, to maintain a high standard of sportsmanship, and to provide facilities that allow students to participate in athletic activities. Through the support of the Athletic Association, Georgia Tech promotes intercollegiate playing schedules in football, basketball, cross country, indoor/outdoor track, golf, tennis, baseball, volleyball, swimming, and softball.

### The Georgia Tech Alumni Association

The Georgia Tech Alumni Association was chartered in 1908 as a nonprofit organization. Its mission is (1) to promote active alumni participation at Georgia Tech events; (2) to promote alumni volunteer support for Tech through Roll Call, special projects, capital campaigns, and other fund-raising activities; (3) to promote the academic and research achievements of the Institute; (4) to act as liaison between the alumni and the administration; and (5) to manage the resources of the Association in a cost-effective manner.

The Georgia Tech Alumni Association has won national and local recognition for its outstanding programs and achievements. It accomplishes its mission through the publication of a quarterly magazine and newspaper, an extensive network of clubs, special events such as homecoming, reunions, and an annual career conference. In addition, the Association manages the annual fund, Roll Call, and maintains statistical records and files necessary for communicating with Tech's many alumni and friends.

The Alumni Association offices are located in the L. W. "Chip" Robert, Jr., Alumni/Faculty House at 190 North Avenue; (404) 894-2391, or 1-800-GTALUMS. Fax number: (404) 894-5113.

### Georgia Tech Foundation, Inc.

The Georgia Tech Foundation, Inc., is a not-for-profit, tax-exempt corporation that receives, administers, and invests virtually all private contributions made in support of the academic programs of the Georgia Institute of Technology. The Foundation maintains its support of the Institute through the regular and emeritus members of its board of trustees, who are distinguished by their expertise in financial management and investments and by their devotion to Georgia Tech.

Endowment funds maintained by the Foundation furnish student scholarships and fellowships, faculty assistance, and general support to the academic divisions of the Institute. In addition, gifts and income from undesignated endowments provide unrestricted funds that help meet the most pressing needs of the Institute.

### The Georgia Tech Research Corporation

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

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## Atlanta

Georgia Tech is located in Atlanta, site of the 1996 Olympic Games. Atlanta, which has been listed in the *Places Rated Almanac* as one of the most livable cities in the nation, is the capital city of Georgia and home to almost 3 million residents and many of the nation's most prominent business, financial, and industrial firms. Its geographic location has made it the transportation center of the Southeast, as demonstrated by the success of Hartsfield International Airport, generally considered one of the nation's largest and busiest air terminals.

At 1,050 feet above sea level, the city, famous for tree-lined streets and beautiful gardens, enjoys a pleasant climate permitting year-round outdoor activities. A moderate cost of living and

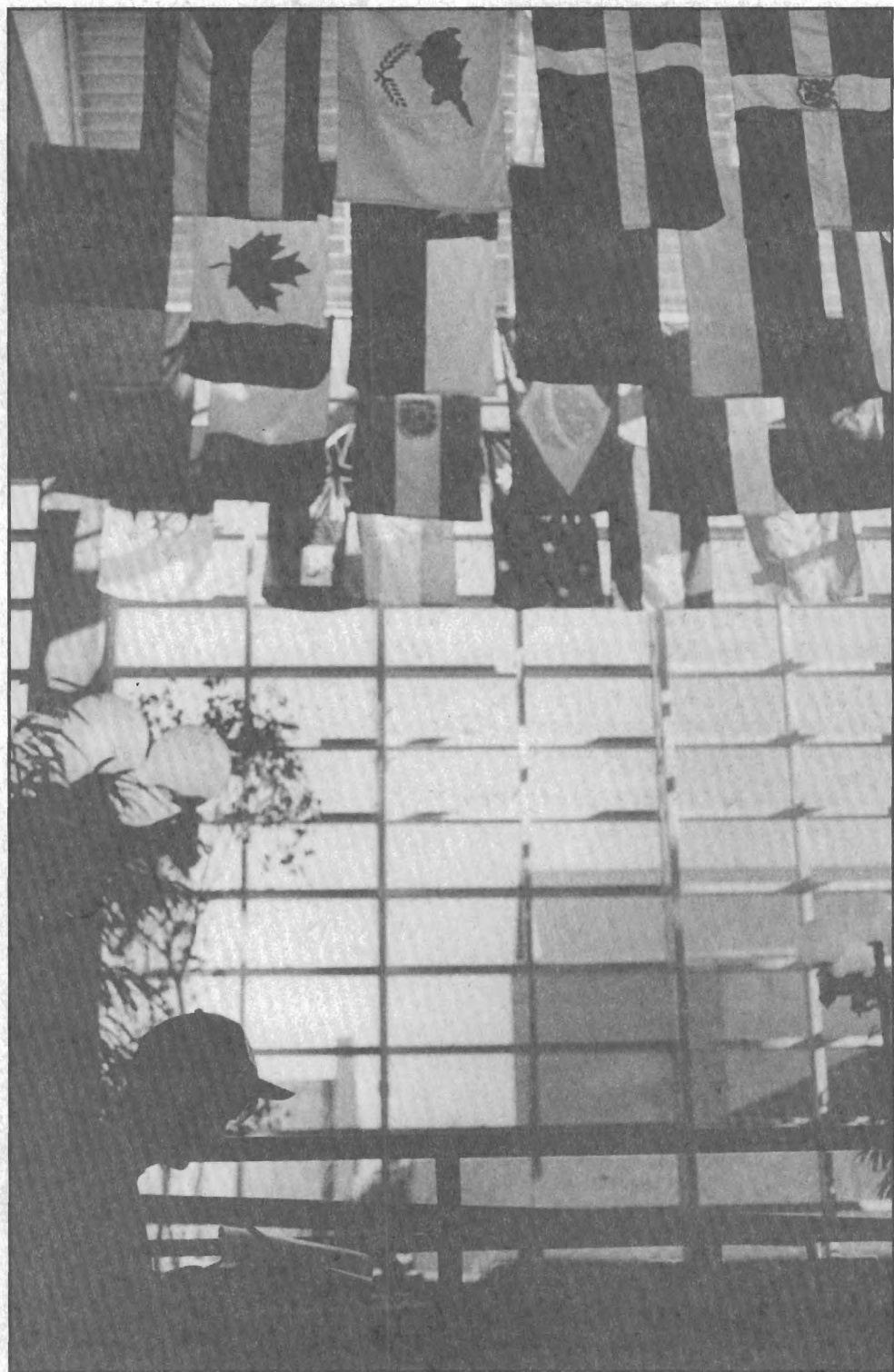
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one of the best public transportation systems in North America contribute to Atlanta's appeal.

Atlanta is also a vigorous city offering an impressive variety of entertainment ranging from sporting events to symphony and theatrical performances, as well as the exciting nightlife of the famous Underground Atlanta. In response to the city's increasing artistic sophistication, Atlanta provides experimental theater, diverse musical events, a thriving film industry, and a respected art museum. Each year, the city sponsors a week-long arts festival in Piedmont Park, two miles from the Georgia Tech campus. The historic Fox Theatre hosts varied cultural and popular performances, including ballet, jazz, opera, country, Broadway musicals, and rock concerts. The Braves, Hawks, Falcons, and Knights offer quality baseball, basketball, football and ice hockey action for Atlanta spectators. Nearby lakes and mountains offer water sports, camping, and snow skiing for those who prefer more energetic activities.

The 1996 Olympics will bring international competition to the city as the Georgia Tech campus hosts the Olympic Village for athletes from around the world. Until then, residents always enjoy such popular attractions as Six Flags over Georgia, the Cyclorama at Grant Park, the Martin Luther King, Jr., Center and Memorial, The Carter Presidential Center, and Stone Mountain Park.





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# INFORMATION FOR UNDERGRADUATE STUDENTS

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## Degrees

Georgia Tech at present offers curricula leading to the following undergraduate degrees:

Bachelor of Aerospace Engineering  
Bachelor of Ceramic Engineering  
Bachelor of Chemical Engineering  
Bachelor of Civil Engineering  
Bachelor of Computer Engineering  
Bachelor of Electrical Engineering  
Bachelor of Industrial Engineering  
Bachelor of Materials Engineering  
Bachelor of Mechanical Engineering  
Bachelor of Nuclear Engineering  
Bachelor of Textile Engineering  
Bachelor of Science  
Bachelor of Science in Applied Mathematics  
Bachelor of Science in Applied Physics  
Bachelor of Science in Applied Psychology  
Bachelor of Science in Biology  
Bachelor of Science in Building Construction  
Bachelor of Science in Chemistry  
Bachelor of Science in Computer Science  
Bachelor of Science in Discrete Mathematics  
Bachelor of Science in Earth and Atmospheric Sciences  
Bachelor of Science in Economics  
Bachelor of Science in History, Technology, and Society  
Bachelor of Science in Industrial Design  
Bachelor of Science in International Affairs  
Bachelor of Science in Management  
Bachelor of Science in Management Science  
Bachelor of Science in Physics  
Bachelor of Science in Science, Technology, and Culture  
Bachelor of Science in Textile Chemistry  
Bachelor of Science in Textiles

Requirements for each degree are listed in "Curricula and Courses of Instruction" under the school responsible for the program. Students should select a degree program as early as possible, preferably with their request for admission, but may postpone the decision and enter as undecided majors. Students who have selected a degree program receive academic advisement from the appropriate school; undecided students are advised through the respective offices of the deans of the five colleges.

Undergraduates who have completed the required number of work quarters through the Cooperative Division receive the degree with the designation "Cooperative Plan."

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## Special Programs

### The Cooperative Plan

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

Approximately 3,100 cooperative students, selected from applicants on the basis of high scholarship, work in about 500 industries throughout the country (as well as a few international assignments), while they complete academic degree programs.

The Cooperative Division offers programs for majors in aerospace, ceramic, chemical, civil, computer, electrical, industrial and systems, materials, mechanical, nuclear, and textile engineering (including textiles and polymer and textile chemistry), and in biology, chemistry,

engineering science and mechanics, computer science, earth and atmospheric science, mathematics, physics, management, management science, economics, international affairs, industrial design, and society, technology, and culture. The academic curricula are identical to those offered regular four-year students.

The cooperative program offers the student practical experience and insight into human relations, as well as financial assistance. The work experience co-op students receive is a valuable asset to graduates starting out in their chosen professions. Neither college laboratory experience nor employment during vacations can take the place of organized co-op training. The plan provides, to a substantial degree, the experience most companies require of their employees before promoting them to positions of responsibility. Work experience may also assist students undecided about their future plans in determining early in their college careers whether they wish to continue in a particular field.

Moreover, daily contact with diverse groups among their fellow employees offers students practical insight into sociology, psychology, economics, and ethics that no textbook can supply. Finally, students receive compensation for their services from their employers. Although students are not able to earn all of their college expenses, as a rule they can earn more than half.

Students interested in applying for admission to the cooperative plan should write to the Director, Cooperative Division, Georgia Institute of Technology, Atlanta, Georgia 30332-0260, for an information packet, including the necessary application form.

## **Multidisciplinary and Certificate Programs**

Multidisciplinary Programs in the College of Engineering and Certificate Programs in the College of Sciences and the Ivan Allen College of Management, Policy, and International Affairs offer students in good standing an opportunity to broaden their areas of expertise or acquire skills or information beyond their major degree requirements. Students interested in pursuing these programs should consult with their major school adviser.

For a description of Multidisciplinary and Certificate Programs offered in the College of Engineering, see page 100. For a description of similar programs in the College of Sciences, see pp. 289-290, and in the Ivan Allen College of Management, Policy, and International Affairs, see pp. 212-213.

## **Summer Language Program**

The Language for Business and Technology Program at Georgia Tech offers an intensive summer program of study in German, French, Japanese, and Spanish coupled with an optional two-week seminar abroad (not yet available for Japan). During the six-week "immersion" program, students attend classes six hours per day, take part in special educational and social activities together, and live in a special section of a Georgia Tech residence hall. Students and their native speaker instructors converse only in the target languages.

The program is designed to take students who have a moderately low familiarity with the language (one year of college or two years of high school instruction) and move them to a level where they will be prepared to take advantage of overseas opportunities for work and study in a business or technological setting.

Upon completion of the summer program and the overseas seminar, students may earn up to 18 hours of credit. For further information, contact the Department of Modern Languages.

## **ROTC**

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

Students may apply six hours of basic ROTC and nine hours of advanced ROTC as elective credit toward a degree. After earning a baccalaureate or graduate degree and completing the advanced ROTC courses for any of the three services, a student may receive a commission in either the reserve or regular forces.

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

## Transfer Programs in the College of Engineering

To encourage and accommodate students who desire to study engineering, but who for various reasons, may prefer to attend another college before coming to Georgia Tech, the College of Engineering offers the opportunity to transfer to Georgia Tech through the **Regents' Engineering Transfer Program (RETP)** or the **Dual Degree Program**.

### Regents' Engineering Transfer Program

The RETP is a cooperative program between Georgia Tech and eight colleges in the University System of Georgia:

- Albany State College
- Armstrong State College
- Columbus College
- Georgia Southern University
- Macon College
- Middle Georgia College
- North Georgia College
- Valdosta State College

For the first two years, students in this program attend one of the participating institutions where they take all of the mathematics and science and many of the engineering courses required in the first two years of the Georgia Tech engineering curricula. Upon successful completion of the RETP requirements at the RETP institution, students are admitted to Georgia Tech to work toward completion of a bachelor of engineering degree.

By enrolling in RETP, students may attend a college close to home that can decrease the cost of their education and ease the adjustment to college life. At the same time, RETP students enjoy many of the following advantages of Tech students: they have equal access to engineering majors at Tech, they can participate in the co-op program, and they are invited to the Tech campus once a year for campus tours, information sessions, and meetings with advisers in their engineering major.

## Dual Degree Program

Under the Dual Degree Program, students attend the participating Dual Degree school for three years and then come to Georgia Tech for approximately two years. Students participating in the Dual Degree Program may seek a degree from any undergraduate degree-granting program in the College of Engineering. Upon completion of the program, the student receives a bachelor's degree from the first school and a bachelor's degree in one of the engineering disciplines at Georgia Tech.

Many of the schools in the University System of Georgia comprise the list of colleges participating in the Dual Degree Program, including Morehouse College, Spelman College, Clark Atlanta University, Morris Brown College, and several traditionally black colleges and predominantly women's colleges in the southeast.

For additional information on either of these programs, contact the College of Engineering at Georgia Tech or the RETP or Dual Degree coordinator at a participating RETP or Dual Degree institutions.

## Preprofessional Programs

Georgia Tech provides all students with a well-balanced basic education giving them diverse options upon graduation. Included in these options are the opportunities to enter medical, dental, veterinarian, and law schools.

Prerequisites for admission into professional schools are relatively minor as they do not require or prescribe a concentration in premedicine, predentistry, preveterinary medicine, or prelaw. They seek students with demonstrated academic skills and a fundamentally balanced education. Students at Tech who are preparing for admission into a professional school obtain the admission requirements through the major of their choice or use the elective hours within any major of their choice to take the additional courses required for entrance to medical, dental, or law schools. Thus, there are no majors at Georgia Tech designated as premedicine, predentistry, or prelaw.

This approach to preprofessional education has

two major advantages. First, students who do not elect to enter professional school upon graduation are prepared to undertake a rewarding alternate career immediately. Second, students who continue into professional school can graduate with backgrounds that uniquely qualify them for desirable careers with special emphases, for example, medical research or the legal aspects of design and construction.

Most successful applicants to medical and dental schools have educational concentrations in the natural sciences or engineering, as well as the humanities and social sciences. No specific undergraduate majors have a clear competitive advantage in assuring admission. Since students whose academic records demonstrate a high level of ability are most likely to gain admission, the best choice of undergraduate major for an individual student is usually the field in which he or she has the greatest inherent interest.

Bachelor's degree programs frequently chosen by premedical and pre dental students are biology, chemistry, psychology, and engineering. Programs chosen frequently by prelaw students are biology, engineering, management, and psychology.

Each major school has preprofessional advisers to assist students in choosing electives to build the appropriate background for their professional interests. Also, the Institute has a chief premedical adviser. Every premedical, pre dental, preveterinarian, and prelaw student should consult early with the preprofessional adviser in his or her major area to plan an appropriate program of elective courses.

### **Preparation for Careers in High School Teaching**

Georgia Institute of Technology provides an opportunity for students to pursue high school teaching careers. Georgia Tech has a cooperative program with Georgia State University in the Atlanta area. Georgia Tech students may use their elective hours to take the required education courses, simultaneously satisfying the requirements for a Tech degree and for teaching certification at the high school level.

Students interested in pursuing this option should consult the academic advisers in the College of Sciences for help in structuring a program of electives that includes the required education courses. This structuring should be done early in the student's academic program to accommodate all requirements.

### **Joint Enrollment Program for High School Students**

Georgia Tech admits a limited number of gifted students who have completed the tenth or eleventh grade with academic credentials comparable to those of scholastically superior freshmen at Tech.

Students admitted in this category may take part of their course work at Tech, including that needed to fulfill high school graduation requirements. The student receives high school credit for the Tech courses and graduates with his or her high school class. Additionally, all work taken at Georgia Tech counts for college credit.

The student should discuss with the high school counselor specific course, test, and recommendation requirements for the Post-secondary Option program. Applications for the program can be obtained from the Office of Admissions at Georgia Tech.

### **Special Academic Services**

In an effort to assist its students in realizing their full intellectual potential, Georgia Tech sponsors a variety of voluntary programs designed to help the student overcome academic problems.

The mathematics department laboratory, open Monday through Friday afternoons while classes are in session, offers a tutoring service for any Tech student in a freshman-level mathematics course. Students who fail the Regents' Examination in composition, required for graduation, may take a special course to improve their skills. International students may take courses in language and literature designed to introduce non-native speakers to written and spoken English as well as to American customs, ideas, and literature.

The STEP program, coordinated through the Office of the Dean of Engineering, provides help with freshman mathematics and science courses. Students attend personal tutoring sessions and participate in occasional group sessions in particularly troublesome areas.

## Developmental Studies

The Office of Academic Affairs administers the Developmental Studies Program. The College of Sciences offers college preparatory courses in mathematics, and the Ivan Allen College offers courses in reading and English composition for students who need further preparation before taking credit courses in English, mathematics, and history.

Students who are required by the Institute to take courses in the Developmental Studies Program will be notified in writing. They must then either test out of the program or register for the required course(s) before they can register for any credit courses that require Developmental Studies (PREP) courses as prerequisites.

Students can test out of taking PREP courses by passing the appropriate Georgia Collegiate Placement Exams administered before the beginning of each quarter through the Office of Academic Affairs. Students who do not pass the appropriate examinations prior to their first quarter in residence must register for the required PREP courses. Students must pass all required PREP courses and the appropriate Georgia Collegiate Placement Exams within their first four quarters in residence in order to register for any further course work. No more than 30 hours of degree credit work may be earned prior to exiting developmental studies.

In addition to those students who are required by the Institute to take PREP courses, any student who wishes further preparation may register for one or more courses. PREP courses are not prerequisite to credit courses when taken on this elective basis.

PREP courses are offered on a pass/fail basis and may not be counted as hours toward graduation.

NOTE: Figures entered below the course number signify the number of class hours per week, the number of laboratory hours per week, and the quarter hour credit earned for the completed course, in that order.

### PREP 0015. Reading Skills

5-0-5.

Development of reading comprehension and speed, vocabulary, and study skills. Review of grammar and usage. Offered fall and as needed.

### PREP 0020. Mathematics Skills

5-0-5.

Intensive review of arithmetic and algebraic skills. Development of mathematics study skills. Offered fall and as needed.

### PREP 0025. English Skills

5-0-5.

Development of basic skills used in writing the sentence, paragraph, and short essay. Development of reading speed. Offered winter and as needed.

### FL 0031. English as a Foreign Language

5-0-5.

Review of basic oral, aural, reading, and writing skills.

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## Admissions

Freshmen may only apply for summer or fall quarters. Deadlines for submission of the Application for Admission, the \$25 application fee, and all required credentials are as follows:

<u>Quarter</u>	<u>Deadline</u>
Summer	February 1
Fall	February 1

Transfer student deadlines for submission of the Application for Admission, a \$25 application fee, and all required credentials are as follows:

<u>Quarter</u>	<u>Deadline</u>
Summer	April 1*
Fall	April 1*
Winter	October 1*
Spring	October 1*

*\*March 1 if seeking financial aid*

Applicants who apply on-line using the ABC program (described on page 14, "On-line Capabilities") will have their application fee waived, but all credentials, including transcripts and standardized test scores, must be received according to the same deadlines.

The Office of Admissions will consider all applications on file by the stated deadlines provided spaces are available for the particular quarter or academic year for which the student applies. An application submitted after the deadline may receive consideration but only at the discretion of the Institute.

Transfer students should plan their transfer so as to allow ample time for their previous school to send transcripts to Georgia Tech. If Tech does not receive official final transcripts prior to the last day of registration, the Office of Admissions will not allow the student seeking transfer to complete registration.

The *Guide to Undergraduate Admissions*, designed to assist applicants until their enrollment at Tech, details policies and procedures concerning areas such as admissions requirements, acceptance notification, housing, financial aid, cooperative plan, joint enrollment, dual degree program, and early admissions. Applicants may obtain this publication from the Office of Admissions.

For any information regarding admission to Georgia Tech, write to

Director of Admissions  
Georgia Institute of Technology  
Atlanta, Georgia 30332-0320

## Admission of International Students

International students who wish to enroll at Georgia Tech should write to the Office of Admissions for a special information pamphlet describing application procedures and other basic information for applicants from foreign countries.

## Advanced Placement and Credit

Students entering Georgia Tech may receive college credit based upon their scores on the College Board Advanced Placement (AP) examinations. A minimum AP score of 3 in American government, comparative politics, mathematics, music theory, or physics, and a score of 4 in biology, chemistry, computer science, economics, English, French, German, Spanish, or history (American and European) is necessary for credit to be awarded.

English and chemistry credit may also be earned based upon scores on the College Board Achievement Tests.

Students who have taken any of the tests mentioned above should have their scores sent directly to Georgia Tech by the College Board.

Under certain conditions, the Department of Modern Languages grants up to nine hours of credit for high school language study. For more information, see College Credit for High School Study under the Department of Modern Languages' section of "Curricula and Courses of Instruction" in this catalog.

## International Baccalaureate

Subject	Higher Level Exam Scores	Georgia Tech Credit
<b>Am. History</b>	4 or higher	6 hours (HIST 1001-2)
<b>Biology</b>	4	4 hours (BIOL 1110)
<b>Biology</b>	5	8 hours (any two of the following: BIOL 1110, 1111, 1112)
<b>Biology</b>	6 or higher	12 hours (BIOL 1110, 1111, 1112)
<b>Chemistry</b>	5 or higher	10 hours (CHEM 1101, 1102)
<b>English Foreign Language</b>	4 or higher	3 hours (ENGL 1001)
<b>Mathematics</b>	5 or higher	Free elective credit
<b>Mathematics</b>	4	10 hours (MATH 1507, 1508)
<b>Mathematics</b>	5 or higher	5 additional hours based on exam content)
<b>Physics</b>	5 or higher	15 hours (PHYS 2121, 2122, 2123)

These guidelines are subject to change without notice.



## Readmissions

Georgia Tech students who find it necessary to discontinue enrollment for one or more quarters, with the exception of summer quarter, must apply for readmission when planning to return to the Institute. The student may obtain an application for readmission from the registrar and should return the completed form no later than the date indicated on the following schedule:

Quarter	Deadline
Fall	August 1
Winter	December 1
Spring	March 1
Summer	June 1

Former students on *drop* or *review* status should apply at least two months prior to these deadlines in order to ensure sufficient time for the review process. The section "Rules and Regulations" in this catalog contains additional information on readmissions.

## Academic Advising

The faculty of each school must provide each student enrolled in that school the opportunity to consult with an informed adviser on the academic program and the selection of courses. Students should regularly seek assistance from their designated faculty advisers during their program of study, particularly when problems occur. Students who do not know the identity of their adviser should consult with the school director. Students undecided about their majors should seek advice from staff members in the office of the appropriate college dean.

Students must follow the approved curriculum of the academic school in which they are registered. Students who do not follow the approved curriculum may be denied registration privileges.

## Choice of Majors/ College of Engineering

Most majors will be available to students in good academic standing with an overall grade point average of *C* or better. However, during some years, the number of students interested in the most popular majors, i.e., electrical engineering and aerospace engineering, may exceed the capacity for those disciplines. When this occurs, continued enrollment in those majors will be limited to the students with the best academic records in their Georgia Tech course work.

## Academic Regulations

The "Rules and Regulations" section of this catalog contains detailed information regarding the academic regulations of the Institute. Students who have questions concerning these regulations should consult either the general office of their major school or the Office of the Registrar, Room 104, Administration Building.

## Grading System

For detailed information about the Georgia Tech grading system, see "Rules and Regulations," Section IV, in this catalog.

## Graduate Course Option

Students who complete both the bachelor's and master's in the same discipline at Georgia Tech may, with the approval of the School of Graduate Enrollment, use up to nine credit hours of graduate-level course work in the major discipline for both degrees. Recognizing that some master's degree programs do not have a unique undergraduate counterpart program, and that some master's programs are offered by several schools, the term "discipline" in the prior sentence will be broadly interpreted in such cases. In order to qualify for this option, the student must complete the undergraduate degree with a cumulative grade point average of 3.5 or higher and complete the master's degree within a two-year period from the award date of the bachelor's degree. Civil Engineering, Electrical Engineering, Engineering Science and Mechanics, Industrial

and Systems Engineering, Mathematics, and Textile Engineering are the only Schools currently participating in this program. The School of Mechanical Engineering participates but allows only three credit hours of graduate-level course work in the major discipline for both degrees.

## Institute Rules for the Pass/Fail System

At the option of the major school, a student may receive up to a maximum of 12 hours credit toward a bachelor's degree or six hours credit toward a graduate degree for courses taken under the pass/fail system with a grade of satisfactory. Such courses apply toward the degree requirements only if the major school has approved the course, either for all majors or for the individual student. The department or school offering a course determines the criteria for a passing grade and may restrict the pass/fail enrollment in any course it offers. The rules for withdrawal from graded courses apply to pass/fail courses as well.

Professors will record only a grade of *satisfactory* or *unsatisfactory* for any student so designated on the official class roll; students may not change their designation from credit to pass/fail or from pass/fail to credit after the last day to make schedule changes. Neither the professor nor the registrar may change a pass/fail grade to a letter grade, nor may the registrar include courses taken pass/fail in the calculation of grade point averages.

Under certain circumstances, a change in degree requirements may affect a department's position on a course previously approved for degree credit under the pass/fail system. In such cases, the student's major school will decide if a course completed with a grade of *pass* before the change will fulfill the amended requirements.

Only students who complete 180 or more hours toward a degree at Georgia Tech may use the entire maximum of 12 hours credit taken on pass/fail toward a bachelor's degree. For transfer students, second undergraduate degree students, and dual degree students, the number of hours completed at Georgia Tech determines the maximum number of pass/fail hours allowed,

according to the following schedule:

<u>Hours included in program of study</u>	<u>Hours allowed on pass/fail basis</u>
50 to 89 credit hours	3 credit hours
90 to 134 credit hours	6 credit hours
135 to 179 credit hours	9 credit hours
180 or more credit hours	12 credit hours

## Examination and Grade Reports

The Institute schedules final examinations during the last week of each quarter and issues grade reports of the student's academic progress after the quarter's close.

## Scholastic Average

A student who passes a course receives both the designated number of credit hours and a number of quality points, calculated by multiplying the course credit hours and the numerical equivalent of the letter grade received ( $A = 4$ ,  $B = 3$ ,  $C = 2$ ,  $D = 1$ ). Thus, a student taking a three-hour credit course and earning a grade of *C* receives six quality points. To determine the undergraduate scholastic average, the total number of quality points earned by the student for all courses scheduled as an undergraduate is divided by the total number of credit hours scheduled; for the graduate scholastic average, only those courses scheduled by the student while enrolled in the graduate division are considered. If a student takes the same course more than once, the later grade does not replace the earlier one; rather, the scholastic average includes both grades. Courses taken pass/fail are not included in the calculation of grade point averages.

## Second Undergraduate Degrees

To be a candidate for a second undergraduate degree, a student must obtain the recommendation of the faculty through the director of the school concerned and the approval of the Undergraduate Curriculum Committee. This is accomplished by submitting the proposed program of study prior to beginning course work. Should course work be

taken prior to receiving the school recommendation and committee approval, the course work completed may have to be used, as applicable, toward the first degree only. See "Rules and Regulations," Section XIII. D for additional information.

## Transfer Credit

Transfer credit is awarded on a course-for-course basis, not hour for hour. 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 and universities in the United States and Canada, provided the courses correspond in time and content to courses offered at the Georgia Institute of Technology. Georgia Tech will not accept credit (except by examination) for courses successfully completed at another institution but previously failed at Tech. The student must request and file an official transcript of transfer courses before the Institute can award credit. Course work completed at colleges and universities outside the United States and Canada will be evaluated on a case-by-case basis.

Enrolled students at Georgia Tech must receive prior approval from the student's major school and the registrar before scheduling courses at other institutions. Students are not to be enrolled at Georgia Tech and another college without specific approval of the registrar and the appropriate faculty committee.

## Auditors

Officially enrolled students who have obtained approval of their advisers and the department of instruction concerned may audit courses at Tech; however, the student will not receive credit for courses scheduled on an auditing basis. If the student wishes to change to or from auditing status, he or she must follow the procedure for schedule changes during the time allotted for schedule modification in the official calendar.

In order for a successful audit to show on the student's permanent record, the student must

comply with all requirements listed by the instructor. If the instructor deems that the student did not successfully audit the course, the grade of W will be assigned.

All students registered as auditors must pay tuition at the regular rate. Members of the faculty or staff of the Georgia Institute of Technology may sit in on a course with the permission of the department concerned and the registrar.

## Constitution and History Examinations

The Georgia law as amended March 4, 1953, requires that before receiving an undergraduate degree all students pass examinations or comparable courses in United States and Georgia history as well as United States and Georgia Constitution. Courses that fulfill the United States and Georgia Constitution requirements are POL 1251 or POL 3200. Courses that fulfill the United States and Georgia history examination requirement are HIST 1001 or HIST 1002.

## Regents' Testing Program

To establish eligibility for an undergraduate degree, every student in the University System of Georgia must pass the Regents' Test, an examination designed to measure proficiency in reading and English composition. Students are invited to take this examination when they have earned ten hours of course credit. Any student accumulating 50 hours of course credit toward a degree without passing the Regents' Test must schedule remedial English along with other credit course work. If a student fails in the first attempt, he or she must repeat the test. Alternative tests of competence and remediation are offered to non-native speakers of English through the Department of Modern Languages.

## ROTC Credit

Students may apply a maximum of six quarter hours in basic ROTC courses and nine quarter hours in advanced ROTC courses toward meeting the requirements for any degree. Students should begin taking basic ROTC courses during the first quarter they are enrolled. For further information, see individual curricula for the schools.

## **Health Sciences Requirement**

All students attending Georgia Tech must satisfactorily complete a health sciences requirement, HPS 1040 or 1061, during their freshman year. Individual schools may allow up to three hours of health and performance sciences credits. Other health and performance sciences (HPS) courses may be used as free electives or technical electives, if approved by the major school. Individual schools may allow up to three hours of physical education (PE) courses to be counted toward degree requirements. Students should check the curricula of their individual schools in order to determine the number of hours they may apply toward the degree.

The health information record will determine any medical exemptions from physical education courses. The Department of Health and Performance Sciences will accept certificates of disability from personal physicians only after the Student Health Service has endorsed the documents.

For a complete description of the health sciences requirements at Georgia Tech, refer to the Department of Health and Performance Sciences listed under the College of Sciences in the "Curricula and Courses of Instruction" section of this catalog.

## Humanities and Social Sciences Requirements

This catalog lists in the section "Curricula and Courses of Instruction" a tabulation of the courses required for degrees in the curricula offered by Georgia Tech.

All curricula leading to an undergraduate degree must include at least 36 hours of humanities and social sciences according to the following distribution:

### HUMANITIES

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

**ENGLISH:** All ENGL undergraduate courses except ENGL 3015, 3020, 4015, 4020, 4380, 4390, 4901, 4902, 4903

**MODERN LANGUAGES:** All CHIN, FL, FREN, GER, LING, RUSS, SPAN undergraduate courses except FL 0031; FREN 4901, 4902, 4903; GER 4901, 4902, 4903; LING 3001, 3002, 3003, 4901, 4902; RUSS 4901, 4902; SPAN 4901, 4902

Note: Students electing to use 1000 level courses in a language must complete the third course in the 1000 level sequence of the language in order to use any of the sequence in satisfying the humanities requirement.

**MUSIC:** 2600, 3410, 3420, 3500, 3600. Students are also permitted to earn six (6) hours of humanities credit for participation in ensembles. See Music Department section of this catalog for information regarding criteria.

**PHILOSOPHY:** All PST undergraduate courses except PST 3113, 4944, 4945, 4946, 4947, 4948, 4949

**ARCHITECTURE:** ARCH 2201, 2202, 2203, 3211, 4247, 4248, 4249

**INDUSTRIAL DESIGN:** ID 1263

## SOCIAL SCIENCES

At least 18 hours of social sciences (including at least three hours of American history—HIST 1001 or HIST 1002—and three hours of American government—POL 1251 or POL 3200) selected from the following subjects:

**HISTORY:** All HIST and HTS undergraduate courses except HIST 4925, 4926, 4927, 4928, 4929 and HTS 4410, 4411, 4925, 4926, 4927

**INTERNATIONAL AFFAIRS:** All INTA undergraduate courses except INTA 4953, 4954, 4955, 4956

**POLITICAL SCIENCE:** All POL undergraduate courses except POL 4950, 4951, 4952, 4953, 4954, 4955, 4956

**SOCIOLOGY:** All SOC undergraduate courses except SOC 3308, 4999

**PSYCHOLOGY:** PSY 3300, 3303, 3304, 4400, 4410, 4423, 4424, 4755

**ECONOMICS:** ECON 2000, 2001, 3000, 3001, 3002, 3400, 3410, 3500, 3501, 4230, 4231, 4300, 4310, 4330, 4331, 4332, 4340, 4341, 4400, 4410, 4420, 4500

Note: 1. Courses completed at the 3000-4000 level may not satisfy the core curriculum area I and area III requirements for students transferring to other units of the University System of Georgia.

2. Any courses completed which were listed in prior catalogs as satisfying the Humanities/Social Science requirement may also be used to satisfy this requirement.

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# INFORMATION FOR GRADUATE STUDENTS

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## General Information

The faculty of the Georgia Institute of Technology grants advanced degrees in engineering, science, management, computing, architecture, city planning, public policy, and other technology-related areas. The goals for graduate studies and research are to establish an educational environment that will encourage and assist students to develop their capabilities both as professionals and as human beings, to encourage students and faculty to press research vigorously for the discovery and generation of new knowledge, to investigate ways of applying such knowledge innovatively for the benefit of society and humanity, and to foster the development of new tools, objects, and ideas.

Students whose interests and aptitudes lead them beyond the limits of the traditional undergraduate curriculum may broaden their knowledge of a given field and pursue independent inquiry through graduate study. A graduate education is of particular benefit to students interested in careers in research, management development, design, or consulting; to those who aspire to formulate and administer policy; and to those who desire to enter the profession of education.

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## Degrees and Programs of Study

### Master's Programs

Programs of study and research leading to the master of science are offered in the following disciplines:

Aerospace Engineering  
Applied Physics  
Architecture

Bioengineering  
Biology  
Ceramic Engineering  
Chemical Engineering  
Chemistry  
City Planning  
Civil Engineering  
Computer Science  
Earth and Atmospheric Sciences  
Economics  
Electrical Engineering  
Engineering Science and Mechanics  
Environmental Engineering  
Health Physics  
Health Systems  
History of Technology  
Industrial Engineering  
Information, Design, and Technology  
Management  
Mathematics  
Materials Engineering  
Mechanical Engineering  
Metallurgical Engineering  
Nuclear Engineering  
Operations Research  
Physics  
Polymers  
Psychology  
Public Policy  
Statistics  
Textile Chemistry  
Textile Engineering  
Textiles

## Doctoral Programs

Programs of study and research leading to the Doctor of Philosophy are offered in the following disciplines and areas:

Aerospace Engineering  
Algorithms, Combinatorics, and Optimization  
Architecture  
Biochemistry  
Bioengineering  
Biology  
Ceramic Engineering  
Chemical Engineering  
Chemistry  
Civil Engineering  
Computer Science  
Earth and Atmospheric Sciences  
Economics  
Electrical Engineering  
Engineering Science and Mechanics  
Environmental Engineering  
History of Technology  
Industrial and Systems Engineering  
Management  
Mathematics  
Mechanical Engineering  
Metallurgical Engineering  
Nuclear Engineering and Health Physics  
Operations Research  
Physics  
Psychology  
Textile Engineering

To locate detailed descriptions of these programs and related courses, please refer to the index on pages 399-400 of this catalog. Areas of specialization may also be found under each program description.

The Institute may award degrees with or without designation of the field, based upon the recommendation of the school concerned.

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## Special Programs

### Interdisciplinary Programs

The schools of the Institute authorized to offer graduate degrees develop and administer their own individual programs and work closely with one another to provide special study and research opportunities for students who wish to pursue a degree with a wider perspective than that presented by a single discipline.

Cooperation between academic units and various research centers and the development of informal programs based on areas of faculty interest have resulted in the establishment of interdisciplinary programs in a number of areas, such as computer integrated manufacturing systems and microelectronics. The College of Engineering lists a large number of multidisciplinary programs on page 100 of this catalog. The College of Computing offers an interdisciplinary certificate in cognitive science, see page 88. The role of the School of Management in multidisciplinary programs is discussed on pages 254-255.

### Video-based Instruction

For students who cannot attend daily classes on campus, graduate courses leading to master's degrees in electrical engineering, environmental engineering, health physics, industrial and systems engineering, mechanical engineering, and nuclear engineering are available by videotape. Selected undergraduate courses are available by tape to co-ops at work. Freshman and sophomore engineering courses are available by two-way interactive video at several units of the University System of Georgia. For more information, see page 16 of this catalog.

### Graduate Cooperative Program

Selected students planning to enroll for graduate study at Georgia Tech have the opportunity to participate in a unique cooperative program leading to advanced degrees in participating schools. Two plans are available. One is designed for Georgia Tech undergraduates who plan to continue as graduate students at Tech and includes study-work periods that span both undergraduate and graduate levels. Eligibility is based on academic achievement at Georgia Tech. The second plan is for graduate students whose undergraduate degrees may be from Tech or other institutions.

Degree requirements under this plan are identical to those for all students enrolled at Georgia Tech. The Graduate Cooperative Plan is designed as an enhancement to the educational programs of students working for advanced degrees and offers the benefits of added facilities



and opportunities for external stimulation. In addition, students receive compensation for their services from companies that employ them.

Preliminary screening of students occurs at the school or college level. The participating companies select students on the basis of academic credentials and interest areas correlated with company activities. Many participating companies require U.S. citizenship or permanent residency. For students planning to participate both at the undergraduate and graduate levels, the program requires at least two work quarters at the undergraduate level and at least two work quarters at the graduate level. Students planning to participate only at the graduate level are required to work at least two quarters.

Academic credit for co-op work is available if the student, with approval of the major school, pursues research at the company that can be used to satisfy requirements for the thesis or other research paper.

Students interested in applying for admission to the Graduate Cooperative Plan should write to the Director, Graduate Cooperative Program, Office of Graduate Studies, Georgia Institute of Technology, Atlanta, Georgia 30332-0265.

## **The Academic Common Market**

The Institute participates in the Academic Common Market Program managed by the Southern Regional Education Board. By interstate agreement, the market enables southern states to share academic programs. Residents of the participating states who qualify for admission and gain the approval of their state coordinators may enroll on an in-state tuition basis. Georgia Tech programs include: architecture (M. Arch.); applied physics (Optics) (M.S.); atmospheric science in geophysical sciences (M.S.); city planning (M.C.P.); health physics (M.S.); materials science and engineering (M.S., Ph.D.); nuclear engineering (M.S., M.A.S., Ph.D.); textile engineering (Ph.D.); and urban transportation/planning (Joint M.C.E/M.C.P.).

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## **Policies and Regulations**

The Graduate Committee, with the approval of the Academic Senate, is responsible for establishing academic policy for the graduate program; however, final authority rests with the Senate. This committee reserves the right to change requirements for degrees as may be appropriate. Students enrolled at the time such changes appear in the catalog 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 that records the change.

This catalog records the Institute-wide policies and regulations that govern the graduate program. Schools may make additional rules concerning their programs and the pursuit of their degrees, but such rules may not contradict Institute policies and regulations.

## **Graduate Student Work Loads**

Full-time students must enroll for at least 12 hours on a letter-grade or pass-fail basis. The adviser and school director may approve the substitution of one course (up to three hours) on an audit basis, excluding 8997 and 8998. Full-time students working exclusively on thesis research should be registered for 18 to 21 hours of 7000 or 9000. The maximum load for full-time students is 21, and the minimum load for part-time students is three hours.

Students with fellowships, assistantships, traineeships, tuition waivers, or student visas and those assigned to the Institute by the armed forces for the purpose of pursuing a degree are required to be enrolled full-time.

## **Staff Members**

No staff member beyond the rank of instructor in a school may work for a master's degree in that school.

No new staff member with the rank of assistant professor in a school may work for a doctoral degree in that school.

## Admissions Information

Prospective students may obtain information and the necessary forms for admission from either the appropriate school or via the Graduate On-line Information and Application to Tech (GOLIATH) system. The student must submit the application, letters of recommendation, and official transcripts of previous academic work to the offices specified by July 1, November 1, February 1, and May 1 for fall, winter, spring, and summer quarters, respectively. For Fall 1996 only, the application deadline will be June 1, due to the 1996 Olympics. Some programs have earlier deadlines, and students are advised to check with the graduate program of interest before applying. It is strongly recommended that international students submit their materials at least six months before the proposed registration date. The \$15 application fee is waived for U.S. citizens and U.S. permanent residents who apply via GOLIATH. Students applying for admission with financial assistance for any quarter are strongly advised to submit their materials by February 1 of the preceding academic year.

## Graduate Record Examinations

Certain programs require applicants to submit results of the General and Subject tests of the Graduate Record Examinations (GRE).

GRE General test scores are required for all graduate applicants with the following exceptions: the School of Civil and Environmental Engineering requires these only for applicants requesting financial assistance; the School of Textile and Fiber Engineering requires these for international applicants only; applicants to the School of Management are required instead to furnish Graduate Management Admission Test scores. In addition, GRE Subject test scores are required for applicants to the College of Computing and the Schools of Chemistry and Mathematics.

Information concerning times and locations for these tests can be obtained from Graduate Record Examinations, Educational Testing Service, Box 6000, Princeton, New Jersey 08541-6000.

General information on the GMAT is available from Educational Testing Service, Box 966, Princeton, New Jersey 08540.

On-campus applicants may pick up GRE information from the Graduate Office and GMAT information from the School of Management.

## Types of Standing

Applicants holding a bachelor's degree in an appropriate field from an approved institution will be accorded full graduate standing provided their previous work is of sufficient quality to indicate immediate success in advanced study.

If the work of an applicant holding an approved bachelor's degree is deficient in content or quality so that supplemental study or demonstrated ability is necessary, the applicant may be accorded conditional graduate standing.

Students who do not wish to qualify for an advanced degree at Tech, but demonstrate the potential benefits of their participation in advanced study, may gain admission as special graduate students. Students who are designated special standing for failure to submit official transcripts or for other administrative reasons may credit not more than 24 quarter hours taken on special standing toward a degree.

Graduate students in good standing at other universities may enroll at Tech as transient graduate students by filing an application for admission and verification of good standing status from their own graduate dean. However, work undertaken in this standing will not apply toward a Georgia Tech degree.

The undergraduate school, not the graduate school, will register students working toward a second bachelor's degree.

In addition to full, conditional, and special graduate standing, graduate students will be classified by academic standing according to their grade point averages—good standing, warning, probation, or drop. For specific information, see "Rules and Regulations," pages 346-362.

## Readmission

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

## Reactivation of Application

Students admitted to the Tech graduate program who do not enter in the quarter for which they applied and subsequently wish to be considered for a later quarter must reactivate their application for the new quarter. Since the graduate admission's office keeps files on "never entered" students for one year only, these students will have to supply a new set of application materials if they delay more than one year in the reactivation request. To reactivate an application, the student must contact the graduate program to which he or she has been admitted by August 1, December 1, March 1, or June 1 for the fall, winter, spring, or summer quarters, respectively. The number of reactivations per applicant is limited.

## Undergraduate Students

Seniors with a grade point average of at least 2.7 may schedule graduate courses. In order to do so, the student must obtain permission both from the student's adviser and from the director of the school offering the course.

Credit toward the master's degree for up to 12 hours of courses taken as an undergraduate may be received under the following conditions.

1. The student was in residence at the Georgia Institute of Technology for at least two quarters before registering for the course(s).
2. The student did not apply credit for the course toward the baccalaureate degree. (See page 29, "Graduate Course Option," for special exceptions in certain schools.)

## Registration

During the week preceding first registration, each new student should consult with the director of the school of specialty to prepare a proposed program and to receive instructions regarding registration procedures.

Tech also conducts orientation for new graduate students each quarter just before registration.

Note: All new students must have submitted health forms to Student Health Services before they can register.

## TOEFL for International Students

All international students from countries in which English is not the native language must take the Test of English as a Foreign Language (TOEFL). Since the results of this test constitute part of the material reviewed for admission to graduate study at Tech, students should arrange to have the Educational Testing Service send their scores to the graduate admissions office as early as possible. The minimum score for graduate admission required by Georgia Tech is 550. Higher TOEFL scores are required for some academic programs.

Students who wish to take the TOEFL should obtain the *TOEFL Bulletin of Information for Candidates, International Edition*. Applicants can acquire copies of the *Bulletin* and the registration form through the offices of the U.S. Information Service (USIS), American embassies and consulates, and U.S. educational commissions and foundations in a number of cities outside the United States. In addition, several private organizations distribute the *TOEFL Bulletin*. These groups include the Institute of International Education (IIE); the African-American Institute (AAI); the American Mideast Educational and Training Services (AMIDEAST); and the American-Korean Foundation.

Students who cannot obtain a *TOEFL Bulletin* and registration form locally should write well in advance of application to Test of English as a Foreign Language, Box 6151, Princeton, New Jersey, U.S.A. 08541-6151, USA.

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## The Master's Degree

### Prerequisites

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

## Matriculation Requirements

While students may enroll in the master's degree program upon admission with either full or conditional standing, they must attain full graduate status to graduate with the M.S. degree.

Students enrolled for the master's degree must register for at least one quarter per year in order for the original requirements for their degree to remain unchanged. In other cases, the school may re-evaluate the student's credentials and impose additional degree requirements.

Students who have completed all course work and are planning to submit a thesis in partial fulfillment of the requirements for a master's degree should register for research hours consistent with a realistic appraisal of the amount of remaining thesis work and required faculty involvement. Students will not receive thesis guidance during any quarter for which they are not registered.

The Institute has no residency requirements for the master's degree.

## Academic Requirements

The master's degree requires a minimum of 45 approved credit hours distributed as follows:

### With thesis:

Minimum course credit hours	
in major field (a basic field	
of knowledge, not a department	
of specialization).....	18
Minimum course credit hours	
at 6000 to 9000 level.....	18
Total course credit hours	
for degree.....	30
Thesis hours.....	15
Total credit hours.....	45

### Without thesis (must have approval of school director):

Minimum course credit hours	
in major field (a basic field	
of knowledge, not a department	
of specialization).....	27
Minimum course credit hours	
at 6000 to 9000 level.....	33
Total credit hours.....	45

Many schools require more than the minimum credit hours. Please refer to specific academic program descriptions for more detailed information.

The student must earn a graduate grade point

average of at least 2.7 and satisfy other requirements of the major school to be certified for a master's degree. To compute the grade point average, the registrar assigns grade points for all course work receiving grades, according to the following scale: 4 points for an *A*, 3 for a *B*, 2 for a *C*, 1 for a *D*, and 0 for an *F*. The graduate average includes the grades on all courses scheduled by the student after admission to graduate study. Other than thesis hours, the student may use only six hours under the pass/fail designation in the approved program of study (see p. 30).

Undergraduate courses required for graduation in the discipline (designated degree) or discipline-of-origin (undesignated degree) at Georgia Tech may not be applied toward a master's degree. (See page 29, "Graduate Course Option," for special exceptions in certain schools.)

The student, in conference with the faculty adviser, should prepare a program of study for the master's degree as a guide for planning an academic schedule. In some cases, the student's school may require that the proposed program be submitted to the director of that school for approval.

## 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. To apply for candidacy, the student must submit to the registrar, during the quarter preceding the anticipated final quarter of work, the petition for a degree with the approved program of study attached. To receive favorable action on this petition, the applicant must ordinarily have met the following requirements.

1. The student's approved program of study must show that course requirements for the master's degree will be satisfied during the final quarter (see Academic Requirements).

2. The student must have completed, or have

scheduled to complete during the final quarter, any required work outlined at the time of matriculation.

3. The student must have an overall grade point average of at least 2.7 and satisfy all school academic requirements.

4. The student must have completed satisfactorily any language requirement imposed.

5. The student must have passed any qualifying or comprehensive examinations required by the student's school.

6. The student must have filed with the Office of Graduate Studies and Research an approved thesis topic and have made satisfactory progress on the thesis if it is a part of the approved program.

### **Requirements for Award of the Degree**

Any candidate who meets the following requirements will normally be recommended to the Academic Senate to receive the master's degree:

1. has an overall grade point average of at least 2.7 and has satisfied all academic requirements of the major school;

2. receives final acceptance of the thesis from the graduate office and submits three unbound copies;

3. satisfactorily completes the approved program of study (complete within a period of not more than six consecutive calendar years);

4. passes any general examinations, oral or written, required by the major school; and

5. is, at the time, a registered student. A waiver of this requirement may be obtained only if all requirements for graduation, including submission of the final approved thesis, have been met prior to the last day of registration and the student was registered for the preceding quarter.

### **Language Requirement**

The student's school may require a reading knowledge of one appropriate language.

### **Transfer of Credit**

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

1. A student may receive transfer credit (up to nine hours) for graduate-level courses taken at an accredited institution in the United States or

Canada and not used for credit toward another degree. The student must supply a current transcript for this evaluation.

2. To obtain transfer of credit, the student must complete the following procedure: (a) The student will confer with the graduate adviser to ascertain whether the courses to be transferred are a logical part of the student's graduate program. The courses would typically be those appearing on the approved program of study form for the master's degree. A doctoral student normally does not request transfer credit. (b) If the courses are appropriate, the student will deliver to the school that teaches such courses a copy of the current transcript, necessary descriptive materials including catalog descriptions, and textbooks used for evaluation. The faculty of the appropriate school will determine the equivalent Georgia Tech course and the number of credit hours accepted. The faculty member who prepares the transfer credit form should have the school director cosign it. The school should then send the form directly to the registrar with a copy of the student's Approved Program of Study attached. (c) If the student wishes to transfer more than nine hours, a petition must be submitted to the graduate committee including statements of possible justification for the granting of such a petition, transfer credit forms, and the recommendation of the student's school director.

3. A joint enrollment student may 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 that (a) Georgia Tech does not offer such courses, (b) the student's adviser and school director approve the courses in writing in advance, and (c) the student passes the courses with a grade of C or better. "Advance approval" is satisfied when the courses appear on the student's proposed program of study.

4. A student may not receive transfer credit from universities outside the United States and Canada; however, an international student can obtain credit for courses previously taken but not applied toward another degree by filling out an "Examination for Advanced Standing Authorization Request Form," paying the appropriate fee at the Cashier's Office, and passing the examination for advanced standing. The school or department that normally teaches the equivalent course will

administer any necessary examinations.

## The Master's Thesis

To complete the requirements for the master's degree, the student must submit a master's thesis unless the school director determines that additional course work is of more importance in meeting approved objectives.

Students who meet the requirements for the master's degree by completing a combination of course work and thesis must register for a minimum of 15 hours of thesis credit. (See Academic Requirements.)

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

The *Manual for Graduate Theses*, available from the graduate office, specifies the requirements for the thesis.

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## The Doctoral Degree

The degree of Doctor of Philosophy recognizes 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 chosen field, culminating in a written dissertation covering that investigation. The dissertation must be either an addition to the fundamental knowledge of the field or a new and better interpretation of facts already known. It must demonstrate that the candidate possesses powers of original thought, talent for research, and ability to organize and present findings.

## Matriculation Requirements

Ordinarily, the graduate school admits to the doctoral program only those students who have graduated in the upper quarter of their class.

The matriculation requirements are identical to those outlined for the master's degree except for the residency requirement. Doctoral students must spend at least three full-time quarters in residence at the Georgia Institute of Technology

and ordinarily must complete research for the dissertation while in residence. Under special circumstances, however, candidates who have met the residence requirement may receive permission to pursue their research in absentia, provided the director of the appropriate school approves and a faculty member directs the project.

## Admission to Candidacy

Doctoral students customarily apply for degree candidacy after completing at least five quarters of course work beyond the B.S. degree.

To qualify for candidacy, students must complete all course requirements (except the minor), achieve a satisfactory scholastic record, and pass the comprehensive examination. In addition, the student must file with the school director and the Office of Graduate Studies a formal statement naming the dissertation adviser and delineating the research topic, the purpose of the investigation, and a proposed methodology for its completion.

Upon satisfactory completion of these requirements, with approval of the dissertation topic, the graduate school formally admits the applicant to candidacy for the degree.

The comprehensive examination assesses both general knowledge of the degree area and specialized knowledge of the student's chosen research field. Each school is responsible for scheduling comprehensive examinations at least once a year, in the fall or spring, and for informing students of their scope. A guidance committee appointed by the director of the school will advise each student in planning a program of study and preparing for the examination, partly through an initial evaluation of the student's background and interests, partly through periodic consultation to evaluate and aid the student's progress.

Students must complete all degree requirements within five years from the end of the quarter in which they pass the comprehensive examination and must have an overall grade point average of 2.7 in order to graduate. During the quarter preceding the anticipated final quarter of work, the candidate must submit a petition for the degree to the registrar. Petition forms are available in the registrar's office.

## Major and Minor Fields of Study

While no fixed course requirements apply for the doctoral degree, the student must include in two or more years of graduate course work both a major and a minor field of study. A minimum of 15 hours of course credit, approved by the student's thesis advisory committee, must be completed on a letter grade basis while enrolled at Georgia Tech.

In addition to an adequate knowledge of the major field of intended research, the student must demonstrate mastery of some other, smaller body of knowledge—the minor field—preferably outside the student's particular school. 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 the student's capabilities.

The minor will normally consist of at least 15 quarter hours of work in related courses, chosen by the student in consultation with a guidance committee and approved by the Office of Graduate Studies. These courses should be at the 6000 level or above, but certain 4000-level courses may also be used with proper approval. Courses taken at other institutions may be included in the minor. Once the student has satisfactorily completed the minor, the school director sends a confirmation, accompanied by course grades, to the graduate office for final approval and recording.

Although the student need not complete the minor as a prerequisite for admission to candidacy, the chosen field must be submitted for approval and the program of study must be completed before clearance for the degree.

## Language Requirements

The student's school may require a reading knowledge of one or more foreign languages.

## The Dissertation

Prior to the student's admission to candidacy, the candidate will present for the approval of the school director or college dean, and the Office of Graduate Studies, a formal statement naming the student's dissertation adviser and setting forth the topic selected for investigation, the objectives the student hopes to gain, and the steps by which the student proposes to achieve 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.

The dissertation must meet the criteria published in the *Manual for Graduate Theses*, which is available in the Office of Graduate Studies.

Prior to the final submission of the completed dissertation to the graduate office, the student must pay the Institute a fee of \$50 for microfilming the dissertation through University Microfilms, Inc.

## The Doctoral Examination

If the dissertation advisory committee finds the dissertation satisfactory, it schedules the candidate for an oral examination on the subject matter for the dissertation and the field in which it lies. An examining committee approved by the Office of Graduate Studies will conduct the examination. The student must register for the quarter in which the final examination occurs and for the quarter of graduation. A waiver of this requirement may be obtained only if all requirements for graduation, including submission of the final approved dissertation, have been completed prior to the last day of registration, and the student was registered for the preceding quarter.

If both the dissertation and the examination are satisfactory and the candidate has completed the requirements of residence, minor field, and any additional school requirements, the Office of Graduate Studies will certify the candidate as qualified to receive the degree of Doctor of Philosophy.

If a candidate should fail to pass the final oral examination, the examining committee may recommend permission for one additional examination. In the case of failure, the registrar does not receive a report of the examination results, but the Office of Graduate Studies keeps a record on file.





# FINANCIAL INFORMATION

## Classification of Students for Tuition Purposes

Under the Constitution and laws of Georgia, the Board of Regents of the University System of Georgia was created to govern, control, and manage a system of public institutions providing quality higher education for the benefit of Georgia citizens. The state, in turn, receives substantial benefit from individuals who are attending or who have attended these institutions through their significant contributions to the civic, political, economic, and social advancement of the citizens of the state of Georgia.

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

The practice followed by state colleges and universities of assessing out-of-state students a higher tuition rate is a rational attempt by states to achieve a partial cost equalization between those who have and those who have not recently contributed to the state's economy, even though no precise way exists to determine the degree to which higher tuition charges equalize the cost of educating in-state and out-of-state students.

Courts that have been faced with challenges to residency classification procedures have consistently recognized the right of public institutions of higher education to charge higher rates to out-of-state students and to adopt reasonable criteria for determining the establishment of in-state status.

For the purpose of these regulations, the question to be answered is not primarily whether a student is a resident or nonresident of Georgia, but rather whether the student meets the criteria to pay University System fees on an in-state basis. The term "resident" is confusing because it may have several definitions as it relates to voter registration, driver's licenses, automobile registration, deeds, contracts, wills, income taxes, and other matters. A student may be a resident of Georgia for some purposes, but not entitled to in-state status for tuition purposes.

The Board of Regents has adopted certain policies governing the classification of students as residents and nonresidents for tuition purposes in keeping with its responsibilities to the citizens of Georgia for an appropriate assessment of fees and to ensure that out-of-state students pay a fair and reasonable share of the cost of their education. The taxpayers of Georgia are thereby assured that they are not assuming the financial burden of educating persons whose presence in the state is not intended to be permanent.

With these considerations in mind, the Board of Regents has adopted the below-listed policies governing the classification of students for fee payment purposes.

1. (a) If a person is 18 years of age or older, he or she may register as an in-state student only upon showing that he or she has resided in Georgia for a period of at least 12 months

immediately preceding the date of registration.

(b) No emancipated minor or other person 18 years of age or older shall be deemed to have gained or acquired in-state status for tuition purposes while attending any educational institution in this state, in the absence of a clear demonstration that he or she has in fact established legal residence in this state.

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

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

4. In the event that a legal resident of Georgia is appointed as guardian of a nonresident minor, such minor will not be permitted to register as an in-state student until the expiration of one year from the date of court appointment, but only upon a proper showing that such appointment was not made to avoid payment of the out-of-state fees.

5. Aliens shall be classified as nonresident students provided, however, that an alien who is living in this country under an immigration document permitting indefinite or permanent residence shall have the same privilege of qualifying for in-state tuition as a citizen of the United States.

6. Waivers: An institution may waive out-of-state tuition for

(a) nonresident students who are financially dependent upon a parent, parents, or spouse who has been a legal resident of Georgia for at least 12 consecutive months immediately preceding the date of registration provided, however, that such financial dependence shall have existed for at least 12 consecutive months immediately preceding the date of registration;

(b) international students selected by the

institutional president or his authorized representative, may be enrolled upon the payment of in-state tuition provided that the number of such waivers in effect does not exceed one percent of the equivalent full-time students enrolled at the institution in the fall quarter immediately preceding the quarter for which the out-of-state tuition is to be waived;

(c) full-time employees of the University System, their spouses, and their dependent children;

(d) nonresident graduate students who hold teaching or research assistantships requiring at least one-third time service at such institution;

(e) full-time teachers in the public schools of Georgia and their dependent children. Teachers employed full-time on military bases in Georgia shall also qualify for this waiver;

(f) career consular officers and their dependents who are citizens of the foreign nation that their consular office represents and who are stationed and living in Georgia under orders of their respective governments. This waiver shall apply only to those consular officers whose nations operate on the principle of educational reciprocity with the United States;

(g) military personnel and their dependents stationed in Georgia and on active duty unless such military personnel are assigned as students to System institutions for educational purposes.

For further information concerning residency, students should contact the Residency Office, Room 103, Administration Building, in writing or by telephone at (404) 894-4152. The Residency Office must receive an application for classification as a legal resident for fee payment purposes no later than one month prior to the academic registration date for the quarter in which the student seeks to pay fees as a resident of Georgia.

## Obligations of Students

An individual is officially enrolled at Georgia Tech upon payment of all applicable matriculation, tuition, transportation, student activity, athletic, and student health fees for the current quarter. Upon enrolling, every student is obligated to remit, return, or submit all other financial obligations that may become due, as well as property or records of the Institute, within the time prescribed by the Institute. Failure to fulfill

## Undergraduate Information

\*Estimated Costs (1995-96 Academic Year)

	Resident of Georgia	Nonresident of Georgia
<b>Quarterly Fees</b>		
Matriculation	\$ 633	\$ 633
Nonresidence	\$ 0	\$ 1,530
Transportation	\$ 19	\$ 19
Student Activity	\$ 41	\$ 41
Health Service	\$ 55	\$ 55
Athletic	\$ 33	\$ 33
<b>Subtotal</b>	<b>\$ 781</b>	<b>\$ 2,311</b>
Books and Supplies	\$ 300	\$ 300
Room and Board	\$ 1,900	\$ 1,900
Personal Expenses (clothing, laundry, recreation, travel, etc.)	\$ 500	\$ 500
<b>Total Per Quarter</b>	<b>\$ 3,481</b>	<b>\$ 5,011</b>
<b>Total Per Year (3 quarters)</b>	<b>\$ 10,443</b>	<b>\$15,033</b>

*\*Quarterly fees shown in this chart are estimated. Final figures approved by the Board of Regents were not available at the time of printing.*

any such obligation will result in denial of registration privileges for subsequent quarter(s). Such denial of registration privileges is in addition to and apart from any disciplinary measures that may be taken pursuant to the Student Conduct Code, "Rules and Regulations," pp. 349.

It is the responsibility of the student to be informed of and to observe all regulations and procedures regarding the payment of fees and the entitlement to refunds. In no case will a regulation be waived or an exception be granted because a student pleads ignorance of the regulation or asserts that he or she was not informed of it by an adviser or other authority. All questions concerning fees and refunds should be directed to the Bursar's Office only. Verbal misinformation is not grounds for a waiver of a regulation.

All fees are payable by the deadline published in the Schedule of Classes for each academic quarter. Registration is not complete until all fees have been paid. Payment may be made either in

cash (at a Teller Window in the Bursar's Office) or by check payable in U.S. currency and drawn on a financial institution in the United States of America or by Visa, Mastercard, or Discover. Credit card payments may be faxed to the Bursar's Office. The Institute reserves the right to determine the acceptability of all checks. All checks not drawn in this manner will be returned to the remitter of the check. Counter checks are not acceptable. If a check given in payment of a student's fees, books, supplies, or residence hall rent is not paid upon presentation to the bank on which it is drawn, an academic hold will be placed on the student's records. A student with an academic hold on his or her record will not be permitted to register for further course work or receive, or have forwarded to external third parties, transcripts of grades until the financial obligation represented by the returned check plus a returned check fee of \$15 or 5 percent of the face amount of the check, whichever is greater, has been paid. Any person who issues an

"insufficient funds" or "no account" check may have violated the statutes of the state of Georgia. This person may not only be permanently withdrawn from the Institute, but may also face legal prosecution. Any person who has a check returned by the bank for any reason should settle that obligation promptly. Failure to do so may result in the placing of the account for collection by a professional collection agency, with the student incurring the full cost of collection.

All matriculation and other charges are subject to change without notice.

Georgia Institute of Technology reserves the right to withhold goods and services for outstanding financial obligations owed to the Institute.

### Fees

A nonrefundable fee of \$25 must accompany all applications for admission to the Georgia Institute of Technology. Upon registration, part-time students (those carrying less than 12 credit hours per quarter) who are legal residents of Georgia pay an estimated \$55 per credit hour and a transportation fee of \$20. Nonresident part-time students pay an estimated \$185 per credit hour (\$55 matriculation and \$130 tuition) and a transportation fee of \$20.

All students scheduling six hours or more must pay the student activity fee estimated at \$43, the athletic fee estimated at \$33, and the health service fee estimated at \$59.\*

Since changes in fees may occur without notice, the student must refer to information provided on registration day by the Office of Senior Vice President for Administration and Finance for official amounts on fees and other institutional charges for each individual quarter.

*\*All figures are estimated pending final determination by the Board of Regents and the senior vice president for Administration and Finance at Georgia Tech.*

### Late Registration Fee

Students who do not meet fee payment deadlines may incur penalty fees. If a student does not pay all required fees by the end of the first week of the quarter, his or her registration may be cancelled.

### Laboratory and Breakage Fees

Chemistry Breakage Cards may be purchased at the Bookstore.

### Account Summaries

Students who require a copy of their account status may request one at any time from the Bursar's Office.

### Other Fees

The fees listed here do not include fraternity, club membership, or personal transportation expenses.

All requests for student transcripts are charged at the rate of \$3 per copy. (Special handling is \$10 per copy.)

Each accepted applicant for admission to the fall quarter must submit a deposit (in addition to the residence hall room deposit) as stated in the letter of admission. This deposit will be applied against fees assessed for students who attend Georgia Tech.

A candidate for the doctoral degree must pay a charge of \$50 for microfilming the dissertation and depositing it with the University Microfilms Service. The Institute assumes the cost of binding the three library copies of a student's thesis or dissertation.

Each student petitioning for graduation must pay a graduation fee upon submitting the petition. The charge is currently \$25. Students must pay this fee each time they submit a petition for graduation.

Georgia Tech reserves the right to charge a fee for the use of Institute property and to levy fines for the improper use of Institute property.

### Refund of Fees

If a student must withdraw from the Institute, the administration will consider requests for fee refunds only through written application. The student should obtain a refund request from the registrar or the Bursar's Office and submit the form, dated and signed, with a copy of the withdrawal application to the Bursar's Office, located in Lyman Hall, by the deadline published in the Schedule of Classes for each academic quarter.

Students withdrawing on or before the last day to register are entitled to a 100 percent refund.

Students withdrawing during the four-week period beginning with the first day after registration are entitled to a refund of a certain percentage of matriculation and tuition fees paid for that quarter as follows.

<b>Withdrawal Effectuated</b>	<b>Percent Refunded</b>
One week following registration	80%
Two weeks following registration	60%
Three weeks following registration	40%
Four weeks following registration	20%

Students should refer to the Schedule of Classes for specific dates and times of each refund period. The date to be used in determining eligibility for a refund will be the date the withdrawal is executed in the Office of the Registrar.

After the last day to register without penalty, the following students are not entitled to any refund of fees paid:

- Students who withdraw after a period of four weeks has elapsed from the last day to register without penalty
- Students who have been suspended for disciplinary reasons
- Students who leave the Institute when disciplinary action is pending
- Students who do not withdraw formally

A stop payment of a check does not constitute a formal withdrawal. There will be a returned check fee of \$15 or 5 percent of the face amount of the check, whichever is greater, as previously stated; the student will be held liable for tuition and fees until the date of official withdrawal.

Requests for refunds must be made in writing to the Bursar's Office, in Lyman Hall, at the time of withdrawal.

## **Undergraduate Financial Assistance**

The Office of Student Financial Planning and Services at Georgia Tech assists students in the search for financial assistance to meet normal college expenses. Our desire is to provide

assistance by assigning Institute funds or by directing students to other sources. The Office of Student Financial Planning and Services receives and administers all funds provided to Tech for undergraduate student assistance, including awards forwarded to the Institute from outside agencies for the use of designated students. Because Georgia Tech will assist students either by awarding funds or by directing the student to other sources of aid, no student should fail to consider attending Tech because of financial problems. However, the financial aid applicant should realize that the amount of aid granted seldom meets all educational expenses, and financial assistance from the Institute will require supplements from the student, family members, and outside sources.

The primary responsibility for financing an education rests with the student and the student's family. Students may receive assistance through scholarships, grants, loans, employment, or a combination of these programs. Of course, the student should help to defray expenses through summer or part-time jobs. Georgia Tech's Career Services Office attempts to keep an up-to-date listing of employment opportunities and can provide more information for interested students. In addition, the Cooperative Program, which is not formally a financial aid program, allows approximately one-fifth of the undergraduate enrollment in the fields of engineering, science, and management to pay part of their college expenses by earning \$6,000 to \$8,000 per year. Financial need is not a prerequisite for consideration in the Co-op plan. Co-op participants are considered for financial aid based upon the same analysis used for other students. Students desiring more information on the Cooperative Program should contact the Director of the Cooperative Division, Georgia Institute of Technology, Atlanta, Georgia 30332-0260.

Students applying for financial aid should file their applications for admission to Georgia Tech by February 1 preceding the summer or fall they expect to enroll.

All entering students, including transfer students, who are interested in scholarships, grants, loans, and/or work opportunities for any quarter of the academic year beginning in June and/or September must submit the Georgia Tech

## Graduate Information

\*Estimated Costs (1995-96 Academic Year)

	Resident of Georgia	Nonresident of Georgia
<b>Quarterly Fees</b>		
Matriculation	\$ 650	\$ 650
Nonresidence Tuition	\$ 0	\$ 1,575
Transportation	\$ 20	\$ 20
Student Activity	\$ 43	\$ 43
Health Service	\$ 59	\$ 59
Athletic	\$ 33	\$ 33
<b>Total</b>	<b>\$ 805</b>	<b>\$ 2,380</b>
<b>Total per Year (3 quarters)</b>	<b>\$ 2,415</b>	<b>\$ 7,140</b>

*\*Quarterly fees shown in this chart are estimated. Final figures approved by the Board of Regents were not available at the time of printing.*

financial aid application and a Free Application for Federal Student Aid (FAFSA). The FAFSA must be submitted to the federal processor by March 1. The Georgia Tech Application for Scholarships and Financial Aid must be filed by March 1.

Entering students usually receive estimated financial aid awards by mid-April. Continuing students receive financial aid awards by mid-May.

For additional information and the *Guide to Financial Aid*, please contact the Office of Student Financial Planning and Services, Georgia Institute of Technology, Atlanta, Georgia 30332-0460.

Special courses may require an additional fee. Graduate students carrying a full academic load (12 credit hours or more per quarter) must pay the full amount of all fees as shown above.

Part-time students who are carrying between six and 11 credit hours per quarter and who are legal residents of Georgia must pay approximately \$53 per credit hour in satisfaction of the matriculation fee and \$129 for the athletic, student activity, and medical fees. Students carrying less than six credit hours pay only the matriculation fee. All nonresident part-time students will have an additional tuition fee of \$128 per credit hour. A student must enroll for a minimum of three hours. All students must pay the \$19 transportation fee.

Note: Conditions may arise beyond the control of the Georgia Institute of Technology that will cause the rate for tuition and fees to be changed during the next year without notice.

## President's Scholarship Program

Georgia Tech's premier merit-based scholarship is the President's Scholarship. Each year approximately 50 incoming freshmen are selected on the basis of demonstrated leadership and scholastic performance. There are two award levels: the first covers the average total expenses of a Georgia resident student; the second covers in-state tuition and fees. The scholarship is renewable annually contingent on satisfactory academic status and campus involvement. To qualify as a candidate for this scholarship, each candidate must

- apply to Georgia Tech prior to applying for the President's Scholarship
- have achieved a minimum SAT score of 1350 (Georgia residents) or 1400 (non-Georgia Residents). [The highest combination of math and verbal SAT scores taken through November will be used to determine eligibility.]

Contact your high school guidance office or the Georgia Tech President's Scholarship Office (404-894-2691) for an application or more information. Applications are available in September and must be received by December 1. All applicants must be U.S. citizens.

## Medals and Prizes

Fraternities, academic schools and departments, professional groups, and community organizations award medals and prizes, such as

the Phi Kappa Phi Award, and present them at the annual Honors Day exercises or at the term's end.

## **Graduate Financial Assistance**

The Institute offers financial aid from a variety of sources to assist students with the pursuit and completion of their degrees as rapidly as circumstances permit. Some of these are briefly described here.

Students should address inquiries for financial assistance to the director of the school in which they plan to study.

## **President's Fellowships**

Each year the Institute awards fellowships to supplement other awards to doctoral matriculants with outstanding academic records and high research potential. The fellowship supplement consists of a \$4,000 stipend for four quarters. These fellowships are renewable for three additional years, based on the major school's evaluation and recommendation.

## **President's Minority Fellowships**

These fellowships are awarded to a select number of outstanding minority doctoral matriculants with outstanding academic records and high research potential. The \$4,000 award is made for four quarters and supplements other support such as departmental assistantships or fellowships. The awards are renewable for three additional years, based on the major school's evaluation and recommendation.

## **President's Minority Research Fellowships**

These fellowships are awarded to a select number of outstanding minority doctoral matriculants who receive research assistantships from an academic unit, center, or laboratory. The award consists of a \$4,000 supplement for four quarters. These fellowships are renewable for three additional years based on the school, center, or laboratory evaluation and recommendations.

## **Graduate Research Assistantships**

Students ordinarily receive these awards on a one-third or half-time basis. Full-time students with at least one-third time appointments pay matriculation fees of \$25, and do not pay nonresidence fees. Other quarterly fees are the same for all students.

## **Graduate Teaching Assistantships**

Schools and departments ordinarily offer these awards on a one-third or half-time basis. Full-time students with at least one-third time appointments pay matriculation fees of \$25, and do not pay nonresidence fees. Other quarterly fees are the same for all students.

## **Federal Fellowships and Traineeships**

The Institute participates in a number of fellowship and traineeship programs sponsored by agencies of the federal government.

In addition, the following traineeships associated with specific training programs are available: water resources planning and management through the Environmental Resources Center, radiation health specialist training program through the School of Mechanical Engineering's Nuclear Engineering Program, air quality control through the School of Chemical Engineering, and minerals and mining through the School of Materials Science and Engineering.

## **Out-of-State Tuition Waivers**

School directors may recommend to the graduate office a limited number of academically outstanding nonresident full-time students for waiver of nonresidence fees.

## **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. Additionally, the company may choose to pay academic fees, costs of texts, and a supply allowance.



### Veterans Program

Because the Veterans Administration must receive certification of enrollment before issuing benefit payments, any student planning to enroll under any of the VA programs should initiate the certification procedure through the Georgia Tech Office of the Registrar as early as possible. For further information about the certification procedure, contact the Office of the Registrar on the Georgia Tech campus, or the local Atlanta Veterans Administration at 730 Peachtree Street, Atlanta, Georgia 30365.

Veterans must apply to Georgia Tech through the usual admissions procedure. Eligibility for VA benefits does not guarantee acceptance to the institution, nor does acceptance to Tech signify eligibility. The institution serves only as a source of certification and information to the Veterans Administration; the student must carry out all financial transactions with the Veterans Administration directly.

### Sponsored Fellowships

The Institute awards a number of fellowships sponsored 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. Most of these fellowships are restricted to specific areas of study, and interested students should contact the director of the school in which they plan to study.

Fellowships and loans that are not restricted to specific schools include the following.

#### Domenica Rea D'Onofrio Fellowship

The recipient, who must be from Italy, receives a stipend of up to \$8,000 and a waiver/out-of-state tuition.

#### National Consortium for Graduate Degrees for Minorities in Engineering Fellowship

Candidates for participation in this program are selected from minorities (African Americans, Puerto Ricans, American Indians, and Chicanos). At the time of application, the student should be enrolled in the junior year of undergraduate study in one of the engineering disciplines. In addition to the graduate stipend, this program provides an opportunity for summer work experience in one

of several off-campus research laboratories. An applicant's record must indicate the ability to pursue graduate studies in engineering. Some students who are presently in their senior year of undergraduate study may be accepted into the program. For further information, write to the College of Engineering, Georgia Institute of Technology, Atlanta, Georgia 30332-0360.

#### Regents' Opportunity Scholarship

The recipients, who must be economically disadvantaged residents of Georgia, receive an award of \$5,000 for the academic year. Awards are not available for summer quarter.

#### United States Steel Foundation Loan Fund

This short-term loan fund is designated to assist graduate students in engineering, physics, chemistry, and mathematics and is administered by the Office of Student Financial Planning and Services.

#### General Electric Foundation Forgivable Loan Program

Forgivable loans are available to doctoral candidates in engineering and computer science. Students must be U.S. citizens who plan to pursue an academic career. This loan is forgivable based on years of service in an academic position after receiving the doctoral degree.

#### Patricia Roberts Harris Fellowships

These fellowships, sponsored by the U.S. Department of Education, are available to minorities and women in aerospace, chemical, electrical, industrial and systems, and mechanical engineering. The award is \$14,000 plus tuition and fees for four quarters and is renewable for up to three years.

# CURRICULA AND COURSES OF INSTRUCTION

This catalog lists alphabetically by colleges the specific degree requirements and course descriptions for each curriculum and course at both the undergraduate and graduate levels.

Course numbers below 1000 denote remedial courses and may not be used in satisfying degree requirements. Course numbers below 3000 indicate lower division (freshman and sophomore) courses. Those numbered 3000-4999 denote upper division (junior and senior) courses, 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 6000 and above; the methods of presentation and quality of work expected make them generally unsuited to undergraduate participation. An upper-division undergraduate student who has an overall grade point average of 2.7 or higher may therefore enroll in a graduate-level course only after consultation with and approval of his or her major school and the dean of the graduate division.

The curriculum listed for each degree program are the requirements that must be completed before becoming a degree candidate. The suggested scheduling sequence for courses in the curriculum is provided as a guide for students. Students who elect to schedule courses out of sequence may require more than 12 quarters in completing degree requirements.

**Figures entered beside 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 hour credit earned for the completed course, in that order. Thus, the entry 4-3-5 in CHEM 1101 means that the course meets**

**for four lecture hours per week and three hours of laboratory per week, and that the student earns five quarter hours credit upon satisfactorily completing the course.**

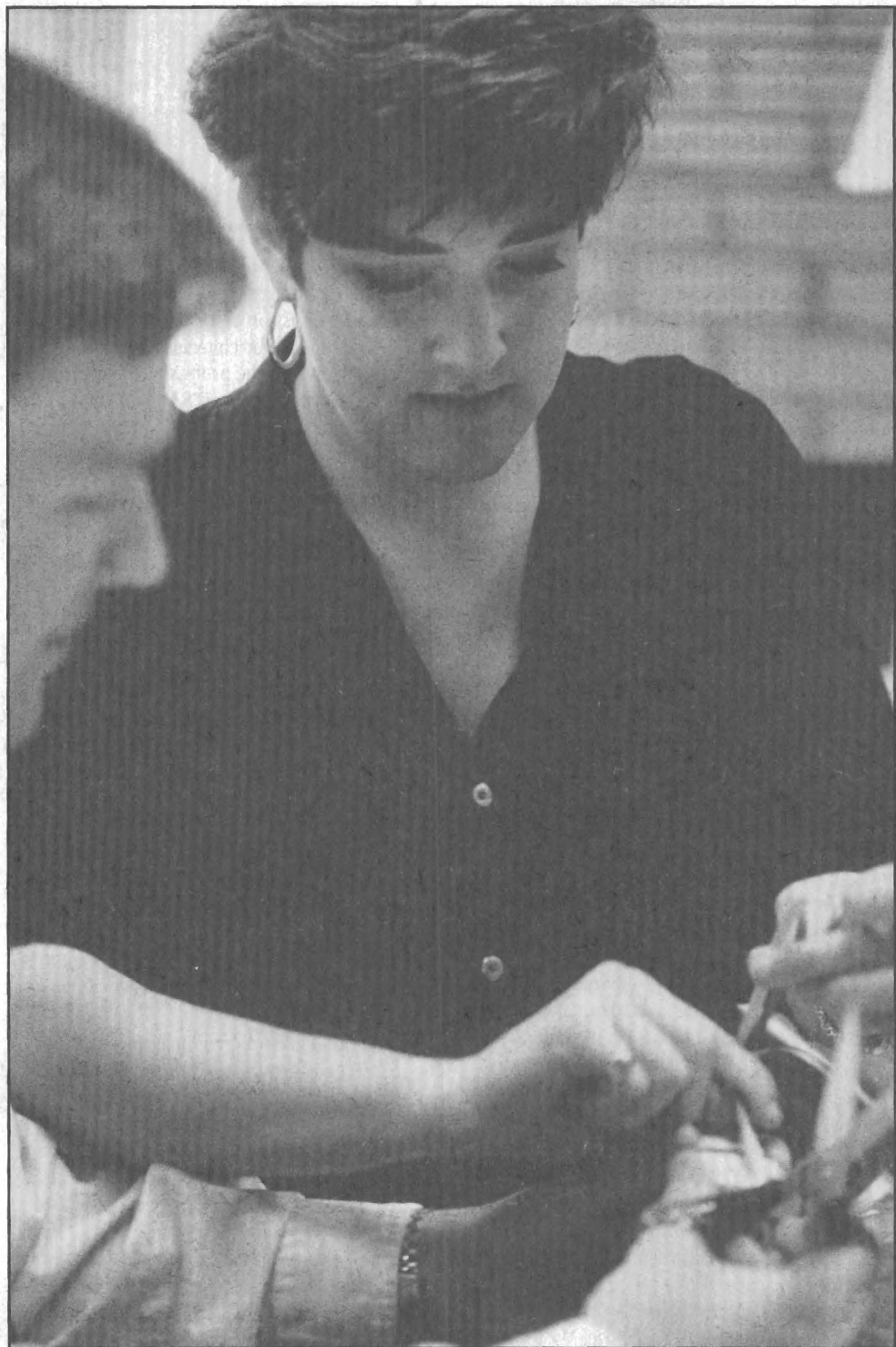
**Example: ARCH 1000. Introduction  
4-3-5.**

4	-	3	-	5
Lecture		Lab		Quarter
Hours		Hours		Hours

## Accommodations for Persons with Disabilities

Reasonable accommodations are provided to self-identified students with disabilities who meet the academic and technical standards requisite to admission or participation in the program of study. Consideration by individual colleges, schools, and departments of instruction may be given to the substitution or modification of certain course requirements—within the limitations imposed by the accreditation criteria for the degree program in which the student is enrolled—and to the extent that such substitutions or modifications of the course or curriculum do not have a net effect of detracting from the quality of the educational experience implied by the course or curriculum designation.

Such substitutions or modifications must be approved by the school director, department head, or college dean, and the Undergraduate Curriculum Committee and/or the Graduate Committee.



# COLLEGE OF ARCHITECTURE

**College established in 1975,  
School in 1948, Department in 1908  
Location: 245 4th Street  
Phone: 894-4885/4886**

*Dean and Professor*—Thomas D. Galloway; *Associate Dean and Professor*—Thomas N. Debo; *Professors*—Douglas C. Allen, Micha Bandini, William C. Bullock, Dale A. Durfee, Steven P. French, Rufus R. Hughes II, John A. Kelly, Ronald B. Lewcock, Richard J. L. Martin, Franklin K. Mooney, Arthur C. Nelson, Elliott A. Pavlos, Catherine B. Ross, David S. Sawicki; *Associate Professors*—James M. Akridge, Stanley C. Bailey, Neill W. Connah, Robert M. Craig, Richard Dagenhart, Harris H. Dimitropoulos, Elizabeth M. Dowling, Garvin T. Dreger, Lane M. Duncan, Michael L. P. Elliott, George B. Johnston, Edward L. Keating, Nancey Green Leigh, John Peponis, H. Randal Roark, C. Virgil Smith, Jean D. Wineman, Craig M. Zimring; *Assistant Professors*—Libero Andreotti, W. J. Blane, William J. Drummond, Nadir Lahiji, William H. Russell, Albert H. Smith; *Instructors*—Leon Eplan, Joseph de Casseres Reshower; *Principal Research Scientist*—Louis J. Circeo; *Research Engineers*—Anatoliusz Lesniewski, Stanley Mitchell; *Research Associate*—Carol Whitescarver; *Research Scientists*—Rand Bohrer, Sharon Bucci, Charles Dyess, Anne Nicole Elder, Sarah Endicott, Richard Erwin, Alan Harp, Michael D. Jones, George Olive, Andrew Roberts, Zena Rubin, Joanie Turner.

## General Information

The College of Architecture offers three undergraduate programs (Architecture, Building Construction, Industrial Design) leading to the Bachelor of Science degree and graduate programs in architecture and city planning leading to the Master of Architecture, Master of

City Planning, Master of Science, and Doctor of Philosophy degrees.

The original mission of the College, established as the Department of Architecture in 1908, was to prepare students for the professional practice of architecture. During the past 85 years, the mission of the College has expanded to provide both continued leadership and to respond to changes in the professions and society. From its original focus on the practice of architecture, the College has become a multidisciplinary setting for teaching, research, and service at every scale of the constructed environment ranging from the design and production of the smallest utilitarian object to the planning and design of the city.

The undergraduate programs of study and the graduate programs of study and research are fully described in the following sections.

All work executed in the College becomes the property of the College and will be retained or returned at the discretion of the faculty. The faculty also reserves the right to refuse for credit any project executed outside the precincts of the College or otherwise executed without proper coordination with the faculty.

## Undergraduate Programs

### Architecture

The undergraduate program in architecture at Georgia Tech is a four-year, preprofessional program leading to the bachelor of science degree. It seeks to provide (1) a general university education in the liberal arts, fine arts, and technology; (2) multidisciplinary foundation in architectural studies with the design studio as major focus of the curriculum; and (3) substantial opportunities for students to explore other disciplines, to concentrate studies in certificate programs, cluster electives, or dual degree programs. This bachelor of science

program prepares students for graduate level studies in architecture, for graduate study in related fields, or a variety of career options related to architecture, the building industry, or government service.

Most states require that an individual intending to become an architect hold an accredited degree. There are two types of degrees that are accredited by the National Architectural Accrediting Board (NAAB): (1) The Bachelor of Architecture, which requires a minimum of five years of study; and (2) The Master of Architecture, which requires a minimum of three years of study following an unrelated bachelor's degree or two years following a related preprofessional bachelor's degree. These professional degrees are structured to educate those who aspire to registration and licensure as architects.

The four-year preprofessional degree, where offered, is not accredited by NAAB. The preprofessional degree is useful for those wishing a foundation in the field of architecture, as preparation of either continued education in a professional degree program or for employment options in architecturally related areas.

## Grade Requirements

Students must maintain a minimum 2.0 grade average in each year grouping of architectural design studio courses (e.g., ARCH 1021, 1022, 1023, etc.) in order to enter the next sequence of studio courses. Each sequence of design studio courses must be started in the fall quarter.

A maximum of 12 credit hours may be taken on a pass/fail basis. Only courses taken as free electives within the undergraduate curriculum are eligible for pass/fail credit. See "Information for Undergraduate Students" for Institute regulations regarding pass/fail courses.

Students who complete both the bachelor's and master's degrees in architecture in the College may apply up to nine credit hours of graduate course work for both degrees, subject to approval of the faculty and certain Institute regulations.

## Bachelor of Science Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 1221</b>			
Introduction to Architecture	3-0-3	.....	.....
<b>ARCH 1021</b>			
Visual Communications	0-9-3	.....	.....
<b>ARCH 1022</b>			
Introduction to Architectural Drawing	.....	0-9-3	.....
<b>ARCH 1023</b>			
Design Fundamentals	.....	.....	0-9-3
<b>ENGL 1001-2</b>			
Analysis of Literature and Language			
I, II	3-0-3	3-0-3	.....
<b>MATH 1507-8</b>			
Calculus I, II	5-0-5	5-0-5	.....
<b>PHYS 2011</b>			
Elementary Physics I	.....	.....	4-0-4
<b>Health and Performance Sciences</b>			
English Literature Elective	.....	3-0-3	.....
Math Elective	.....	.....	3-0-3
Social Science or Humanities Electives	3-0-3	3-0-3	3-0-3
<b>TOTALS</b>	14-9-17	14-9-17	13-9-16

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 2011-2-3</b>			
Architectural Design I, II, III	0-12-4	0-12-4	0-12-4
<b>ARCH 2201-2-3</b>			
History of Architecture I, II, III	3-0-3	3-0-3	3-0-3
<b>ARCH 2341</b>			
Fundamentals of Structural Design	.....	.....	4-0-4
<b>ARCH 2322</b>			
Introduction to Microcomputers in Architecture	1-6-3	.....	.....
<b>PHYS 2012-3</b>			
Elementary Physics II, III	3-0-3	3-0-3	.....

<b>Humanities or Social Science Electives</b>	3-0-3	3-0-3	3-0-3
<b>Free Electives</b>	.....	X-X-3	X-X-3
<b>TOTALS</b>	12-18-16	12-12-16	13-12-17

### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 3011-2-3</b> Architectural Design I, II, III	1-12-5	1-12-5	1-12-5
<b>ARCH 2311-2-3</b> Architectural Technology I, II, III	3-0-3	3-0-3	3-0-3
<b>ARCH 3211</b> History and Theory of Modern Architecture	3-0-3	.....	.....
<b>Social Science or Humanities Electives</b>	3-0-3	3-0-3	3-0-3
<b>Architecture Electives</b>	.....	X-X-3	.....
<b>Free Electives</b>	X-X-3	X-X-3	X-X-3
<b>TOTALS</b>	13-12-17	13-12-17	10-12-14

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Cluster Electives</b>	X-X-5	X-X-5	X-X-5
<b>Architecture Electives</b>	.....	X-X-3	X-X-3
<b>Urban History</b>	3-0-3	.....	.....
<b>Free Electives</b>	X-X-7	X-X-7	X-X-7
<b>TOTALS</b>	X-X-15	X-X-15	X-X-15

**Total Required Credit Hours for Graduation = 192**

## ELECTIVES

### Health and Performance Sciences Electives

Georgia Tech requires students to complete HPS 1040 or 1061 for the degree. Other health and performance science courses may count as free electives. No physical education course will count towards the degree.

### Humanities Electives

Eighteen credit hours of humanities courses are required. The required ENGL 1001, 1002, three credit hours of English literature electives, and any other nine credit hours of Institute approved humanities courses satisfy this requirement. ARCH 2201, 2202, 2203, and 3211 do not count towards this requirement for architecture majors.

### Social Sciences Electives

Eighteen credit hours of approved social sciences courses are required. All students are required to

pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement. Either ARCH 4221 or HIST 4075 is also required. Any other nine credit hours of Institute approved social science courses will satisfy the remainder of this requirement.

### Math Electives

A minimum of three credit hours of mathematics electives are required and must be selected from an approved list of mathematics electives in the *Undergraduate Architecture Handbook*.

### Architectural Electives

Twelve credit hours of approved architecture electives are required. Courses chosen from the list of required electives for the M.Arch. I degree or any other courses taught in the College and not otherwise required will satisfy this requirement. The selection of any architecture elective should be made in consultation with the student's academic adviser.

### Cluster Electives

A minimum of 15 credit hours in a concentrated cluster is required for the B.S. degree. Clusters may be made up from courses from within or outside of the College. This requirement may be fulfilled by several existing certificate programs on the campus, the senior year sequence of architectural design, or by a 15-hour concentration approved by the architecture faculty.

### Free Electives

Thirty-six credit hours of free electives are included in the curriculum to allow students to pursue architectural studies in additional depth or to pursue other educational interests within or outside the College. Courses chosen from the list of required electives for the M.Arch. degree or any other courses taught in the College or Institute and not otherwise required will satisfy this requirement.

The selection of these courses should be made in consultation with the student's adviser. Military training is an optional program of the Institute, but if basic ROTC and advanced military are elected, no more than 15 credit hours of free electives may be used for this purpose or will be

credited toward the requirements for a degree. No course covering the same material as other courses may be applied for credit for the B.S. degree. MATH 1708 and 1709 will not be counted toward any degree requirement.

## Senior Year Study Abroad Program

The College of Architecture conducts an annual Study Abroad Program in Paris, France, in association with the Ecole d'Architecture Paris-LaVillette. This program is designed to give qualified senior students in architecture the opportunity to complete all or part of their senior year in residence in Paris. The program offers courses, taught by Georgia Tech faculty, generally paralleling those courses taught in Atlanta. Opportunities also exist for individual study and travel.

Students interested in the Study Abroad Program must enroll in French language courses well in advance of their senior year.

## Building Construction

In tandem with the architect and engineer, the constructor is an equal partner in a complexity of integrated professional disciplines responsible for the physical reality of the habitable structures in the built environment. Building construction education is a unique academic discipline with increasing demands for innovation, research, and leadership preparation. The building construction degree program is structured to accommodate contemporary and future industry directions with the objective of providing an innovative and forward-looking educational experience to prepare participants for entry and advancement into leadership roles in major segments of the dynamic industry.

Three formal degree options are offered that provide individual concentrations of study in three major disciplines in the industry:

(1) management, (2) development, and (3) science. Students select an option that is compatible with their interests and career objectives. The three options include a foundation core of study in construction technology and practice, physical sciences and mathematics, and humanities and social sciences. Each total curriculum combines technical and liberal arts elements into a synergistic building sequence,

which culminates in the senior year with the development and presentation of a comprehensive terminal project that serves as the core evaluation of the student's overall educational experience in building construction. The degree granted is a Bachelor of Science in Building Construction.

## Certificate Program in Building Construction

The College of Architecture also offers the opportunity for students in all disciplines at Georgia Tech to broaden their academic experience by granting recognition for study in building construction. The certificate program provides a course of study in the management and financial processes required to produce buildings in today's complex and dynamic industry. Students will acquire a working knowledge of the business of construction including the means and methods used to plan and manage the resources required in building delivery processes. The program should be particularly attractive to students in architecture, management, and the engineering disciplines.

The certificate requires a minimum of 15 quarter hours of building construction courses at the 3000 and 4000 course levels in which a grade of C or better must be earned. Participants must also satisfy the requirements for an undergraduate degree and be in good standing. The required and elective courses are as follows:

### Required Courses:

BC 3310	Construction Contracting
BC 3320	Construction Law
BC 3330	Real Estate and Construction Finance

### Elective Courses:

Select two from the following:

BC 4301	Construction Systems
BC 4442	Value Engineering in Construction
BC 4450	Building Production
BC 4460	Risk Management

## Option 1 - Construction Management

The construction management curriculum provides students the opportunity to pursue specialized study and develop skills in managerial systems and practices utilized by constructors to manage the planning and delivery processes of buildings in the contemporary practice of construction.

Managerial areas of study range from internal management systems used by general contractors and builders in office operations and practice to management and systems controls employed by construction managers in the planning, design, and construction phases of complex building projects. Studies in construction management coupled with the strong educational base in construction technology and practice prepare students for fulfilling careers in the fields of general contracting, specialty contracting, construction consulting, and construction management.

## Construction Management Curriculum (Suggested Schedule)

### Freshman Year

Course	1st Q.	2nd Q.	3rd Q.
<b>ARCH 2201-2-3</b>			
History of Architecture I, II, III	3-0-3	3-0-3	3-0-3
<b>BC 1010</b>			
Building Construction Seminar	....	....	1-0-1
<b>CHEM 1101-2</b>			
General Chemistry	4-3-5	4-3-5	....
<b>EAS 2102</b>			
General Geology Lab	....	....	0-3-1
<b>EAS 2501</b>			
Geology I	....	....	3-0-3
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	....
<b>Health and Performance Sciences</b>	....	....	3-0-3
<b>Electives</b>	....	....	3-0-3
<b>TOTALS</b>	15-3-16	15-3-16	18-3-19

### Sophomore Year

Course	1st Q.	2nd Q.	3rd Q.
<b>ARCH 2311-2-3</b>			
Architectural Technology I, II, III	3-0-3	3-0-3	3-0-3
<b>BC 2010</b>			
Construction Technology I	3-6-5	....	....
<b>BC 2020</b>			
Construction Technology II	....	3-6-5	....
<b>BC 2030</b>			
Construction Cost Estimating	....	....	2-9-5
<b>MGT 2000</b>			
Accounting I	....	3-0-3	....
<b>PHYS 2011-2-3</b>			
Elementary Physics	4-0-4	3-0-3	3-0-3
<b>ARCH 2341</b>			
Fundamentals of Structural Design	....	....	4-0-4
<b>MGT 2050</b>			
Management Applications of Information Technology	2-3-3	....	....
<b>ECON 2000</b>			
Principles of Economics I	3-0-3	....	....
<b>Electives</b>	....	3-0-3	3-0-3
<b>TOTALS</b>	15-9-18	15-6-17	15-9-18

### Junior Year

Course	1st Q.	2nd Q.	3rd Q.
<b>ARCH 4331-2-3</b>			
Architectural Structures I, II, III	3-3-4	3-3-4	3-3-4
<b>BC 3310</b>			
Construction Contracting	3-0-3	....	....
<b>BC 3320</b>			
Construction Law	....	3-0-3	....
<b>BC 3330</b>			
Real Estate and Construction Finance	....	....	3-0-3
<b>ISYE 4725</b>			
Engineering Economy	....	3-0-3	....
<b>MGT 3050</b>			
Computer-based Management Systems	....	....	3-0-3
<b>MGT 3150</b>			
Management Theory	....	3-0-3	....
<b>MGT 3260</b>			
Business Law	3-0-3	....	....
<b>ENGL 3015</b>			
Public Speaking	....	3-0-3	....
<b>ENGL 3020</b>			
Technical Writing	3-0-3	....	....
<b>Electives</b>	3-0-3	....	9-0-9
<b>TOTALS</b>	15-3-16	15-3-16	18-3-19



**Senior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>BC 4500-10</b>			
Terminal Project I, II	....	3-0-3	1-12-5
<b>BC 4440</b>			
Construction Scheduling	3-6-5	....	....
<b>BC 4442</b>			
Value Engineering in Construction	....	3-0-3	....
<b>BC 4450</b>			
Building Production	3-0-3	....	....
<b>BC 4460</b>			
Risk Management	....	3-0-3	....
<b>MGT 4100</b>			
Organizational Analysis	3-0-3	....	....
<b>MGT 4200</b>			
Industrial Relations	....	3-0-3	....
<b>PSY 4401</b>			
Industrial Psychology	....	3-0-3	....
<b>Electives</b>	6-0-6	3-0-3	9-0-9
<b>TOTALS</b>	<b>15-6-17</b>	<b>18-0-18</b>	<b>10-12-14</b>

**Total Required Credit Hours for Graduation = 204**

**Option 2 - Construction Development**

The construction development curriculum introduces students to entrepreneurial theories and practices used in the development of construction projects ranging from single facilities to multiple-building complexes. This concentration of specialized study focuses on urban economic theories, planning legislation and regulation, and urban development methods applicable in land and real estate investment. Emphasis is on the development and marketing theories of building projects in the context of contemporary planning and urban development issues. The core curriculum requirements in construction technology and practice combined with building investment and development theories provide a broad educational foundation for rewarding career opportunities in the entrepreneurial development areas of the construction industry.

**Construction Development Curriculum (Suggested Schedule)**

**Freshman Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 2201-2-3</b>			
History of Architecture I, II, III	3-0-3	3-0-3	3-0-3
<b>BC 1010</b>			
Building Construction Seminar	....	....	1-0-1
<b>CHEM 1101-2</b>			
General Chemistry	4-3-5	4-3-5	....
<b>EAS 2102</b>			
General Geology Lab	....	....	0-3-1
<b>EAS 2501</b>			
Geology I	....	....	3-0-3
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	....
<b>Health and Performance Sciences</b>	....	....	3-0-3
<b>Electives</b>	....	....	3-0-3
<b>TOTALS</b>	<b>15-3-16</b>	<b>15-3-16</b>	<b>18-3-19</b>

**Sophomore Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 2311-2-3</b>			
Architectural Technology	3-0-3	3-0-3	3-0-3
<b>BC 2010</b>			
Construction Technology I	3-6-5	....	....
<b>BC 2020</b>			
Construction Technology II	....	3-6-5	....
<b>BC 2030</b>			
Construction Cost Estimating	....	....	2-9-5
<b>MGT 2000</b>			
Accounting I	....	3-0-3	....
<b>PHYS 2011-2-3</b>			
Elementary Physics I, II, III	4-0-4	3-0-3	3-0-3
<b>ARCH 2341</b>			
Fundamentals of Structural Design	....	....	4-0-4
<b>MGT 2050</b>			
Management Applications of Information Technology	2-3-3	....	....
<b>ECON 2000</b>			
Principles of Economics I	3-0-3	....	....
<b>Electives</b>	....	3-0-3	3-0-3
<b>TOTALS</b>	<b>15-9-18</b>	<b>15-6-17</b>	<b>15-9-18</b>

**Junior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 4331-2-3</b>			
Architectural Structures I, II, III	3-3-4	3-3-4	3-3-4
<b>BC 3310</b>			
Construction Contracting	3-0-3	.....	.....
<b>BC 3320</b>			
Construction Law	.....	3-0-3	.....
<b>BC 3330</b>			
Real Estate and Construction Finance	.....	.....	3-0-3
<b>ISYE 4725</b>			
Engineering Economy	.....	3-0-3	.....
<b>MGT 3060</b>			
Finance I	.....	3-0-3	.....
<b>MGT 3061</b>			
Finance II	.....	.....	3-0-3
<b>MGT 3260</b>			
Business Law	3-0-3	.....	.....
<b>ENGL 3015</b>			
Public Speaking	.....	3-0-3	.....
<b>ENGL 3020</b>			
Technical Writing	3-0-3	.....	.....
<b>Electives</b>	3-0-3	.....	9-0-9
<b>TOTALS</b>	15-3-16	15-3-16	18-3-19

**Senior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>BC 4500-10</b>			
Terminal Project I, II	.....	3-0-3	1-12-5
<b>BC 4440</b>			
Construction Scheduling	3-6-5	.....	.....
<b>BC 4442</b>			
Value Engineering in Construction	.....	3-0-3	.....
<b>BC 4450</b>			
Building Production	3-0-3	.....	.....
<b>BC 4460</b>			
Risk Management	.....	3-0-3	.....
<b>CP 4002</b>			
Contemporary Planning and Development Issues	3-0-3	.....	.....
<b>CP 4022</b>			
Foundations of Urban & Regional Development	.....	3-0-3	.....
<b>CP 4041</b>			
Introduction to Real Estate Investment and Development	3-0-3	.....	.....
<b>Electives</b>	3-0-3	6-0-6	9-0-9
<b>TOTALS</b>	15-6-17	18-0-18	10-12-14

**Total Required Credit Hours for Graduation = 204**

**Option 3 - Construction Science**

The construction science curriculum is an analytically oriented course of study designed to encourage students to challenge current methods of building construction and delivery techniques and to seek innovative solutions through study, research, and technical inquiry. Emphasis is on the means and methods of constructing buildings, the intrinsic nature and use of construction materials, the anatomy of building systems and components, and prefabricated building systems and components development and production concepts. Graduates are prepared to enter and advance in the construction industry in the management and production areas of general contracting, specialty contracting, specialty consulting, the pre-engineered building systems and components industry, and the construction materials and equipment industry. The construction science option provides an outstanding undergraduate foundation leading to graduate study and research in the building construction field.

**Construction Science Curriculum (Suggested Schedule)**

**Freshman Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 2201-2-3</b>			
History of Architecture I, II, III	3-0-3	3-0-3	3-0-3
<b>BC 1010</b>			
Building Construction Seminar	.....	.....	1-0-1
<b>CHEM 1101-2</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>EAS 2102</b>			
General Geology Lab	.....	.....	0-3-1
<b>EAS 2501</b>			
Geology I	.....	.....	3-0-3
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>Health and Performance Sciences</b>	.....	.....	3-0-3
<b>Electives</b>	.....	.....	3-0-3
<b>TOTALS</b>	15-3-16	15-3-16	18-3-19

## Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 2311-2-3</b> Architectural Technology I, II, III	3-0-3	3-0-3	3-0-3
<b>BC 2010</b> Construction Technology I	3-6-5	.....	.....
<b>BC 2020</b> Construction Technology II	.....	3-6-5	.....
<b>BC 2030</b> Construction Cost Estimating	.....	.....	2-9-5
<b>MGT 2000</b> Accounting I	3-0-3	.....	.....
<b>MATH 2307</b> Calculus IV	5-0-5	.....	.....
<b>PHYS 2121-2</b> Particle Dynamics- Electromagnetism	.....	4-3-5	4-3-5
<b>ARCH 2341</b> Fundamentals of Structural Design	.....	.....	4-0-4
<b>ECON 2000</b> Principles of Economics I	3-0-3	.....	.....
<b>Electives</b>	.....	3-0-3	.....
<b>TOTALS</b>	17-6-19	13-9-16	13-12-17

## Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 4331-2-3</b> Architectural Structures I, II, III	3-3-4	3-3-4	3-3-4
<b>BC 3310</b> Construction Contracting	3-0-3	.....	.....
<b>BC 3320</b> Construction Law	.....	3-0-3	.....
<b>BC 3330</b> Real Estate and Construction Finance	.....	.....	3-0-3
<b>ISYE 4725</b> Engineering Economy	.....	3-0-3	.....
<b>PHYS 2123</b> Optics and Modern Physics	4-3-5	.....	.....
<b>CE 3513</b> Applications of Digital Computers	3-0-3	.....	.....
<b>CE 3309</b> Materials of Construction	.....	3-3-4	.....
<b>ENGL 3015</b> Public Speaking	.....	.....	3-0-3
<b>ENGL 3020</b> Technical Writing	.....	3-0-3	.....
<b>Electives</b>	3-0-3	.....	7-0-7
<b>TOTALS</b>	16-6-18	15-6-17	16-3-17

## Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>BC 4500-10</b> Terminal Project I, II	.....	3-0-3	1-12-5
<b>BC 4301</b> Construction Systems	3-0-3	.....	.....
<b>BC 4440</b> Construction Scheduling	3-6-5	.....	.....
<b>BC 4442</b> Value Engineering in Construction	.....	3-0-3	.....
<b>BC 4450</b> Building Production	3-0-3	.....	.....
<b>BC 4460</b> Risk Management	.....	3-0-3	.....
<b>ISYE 3231</b> Deterministic Operations Research	3-0-3	.....	.....
<b>Electives</b>	3-0-3	9-0-9	9-0-9
<b>TOTALS</b>	15-6-17	18-0-18	10-12-14

**Total Credit Hours Required For Graduation = 204**

## Electives

A total of 39 hours of electives is included in Options 1 and 2 and 37 in Option 3, and with the advice of faculty counselors, electives should be selected to include the following categories. These categories will satisfy the core curriculum requirements of the College of Architecture in the humanities and social sciences and the additional professional requirements of the building construction program.

### Humanities Electives

Eighteen credit hours are required. The required architectural history sequence, ARCH 2201-2-3, and the required English sequence, ENGL 1001-2, will satisfy 15 hours. The remaining three hours are selected by the student from approved English literature courses.

### Social Sciences Electives

Eighteen credit hours of social sciences are required, including at least three hours in each of sociology and psychology. Note that ECON 2000 will satisfy three additional hours of social sciences requirements. All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia.

HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

### General Electives

Twenty-one hours for Options 1 and 2 and 19 for Option 3 are required. Twelve credit hours for Options 1 and 2 and 10 for Option 3 of professional electives are required at the 3000 level or above as approved by the department. Three hours of professional elective credit may be satisfied on a pass/fail basis for summer intern employment in the construction industry with departmental consent and approval. Nine hours for Options 1, 2, and 3 of free electives are required for the B.S.B.C. degree; these electives may be taken on a pass/fail basis.

Military training is an option allowed by the Institute. If basic ROTC is elected, six credit hours of free electives may be used. If advanced military training is elected, nine credit hours of professional hours for this purpose will be credited toward meeting degree requirements.

The College of Architecture will accept only the three required hours of physical education toward meeting degree requirements. Math 1708 and 1709 will not count toward fulfilling any of the degree requirements.

### City Planning

The City Planning Program offers no undergraduate degrees. However, a number of undergraduate courses are offered each quarter, and two different certificates, one in land development and the other in urban policy, are available to undergraduate students. In addition, four planning courses are available for social sciences credit: CP 4004 (Negotiation and Conflict Management), CP 4014 (Environmental Policy and Regulation), CP 4022 (Foundations of Urban and Regional Development), and CP 4028 (International Development Planning).

An accelerated program is available to Tech undergraduate students wishing to pursue the master's degree in city planning simultaneously with their undergraduate degree. See details in the graduate section on City Planning.

### Industrial Design

Industrial design is the professional service of creating and developing concepts and specifications that optimize the function, value,

and appearance of products and systems for the mutual benefit of both user and manufacturer. Industrial designers, with their wide range of interests and generalist outlook in an age of specialization, must be part artist, part entrepreneur, and part engineer.

The industrial designer's work touches all of our lives in the form of home furnishings, transportation, appliances, recreational equipment, and a myriad of other consumer and industrial products and services. While giving form to the efforts of industry, the designer is at the same time a consumer advocate, providing the humanizing link between technology and the consumer.

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

Grade averages in design courses are checked at the end of each year—group of three courses (ID 2001-2-3, etc.). A student may not enter a more advanced group until his or her record in the previous group equals 2.0 or better. All work executed in the College becomes the property of the College and will be retained or returned at the discretion of the faculty. The faculty also reserves the right to refuse credit for any project executed outside the precincts of the College or otherwise executed without proper coordination with the instructor.

### Bachelor of Science in Industrial Design (Suggested Schedule)

#### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ARCH 1011-2-3</b>			
Design Fundamentals I, II, III	0-9-3	0-9-3	0-9-3
<b>ARCH 1501-2-3</b>			
Visual Communications I, II, III	0-6-2	0-6-2	0-6-2
<b>MATH 1507-8</b>			
Calculus I, II	5-0-5	5-0-5	.....
<b>Math Elective</b>	.....	.....	3-0-3
<b>ENGL 1001-2</b>			

Analysis of Literature and Language 1, II	3-0-3	3-0-3	.....
<b>ENGL 2XXX</b>			
English Elective	.....	.....	3-0-3
<b>Social Sciences Elective ID 1263</b>	3-0-3	3-0-3	.....
History of Industrial Design	.....	.....	3-0-3
<b>Health and Performance Sciences</b>	.....	.....	3-0-3
<b>TOTALS</b>	11-15-16	11-15-16	12-15-17

## Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ID 2001-2-3</b>			
Industrial Design	1-12-5	1-12-5	1-12-5
<b>ID 2301-2</b>			
Materials and Processes	1-3-2	1-3-2	.....
<b>Visual Communications</b>			
<b>Elective (Drawing)</b>	.....	.....	0-6-2
<b>PHYS 2011-2-3</b>			
Elementary Physics I, II, III	4-0-4	3-0-3	3-0-3
<b>Elective</b>	.....	.....	3-0-3
<b>ECON 2000</b>			
Microeconomics	.....	3-0-3	.....
<b>History of Philosophy of Science and Technology</b>			
<b>Elective:</b>			
HIST 1028, 3015, 3016, 3030, 3047-8-9, 4008, 4016, or PST 1127	3-0-3	.....	.....
<b>ARCH 4247-8</b>			
History of Art I, II or			
<b>ARCH 2201-2</b>			
History of Architecture I, II	3-0-3	3-0-3	.....
<b>TOTALS</b>	12-15-17	11-15-16	10-18-16

## Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ID 3001-2-3</b>			
Industrial Design	1-12-5	1-12-5	1-12-5
<b>ID 3301-2-3</b>			
Materials and Processes	1-3-2	1-3-2	1-3-2
<b>PSY 3303</b>			
General Psychology I	3-0-3	.....	.....
<b>Visual Communications</b>			
<b>Elective (Photography)</b>	0-6-2	.....	.....
<b>Human Factors Elective</b>			
ARCH 4751, ISYE 3010, 3113, 3115, PSY 4409, 4751 or 4756	.....	3-0-3	3-0-3
<b>Social Sciences Elective</b>	.....	.....	3-0-3

<b>Electives</b>	3-0-3	3-0-3	3-0-3
<b>Visual Communications Elective</b>	.....	.....	2-0-2
<b>Electives</b>	3-0-3	3-0-3	.....
<b>TOTALS</b>	11-21-18	11-15-16	13-15-18

## Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ID 4101</b>			
Industrial Design	1-12-5	.....	.....
<b>ID 4002-3</b>			
Industrial Design	.....	1-18-8	1-18-8
<b>ID 4451</b>			
Professional Practice of Industrial Design	3-0-3	.....	.....
<b>MGT 3300</b>			
Marketing	3-0-3	.....	.....
<b>Electives</b>	3-0-3	6-0-6	6-0-6
<b>TOTALS</b>	13-12-14	7-18-14	7-18-14

**Total Required Credit Hours for Graduation = 192**

## Electives

A total of 36 hours of required electives should be selected to include the following categories. These categories will satisfy the core curriculum requirements in the humanities and social sciences and the additional professional requirements of the program.

### Humanities Electives

Eighteen credit hours are required and are satisfied by the required freshman English sequence and the required History of Art or History of Architecture classes plus a humanity elective.

### Social Sciences Electives

Eighteen credit hours are required. Nine hours are satisfied by the required PSY 3303, ECON 2000, and the History of Philosophy of Science and Technology elective. The remaining nine hours are selected from the approved list of social sciences courses in this catalog. All students are required to pass examinations in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 can satisfy this requirement.

## General and Technical Electives

Twenty-four general elective hours and 12 technical elective hours are required. The general elective hours may include six hours credit for basic ROTC courses. The 12 technical elective hours are to be chosen from the College's list and may include nine hours of advanced ROTC. Those enrolling in ROTC must schedule appropriate ROTC courses in the freshman and sophomore years.

The College of Architecture will not accept hours of physical education toward meeting the requirements for a degree. Only 12 hours of free electives taken on pass/fail basis may be applied toward fulfilling requirements for the B.S.I.D. degree. MATH 1708 and 1709 will not count toward fulfilling any of the degree requirements.

## Graduate Programs

### Architecture

The master's degree programs in architecture have two parallel and mutually dependent objectives. The first is to provide multidisciplinary graduate study in architecture that is oriented to intellectual inquiry, scholarship, and research. The second is to provide a professional education in architecture at the highest levels of accomplishment and aimed toward the leadership of the profession. Graduate study in architecture, therefore, is concerned with theory and practice, research and design, and confirmation of traditions as well as expansion of the limits of the discipline and practice of architecture.

All of the master's degree curricula have three primary characteristics:

- 1) The curricula are structured around a core of courses that engage architectural theory, research, and practice within the framework of the city as a critical setting for architecture.
- 2) The faculty and the programs encourage rigorous in-depth investigations in the study of architecture in one or more areas of inquiry:
  - a) history, theory, and criticism; b) urban design; c) architectural technology; and d) architecture and behavior.
- 3) The program requires each student to use the resources of the College of Architecture, the Institute, and the city of Atlanta to construct an individual program of study extending from the core curriculum to the required master's thesis in the M.Arch.I Program or a significant

independent study project in the M.Arch II and the M.S. Programs.

The three master's programs in architecture are as follows:

### Master of Architecture (M.Arch.I)

The M.Arch.I Program, leading to the Master of Architecture as the first professional degree, is oriented toward the professional practice of architecture and is fully accredited by the NAAB. Applicants to the program may have undergraduate degrees in architecture or in other disciplines. The program requires from two to three and two-thirds academic years of full-time study depending on the applicant's prior education in architecture and the amount of advanced standing granted by the program. Graduates from a four-year undergraduate program in architecture similar to that at Georgia Tech can normally expect to complete the program in two academic years, if they pursue architecturally related elective course work during their undergraduate years. Specific information regarding applications for advanced standing and degree requirements is available from the architecture program.

The minimum requirements for the M.Arch.I degree are as follows:

Master's Thesis.....	18 credit hours
Thesis Preparation.....	3 credit hours
Architectural Design Studios.....	18 credit hours
Individual Program of Study.....	15 credit hours
Professional Courses and	
Electives.....	21 credit hours
Free Electives.....	15 credit hours
TOTAL (Minimum).....	90 credit hours

### Total Minimum Required Credit Hours for M.Arch.I Program = 90

### Master of Architecture (M.Arch.II)

The M.Arch.II Program is a postprofessional degree in architecture and has the primary purpose of providing advanced studies in architecture and urban design, with an emphasis on the studio. A previous professional degree in architecture is required (B.Arch. or M. Arch.) prior to entry into the program. The minimum length of study is one academic year. The minimum requirements are as follows:

Core Course.....	3 credit hours
Architectural Design Studios.....	12 credit hours
Architecture Electives or Thesis.....	18 credit hours
Free Electives.....	12 credit hours
TOTAL.....	45 credit hours

**Total Minimum Required Credit Hours for the M.Arch.II Program = 45**

## Master of Science (M.S.)

The M.S. Program is a non-professional program in advanced architectural studies and is oriented toward scholarship and research. Applicants may have previous degrees in architecture or other related fields. The areas of specialized study include a) history, theory, and criticism of architecture; b) architectural technology and building science; c) architecture and behavior, and d) computing and information technologies in architecture. In addition, faculty interests support a wide range of other interests and study areas. Applicants to the program must visit the school and discuss research interests with the appropriate faculty prior to submission of the application. The minimum length of study is one academic year. The minimum requirements are as follows:

Core Course.....	3 credit hours
Architecture Electives or Thesis.....	18 credit hours
Free Electives.....	24 credit hours
TOTAL.....	45 credit hours

**Total Minimum Required Credit Hours for the M.S. Program = 45**

## Multidisciplinary Study

Multidisciplinary studies are strongly encouraged in all of the master's programs in architecture. These studies may be part of formal dual degree programs, including architecture and city planning, architecture and civil engineering, architecture and management, etc. Other multidisciplinary studies are possible within the College of Architecture, the Institute, and at Emory University, Georgia State University, and the Atlanta College of Art among other Atlanta area colleges and universities. Course work outside the architecture program frequently includes city

planning, public policy, history, philosophy, real estate development, engineering, and studio art.

## Foreign Study Programs

Graduate students in architecture are eligible to participate in two foreign study programs. The first is the Summer Program in Europe, which has a primary focus on modern and contemporary architecture in Paris, Berlin, and Holland. The second is an academic year program in Paris, France, which can occur in the final year of study in conjunction with the student's thesis research and design.

## Applications

The deadline for applications is February 1 for the following fall quarter. Each applicant must have an outstanding undergraduate record and must submit a portfolio of creative work. The Graduate Record Examination is required for all applicants. A minimum TOEFL score of 560 is required for all foreign applicants. All applicants should be aware that the Master's Program in Architecture has specific application requirements; therefore, all applicants should request a complete application package and instructions by calling (404) 894-4885 (FAX 853-9060) or writing to Master's Degree Programs, College of Architecture, Georgia Institute of Technology, Atlanta, GA 30332-0155.

## City Planning

Founded in 1951, Tech's planning program is one of the oldest professional planning programs in the United States, with nearly 700 alumni. Graduates are employed in both the public and private sectors, at all levels of government, by banks, real estate and development companies, utilities, and private corporations. The program is accredited by the Planning Accreditation Board; it is the only accredited planning program in Georgia.

The city planning program offers course work in seven major areas of urban and regional planning: land development, environmental policy and planning, transportation, economic development, planning and geographic information systems, urban design, and land use policy. Several types of programs of study are

available: the professional Master of City Planning; joint degrees with other Tech programs; a five-year B.S./M.C.P. degree; and undergraduate and graduate certificates. Each is described below.

## Master of City Planning Degree

This program educates the student whose career goal is professional planning. Since the course material is sequential, fall matriculation is strongly preferred. Approximately half of the program consists of required courses, called the core. The core is composed of three substantive streams: urban, regional, locational, and development economics and policy; planning theory and process, including decision analysis, planning law, institutional analysis, dispute resolution, policymaking processes, risk analysis, implementation, and history and theory of the profession itself; and planning methods, including data analysis, computer applications, descriptive and inferential statistics, microeconomic analytic techniques, modeling, and planning intelligence and information systems. The core is largely contained within the student's first year. Students may choose between two tracks, comprehensive or development track, each consisting of six required courses. Generally in the second year, he or she chooses from among several areas of concentration described above.

The two-year curriculum requires, for most students, six quarters of course work, including a six-credit applied research paper. Some students choose to write a full 15-credit hour thesis. A salaried approved internship is required for those students with no previous planning work experience.

The Graduate Record Examination is required for all applicants to the Master of City Planning program. A minimum TOEFL score of 570 is required for all foreign applicants. Since the course material is sequential in nature, fall matriculation is strongly recommended. Completed applications must be received before March 1 to insure consideration for financial aid.

## The Joint Degree

The city planning program maintains joint degree programs with several other academic units at Georgia Tech: urban design in architecture and

transportation in civil engineering. The concept behind the joint degree program is that a student can structure his or her program so that required courses taken in one program can serve as elective credit in the other, thus allowing the student to receive two master's degrees in less time than the two would take to complete if pursued separately. Candidates seeking the joint degree should state their intentions and be officially admitted into city planning and simultaneously accepted internally by the second program. In addition to the joint degree programs, the business administration program in real estate at Georgia State University offers a certificate in real estate that some planning students elect to pursue; likewise, the history program at Georgia State University offers a historic preservation certificate.

## The Five-year B.S./M.C.P. Degree

Undergraduates may work simultaneously on their bachelor's degree and a master's in planning. By enrolling in all required planning classes as electives for the baccalaureate degree, students may obtain both an undergraduate degree as well as complete course work toward a graduate degree. Students should request and receive permission from the director of the planning program to begin their program of study in planning no later than fall of their junior year. Students with cumulative GPAs above 3.0 will be automatically approved. By proper scheduling, students can complete the normally two-year master's program in one year beyond the usual bachelor's degree. The key is to carefully schedule the program of study early in the undergraduate program. This program is particularly appropriate for architecture, management, economics, civil engineering, and environmental science majors.

## Undergraduate and Graduate Certificates

Certificates in both urban policy and in land development can be obtained at the undergraduate and graduate levels. Students must complete 15 hours of course work in planning-related courses and be in good standing. With approval of their major school adviser, and in consultation with a designated adviser in planning, students may develop a coherent plan of study tailored to meet their individual needs and



interests. Students who complete one or both of these special programs satisfactorily will receive a certificate of recognition.

## **Total Required Credit Hours for Graduation from the City Planning Program = 84**

### **Doctoral Program**

The program leading to the Doctor of Philosophy degree in the College of Architecture has been developed to enable students of exceptional ability to undertake advanced study and original research in the fields of architecture and planning. Currently the program includes several fields of study: 1) City Planning; 2) Architecture, Culture, and Behavior; 3) Architectural History, Theory, and Criticism; 4) Building Technology.

Several areas of advanced City Planning studies are available for dissertation research: studies of urban design, transportation, urban development and redevelopment, economic development, and physical planning. Students in the Architecture, Culture, and Behavior field pursue both human factors studies such as studies of environmental perception and cognition, experimental aesthetics, building safety and regulation, facilities programming and evaluation, and human responses to design and cultural issues relating to morphological studies, design of housing, museums, workplaces, and cities. The Architectural History, Theory, and Criticism field addresses the following: architectural history, philosophy, criticism and practice, including design philosophies, methods, and criticism; it also allows study of preservation and conservation focusing on technical and methodological issues in preservation of historical and contemporary building components, buildings, and cities. The Building Technology field includes computer applications, building science, studies of climate controls, and construction management.

The fields may require students to take additional requirements relevant to their programs of study. For further details of the program, contact the Director of the Doctoral Program, College of Architecture, Georgia Institute of Technology, Atlanta, Georgia 30332-0155.

## **Courses of Instruction**

### **ARCHITECTURE**

#### **ARCH 1021. Visual Communication**

0-9-3.

Introduction to freehand drawing and color theory.

#### **ARCH 1022. Introduction to Architectural Drawing**

0-9-3.

Fundamentals of architectural drawing and representation, including orthographic projection, perspective, shade and shadow, and other exercises in descriptive geometry.

#### **ARCH 1023. Fundamentals of Architectural Design**

0-9-3.

Introductory studio exercises in two- and three-dimensional visual composition and design.

#### **ARCH 1221. Introduction to Architecture**

3-0-3.

Introduction to historic and contemporary issues in the discipline and practice of architecture.

#### **ARCH 2011-2-3. Architectural Design I, II, III**

0-12-4 each. Prerequisite: ARCH 1011-2-3.

Studio problems in architectural design at an elementary level with an emphasis on the interrelationships among design, history, and technology of construction.

#### **ARCH 2201-2-3. History of Architecture I, II, III**

3-0-3 each.

Survey of architectural history from the beginning of recorded history to the present. Emphasis on the interrelationships among architecture, western culture and civilization, and technology.

#### **ARCH 2311-2-3. Architectural Technology I, II, III**

3-0-3 each.

Introduction to building materials and assemblies; heating, ventilating, and air conditioning; sanitary systems; electrical systems; lighting; acoustics; and building laws and codes.

#### **ARCH 2322. Introduction to Microcomputing in Architecture**

1-6-3.

Introduction to quantitative and graphic minicomputer applications in the field of architecture.

#### **ARCH 2341. Fundamentals of Structural Design**

4-0-4.

Statics, strengths of materials, behavior of structural elements in terms of their interaction, the forces acting upon them, and their roles in the overall structural system.

#### **ARCH 3011-2-3. Architectural Design IV, V, VI**

1-12-5 each. Prerequisite: ARCH 2011-2-3.

Studio problems in architectural design at an intermediate level with an emphasis on the theory and practice of architecture as applied to contemporary building types.

### **ARCH 3211. History and Theory of Modern Architecture**

3-0-3. Prerequisites: ARCH 2201-2-3.

Study of the history and theories of the modern movement in architecture with a parallel emphasis on architectural texts and constructed works of architecture.

### **ARCH 4011-2-3. Architectural Design VII, VIII, IX** 1-12-5 each. Prerequisites: ARCH 3011-2-3.

Studio problems in architectural design emphasizing advanced investigations in urban, historical, theoretical, and technological issues.

### **ARCH 4101. Introduction to Historic Preservation and Conservation**

3-0-3.

Introduction to historic preservation in an architectural context with a concentration on the properties of building materials and the technologies of conservation and restoration.

### **ARCH 4111. Housing and Culture**

3-0-3.

Examination of psychological, sociological, and anthropological theories of house and housing form, and their relationships to current architectural theory and practices.

### **ARCH 4121. Introduction to Architecture and Behavior**

3-0-3.

Examinations of how society and individuals use and experience buildings and landscapes, including housing, work environments, institutions, and public spaces.

### **ARCH 4122. Post Occupancy Evaluation**

3-0-3.

Case-based investigations of methods and issues in user-oriented research about buildings. Covers the entire life cycle of buildings from initial planning to occupancy and operations. The course focuses on research methods, analytic techniques, and policy implications.

### **ARCH 4131. Introduction to Interior Architecture**

3-0-3.

Introduction to the field of interior design and space planning and their relationship to the theory and practice of architecture.

### **ARCH 4132. Problems in Interior Architecture**

1-6-3.

Seminar on issues and problems of interior and furniture design.

### **ARCH 4211. History of Classical Architecture**

3-0-3. Prerequisites: ARCH 2201-2-3, ARCH 3211, or consent of the College.

Investigations of the classical traditions of architecture with an emphasis on Greek and Roman architectural history and theory.

### **ARCH 4212. History of Medieval Architecture**

3-0-3. Prerequisites: ARCH 2201-2-3, ARCH 3211, or consent of the College.

Investigations of the architecture of medieval Europe with selected inquiries in Early Christian, Byzantine, Romanesque, and Gothic eras.

### **ARCH 4213. History of Renaissance and Mannerist Architecture**

3-0-3. Prerequisites: ARCH 2201-2-3, ARCH 3211, or consent of the College.

Investigations of the history and theory of Renaissance and Mannerist architecture with a primary emphasis on Italy.

### **ARCH 4214. History of Baroque and Rococo Architecture**

3-0-3. Prerequisites: ARCH 2201-2-3, ARCH 3211, or consent of the College.

Investigations of European architecture during the seventeenth and eighteenth centuries.

### **ARCH 4215. History of Architecture in the United States**

3-0-3. Prerequisites: ARCH 2201-2-3, ARCH 3211, or consent of the College.

Historical investigations of architecture within the continental United States from the colonial period to the twentieth century.

### **ARCH 4221. Paris: Social, Urban, and Architectural History**

3-0-3.

The social, cultural, urban, and architectural history of the city of Paris, from its founding until the beginning of the Second Empire. Course offered in Paris only.

### **ARCH 4222. History of Urban Form**

3-0-3.

Survey of major forces and ideas that have directed the growth and form of cities from antiquity to the present.

### **ARCH 4247-8-9. History of Art I, II, III**

3-0-3 each.

A survey in the study of artistic manifestations from primitive times to our own day. First quarter of sequence: prehistoric through Roman; second quarter: Early Christian through Baroque; third quarter: nineteenth and twentieth centuries.

### **ARCH 4311. Seminar in Architectural Mechanical Systems**

3-0-3. Prerequisites: ARCH 2311-2-3 or consent of the College.

Building energy use and design methods including solar analysis, transient thermal analysis, thermal comfort and optimal use of mechanical systems.

### **ARCH 4312. Seminar in Architectural Lighting**

3-0-3. Prerequisites: ARCH 2311-2-3 or consent of the College.

Analytical and design methods for interior and exterior artificial lighting and natural day lighting in architectural settings.

### **ARCH 4313. Advanced Structures Seminar**

3-0-3. Prerequisites: ARCH 3311-2-3 or consent of the College.

Advanced investigations in the integration of structural systems into the architectural design and construction process.

### **ARCH 4314. Site Planning and Design**

1-6-3. Prerequisites: ARCH 1021, 2, 3.

Introduction to site planning and design, including layouts, grading, drainage, and circulation.

### **ARCH 4321. Computer Methods in Architecture I**

1-6-3. Prerequisite: ARCH 2321

Computer methods in information management and quantitative problem determination. Introduction to programming of a procedural language and manipulation of general software applications.

**ARCH 4322. Computer Graphics in Architecture I**  
1-6-3. Prerequisite: ARCH 2321.

Introduction to computer graphics including extensive manipulation of the two-dimensional aspects of computer-aided design systems.

**ARCH 4331, 2, 3. Architectural Structures I, II, III**  
3-3-4 each. Prerequisite: ARCH 2341.

Structural analysis and design in wood, masonry, steel, concrete, and composite materials with reference to integration of technical systems and architectural design decisions in small, medium, and large buildings.

**ARCH 4402. Professional Practice of Architecture**  
3-0-3.

Introduction to principles of professional practice, including the historic, ethical, legal, and economic framework of the practice of architecture.

**ARCH 4501-2. Advanced Drawing I, II**  
0-6-2. Prerequisites: ARCH 1501-2-3 or consent of the College.

Representational drawing from still life, the landscape, and architectural sources including skill development in a variety of media and methods.

**ARCH 4511-2. Life Drawing I, II**  
0-6-2 each. Prerequisites: ARCH 1501-2-3 or consent of the College.

Studio instruction in figure drawing from the live model with an emphasis on the structure and dynamics of the human form.

**ARCH 4521-2. Multimedia Studio I, II**  
0-6-2 each. Prerequisites: ARCH 1501-2-3 or consent of the College.

Studio instruction in the visual arts with a concentration on experimental graphics utilizing numerous techniques ranging from air brush and lithography to video.

**ARCH 4531-2. Painting I, II**  
0-6-2 each. Prerequisites: ARCH 1501-2-3 or consent of the College.

Studio instruction in the theories and techniques of painting including color, composition, methods, and materials.

**ARCH 4535. Watercolor**  
0-6-2. Prerequisites: ARCH 1501-2-3 or consent of the College.

Studio instruction in watercolor color theory, pigment characteristics, materials, and painting techniques for the preparation of architectural delineation.

**ARCH 4541-2. Photography I, II**  
0-6-2 each. Prerequisites: ARCH 1501-2-3 or consent of the College.

Studio, darkroom, and field instruction in photography, with an emphasis on operations, methods, and techniques for general and architectural photography.

**ARCH 4601-2-3. Architectural Design Studio I, II, III**  
1-12-5 each. M.Arch.I students only.

Introductory studio problems in architectural design with an emphasis on architectural representation, history, morphology, and technology and their interrelationships.

**ARCH 4611-2-3. Architectural Design Studio IV, V, VI**  
1-12-5 each. M.Arch.I students only.

Intermediate and advanced studio problems in architectural design with an emphasis on urban, historical, theoretical, and technological issues in relation to contemporary building forms.

**ARCH 4621. Seminar in the Theory and Practice of Architecture I**  
3-0-3.

Investigations in architecture with an emphasis on contemporary architectural theory, the relationships between theory practice, and the technological production of architecture.

**ARCH 4751-2. Psychology of Environmental Design I, II**  
3-3-4 each. Prerequisite: consent of the College.

Course listing and description found under PSY 4751-2.

**ARCH 4821-2-3. Special Topics in History and Theory**  
3-0-3 each. Prerequisite: consent of the College.

Topics in advanced areas of history and theory of architecture.

**ARCH 4831-2-3. Special Topics in Technology**  
3-0-3 each. Prerequisite: consent of the College.

**ARCH 4851-2-3. Special Topics**  
3-0-3 each.

**ARCH 4871-2-3. Special Topics in Environment/Behavior**  
3-0-3 each. Prerequisite: consent of the College.

**ARCH 4911-2-3-4-5-6-7-8. Special Problems - Visual Communications**  
0-3-1 to 0-15-5. Prerequisite: consent of the College.

**ARCH 4941-2-3. Special Problems**  
Credit to be arranged.

**ARCH 4944-5. Special Research**  
Credit to be arranged.

**ARCH 4951-2-3-4. Special Problems**  
Credit to be arranged.

**ARCH 6012. Architectural Design Studio I**  
1-15-6.

Advanced problems in architecture investigating the multidisciplinary relationships between theory and practice and between research and design with an emphasis on the integration of knowledge from related seminars.

**ARCH 6013. Architectural Design Studio II**  
1-15-6. Prerequisite: ARCH 6012.

Advanced problems in architecture with an emphasis on theory and research in the areas of history, theory, and criticism; urban design; architectural technology; and architecture and behavior.

**ARCH 6201. Contemporary Theory in Architecture**  
3-0-3.

Investigations into the nature of architectural theory and a critical analysis of the major theoretical positions influencing contemporary architectural design.

**ARCH 6202. Theories of Modernism and Architecture**  
3-0-3. Prerequisite: ARCH 6201.

Detailed analysis of selected texts and architectural projects produced since the Enlightenment with a focus on architectural theories in practice and the power and limits of architecture in contemporary society.

**ARCH 6203. Architecture and Ideology**  
3-0-3. Prerequisite: ARCH 6201.

A critical examination of architecture and the form of the city as a carrier of ideology with reference to texts and projects in antiquity, the Enlightenment, and present.

**ARCH 6204. Architectural Representation**  
3-0-3. Prerequisite: ARCH 6201.

Examination of architectural theories of representation, particularly architecture as a system of instrumental and symbolic representational knowledge.

**ARCH 6211. Architectural Design Methods**  
3-0-3.

Examination of processes and methods of architectural design within the framework of science and the arts including a variety of historical and contemporary positions.

**ARCH 6212. Traditions in Architectural Practice**  
3-0-3.

Examinations of architectural practice from its mythic origins to its present multidimensional conditions with speculation concerning the future of the discipline, profession, and practice of architecture.

**ARCH 6213. Case Studies in Commercial Architecture I**  
3-0-3.

Case studies of the history, development, and design of selected types of commercial architecture.

**ARCH 6221. Urban Design Theory**  
3-0-3.

Evolution of urban design theory from the Renaissance city to the present, particularly the dialectic of Utopian thought and actual historical evidence of city form.

**ARCH 6222. Readings in Urban Theory**  
3-0-3.

Investigations of urban design theory and practice during the nineteenth and twentieth centuries. Emphasis on formal, scientific, social, and economic interpretations of the city.

**ARCH 6223. Studies in Landscape Architecture**  
3-0-3.

History of the design of the landscape and the garden from Ancient Egypt, Persia, and the Orient to the present.

**ARCH 6224. History and Theories of the 20th Century City**

3-0-3. Prerequisite: ARCH 6221.

Presentation and discussion of the history of the twentieth century city with particular reference to architectural city planning and urban design theories.

**ARCH 6262. Readings in Architectural History**  
3-0-3.

Presentation and discussion of topics of current interest and specialized scope, utilizing the special resources of the architecture library and current architectural history publications.

**ARCH 6263. Housing and Culture**  
3-0-3.

Anthropological, psychological, and architectural theories of house form and culture.

**ARCH 6343. Energy in Architecture**  
3-0-3.

An investigation of energy requirements in buildings and the use of interactive computer programs to analyze and minimize energy usage.

**ARCH 6344. Building Energy Analysis**  
3-0-3. Prerequisite: ARCH 6341.

Appropriate techniques, strategies, and methods for predicting and evaluating building energy performance with an emphasis on the relationship between architectural design decisions and predicted building performance.

**ARCH 6371-2. Computer Programming for Architects I, II**

3-0-3 each. Prerequisite: consent of the College.

Advanced problems in architectural computing with an emphasis on quantitative and graphic applications to the design process.

**ARCH 6402. Introduction to the Preservation and Conservation of Cultural Resources**

3-0-3. Prerequisite: graduate standing.

Review of preservation and conservation as social attitudes, as public policy concerns, and as discrete areas of knowledge. Emphasis will be given to historic preservation as a specialty within the general context of the built environment.

**ARCH 6403. Preservation/Conservation Methods**  
3-0-3.

Contemporary methods and processes of historic preservation considering technical, economic, marketing, and aesthetic problems of assessing, restoring, and adapting historical buildings for alternative occupancies.

**ARCH 6422. Transportation Architecture**  
3-0-3.

The transportation terminal as a building type and urban institution, including historical development, technological change, economic change, and architectural expression in the city.

**ARCH 6423. The Pedestrian and the City**  
3-0-3.

Examination of the urban-built environment with regard to history, theories, methods, and recent research findings regarding design for the pedestrian.

**ARCH 6999. Thesis Preparation Seminar**

1-0-1. Prerequisite: consent of the College. Pass/fail only.

**ARCH 7000. Thesis****ARCH 7011. Architectural Design Studio**

1-15-6.

Advanced problems in architectural design. Studio exercises emphasize the experimental development and application of theories and methods to complex problems.

**ARCH 7021. Urban Design Studio**

1-15-6.

Advanced design problems in the contemporary city formulated on theoretical positions, including considerations of Utopian positions, type and typology, historical precedent, civic design, and contextualism.

**ARCH 7041. Architectural Technology Studio**

1-15-6.

Experimental application in architectural technology in the area of building physics, material performance, and construction methods.

**ARCH 7061. Behavior in Architecture Studio**

1-15-6.

Exploring new boundaries in the application of behavioral information to architectural design.

**ARCH 7201. Readings in Architectural Theory**

3-0-3.

Detailed critical analysis of selected works in architectural theory.

**ARCH 7202. Architectural Criticism**

3-0-3.

An examination of theories of criticism in architecture, historiography, film, and literature and their application to subjects in architecture and urban design.

**ARCH 7203-4-5. The Art of Architecture I, II, III**

3-0-3 each. Prerequisite: consent of the College.

Advanced investigations of architectural theory and practice focusing on the question of architectural history and its role in the definition of architectural production.

**ARCH 7206. Architectural Devices**

3-0-3. Prerequisite: consent of the College.

Critical examination of historic and contemporary architectural theories and exemplars in terms of aesthetic philosophies and principles of perception.

**ARCH 7223. Language of the City**

3-0-3.

Critical analysis of contemporary theories in the representation of architecture and the city in literature, graphic arts, and film.

**ARCH 7224. Studies of the American Landscape**

3-0-3.

A topical study of the American-made landscape, with emphasis on the theme of pastoralism in American culture.

**ARCH 7441. Urban Design Workshop I**

0-18-6.

Advanced problems in urban design and development in the city of Atlanta. Integration of urban design theory and methods, economic development, political negotiation, and communication.

**ARCH 7442. Urban Design Workshop II**

0-9-3.

A continuation of projects begun in ARCH 7441.

**ARCH 7462. Architecture of the Work Place**

3-0-3. Prerequisite: consent of the College.

Detailed examination of the social, functional, and organizational aspects of the work place that influence and are influenced by architectural design.

**ARCH 7466. Readings in Architecture and Behavior**

3-0-3. Prerequisite: consent of the College.

Critical examination of recent research literature on topical issues in the field of architecture and behavior.

**ARCH 8143-53-63. Special Topics in Architecture**

3-0-3 each. Prerequisite: consent of the M.ARCH program.

Special topics of current and emerging interest in architecture that extend beyond the professional curriculum.

**ARCH 8151-52-53. Special Topics in Architecture**

1-0-1 through 6-0-6 each. Prerequisite: consent of the M.Arch program.

Special topics investigations of varying scope in subject areas that extend beyond the professional curriculum.

**ARCH 8154-55-56. Special Topics in Advanced Architectural Studies**

1-0-1 through 6-0-6. Prerequisite: consent of the Ph.D. program in architecture.

Special topics investigations of varying scope related to current directions in architectural research and scholarship.

**ARCH 8173-83-93. Special Topics in Advanced Architectural Studies**

3-0-3 each. Prerequisite: consent of the Ph.D. program in architecture.

Special topics of current and emerging interest in architectural scholarship and research.

**ARCH 8213-4-5. Special Topics - Urban Design**

3-0-3 each.

**ARCH 8223-4-5. Special Topics - History and Theory**

3-0-3 each.

**ARCH 8233-4-5. Special Topics - Architectural Technology**

3-0-3 each.

**ARCH 8243-4-5. Special Topics - Architecture and Behavior**

3-0-3 each.

**ARCH 8253-4-5. Special Topics - Architectural Research**

3-0-3 each.

### **ARCH 8263-4-5. Special Topics - Architectural Conservation Technology**

3-0-3 each. Prerequisite: ARCH 4101 or consent of the College.

### **ARCH 8273-4-5. Special Topics - Architecture and Building Construction**

3-0-3 each.

### **ARCH 8283-4-5. Special Topics - Architecture and Industrial Design**

3-0-3 each.

### **ARCH 8550-1-2-3-4-5-6. Special Problems in Architectural Theory and Design**

Credit to be arranged.

### **ARCH 8560-1-2-3-4-5-6. Special Problems in Architecture and Building Construction**

Credit to be arranged.

### **ARCH 8570-1-2-3-4-5-6. Special Problems in Architecture and Industrial Design**

Credit to be arranged.

### **ARCH 8580-1-2-3-4-5-6. Special Problems in Advanced Studies in Architecture**

Credit to be arranged.

### **ARCH 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of School.

For graduate students holding graduate teaching assistantships.

### **ARCH 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of College.

For graduate students holding graduate research assistantships.

### **ARCH 8999. Preparation for Doctoral Dissertation**

Credit to be arranged. Pass/fail only.

### **ARCH 9000. Doctoral Dissertation**

Credit to be arranged. Pass/fail only.

## **BUILDING CONSTRUCTION**

### **BC 1010. Building Construction Seminar**

1-0-1.

An introduction to the building construction industry, the participants, and their roles in the construction process and career opportunities in building construction.

### **BC 2010. Construction Technology I**

3-6-5. Prerequisite: BC 1010.

Study and analysis of job planning, layout, building and site work methods, materials, systems, and equipment employed on light construction projects including residential and commercial buildings.

### **BC 2020. Construction Technology II**

3-6-5. Prerequisite: BC 2010.

Continuation of BC 2010, with emphasis on medium to large commercial, institutional, and industrial building projects.

### **BC 2030. Construction Cost Estimating**

2-9-5. Prerequisite: BC 2020.

Introduction to cost principles and cost analysis of construction projects, including classification of work, quantity survey techniques, construction operations cost, and the preparation of bid proposals.

### **BC 3310. Construction Contracting**

3-0-3. Prerequisite: BC 2030.

Principles, practices, and organizational models employed in company operations in the building construction industry and an analysis of the complexities in construction contracting.

### **BC 3320. Construction Law**

3-0-3. Prerequisites: BC 3310.

Legal aspects of construction contracts, bonds, insurance, and bidding. Owner, architect, contractor, and subcontractor relationships.

### **BC 3330. Real Estate and Construction Finance**

3-0-3. Prerequisite: BC 3320.

General introduction to the financing of construction and real estate development projects. Emphasis on financing requirements, activities, sources, and uses.

### **BC 4301. Construction Systems**

3-0-3. Prerequisites: BC 3330 and senior standing.

Review and examination of major building systems in use today. Discussion of anticipated future requirements for systems and potential impacts on the construction process.

### **BC 4440. Construction Scheduling**

3-6-5. Prerequisite: BC 3330.

Introduction to the principles of time analysis and scheduling practices in the project planning and control process, including network planning, CPM scheduling, resource leveling, and computer program applications.

### **BC 4442. Value Engineering in Construction**

3-0-3. Prerequisites: BC 3330 and senior standing.

Analysis of material, equipment, facilities, procedures, and supplies to achieve the lowest possible cost consistent with performance requirements to attain optimum quality in building.

### **BC 4450. Building Production**

3-0-3. Prerequisite: senior standing in BC or consent of the College.

Methods analysis and human factors in the construction project management and delivery process, emphasizing organizational structures, productivity measurement, management control methods, environmental concerns, and the decision-making process.

### **BC 4460. Risk Management**

3-0-3. Prerequisite: senior standing in BC or consent of the College.

Analysis of the construction management process dealing with preventive methods for avoiding litigation. Special attention is given to the jobs of architects, owners, and contractors. Management record keeping, personnel relationships, safety precautions, and field procedures are analyzed.

**BC 4500. Terminal Project I**

3-0-3. Prerequisite: senior standing in BC—degree candidates only.

Perform research and prepare a terminal project comprehensive proposal for approval by the faculty committee.

**BC 4510. Terminal Project II**

1-12-5. Prerequisite: BC 4500.

Terminal Project.

**BC 4951-2-3. Special Problems in Construction**

Credit to be arranged.

**CITY PLANNING****CP 1100. Introduction to City Planning**

3-0-3. Fall quarter.

An orientation to urban and regional planning, including organization, functions, techniques, and methods of implementation.

**CP 4002. Contemporary Planning and Development Issues**

3-0-3.

The course examines the theoretical foundations of planning and urban development. Particular attention is paid to economic development and the institutional and social contexts in which it operates.

**CP 4003. Urban Development Law**

3-0-3.

Survey of law affecting public and private real estate development techniques, including real estate law, contracts, eminent domain, and public regulation.

**CP 4004. Negotiation and Conflict Management**

3-0-3.

Offers practical instruction on techniques of negotiation and the theory and practice of conflict resolution. Focuses on the sources of conflict and approaches to resolving differences in organizations and in the public policymaking arena.

**CP 4012. Environmental Impact Assessment in Urban Planning**

3-0-3.

Analysis of noise, air, water, land, and spatial pollution, including field demonstration of impact assessment technology. Students identify, evaluate, and apply city planning solutions to environmental problems.

**CP 4014. Environmental Policy and Regulation**

3-0-3.

Environmental policy and its role in shaping environmental quality. Topics include the policymaking process, the legal basis for environmental regulation, the impact of environmental policy, and implementation and enforcement strategies.

**CP 4022. Foundations of Urban and Regional Development**

3-0-3.

Explores the causes of growth and decline of cities and regions in the United States. Emphasis is given to economic factors influencing development, although social and political factors are also discussed.

**CP 4028. International Development Planning**

3-0-3.

Examination of differing approaches to planning for comprehensive development in the less-developed countries. Analysis of interrelationships between developing and developed countries which affect planning.

**CP 4041. Introduction to Real Estate Investment and Development**

3-0-3.

The course provides an introduction to real estate investment development, including principles of land appraisal, alternate financing vehicles and ownership forms, market analysis, and financial feasibility analysis.

**CP 4045. Housing and Real Estate Economics**

3-0-3.

An introduction to the operation of local housing and land markets and the nation, state, regional, and local policies intended to influence those markets.

**CP 4080. Urban Transportation**

3-0-3.

An overview of urban transportation planning and policy analysis; understanding movement patterns in cities; the geography of urban transportation.

**CP 4800. Special Topics/Planning Process**

3-0-3.

**CP 4810. Special Topics/Environmental Policy & Planning**

3-0-3.

**CP 4820. Special Topics/Economic Development**

3-0-3.

**CP 4830. Special Topics/Land Use Planning**

3-0-3.

**CP 4840. Special Topics/Real Estate Development**

3-0-3.

**CP 4850. Special Topics/Planning Methods**

3-0-3.

**CP 4860. Special Topics/Urban Design**

3-0-3.

**CP 4880. Special Topics/Transportation**

3-0-3.

**CP 4890. Special Topics/Professional Practice**

3-0-3.

**CP 6011. History of Modern Cities**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

Traces development of the American city from colonial to late twentieth century; documents changes in social, economic, and physical structures and institutions of urban America.

**CP 6021. Theory and History of Urban Planning**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

Introduction to the history of the planning profession; examination of theories of planning, comprehensiveness, citizen participation, professionalism, public interest, and planning roles and practices.

**CP 6030. Planning Legislation and Regulation**

3-0-3.

Theory and use of eminent domain, taxing and police powers, enabling acts, charters, official maps, codes restrictive covenants, controlled highway access legislation.

**CP 6041. Political and Institutional Analysis for Planning**

3-0-3. Prerequisite: graduate standing or permission of the instructor.

Examines the nature of the American political system, how it is managed today, and the role of planning within that system. Conveys techniques for facilitating goal setting, plan making, and plan implementation.

**CP 6051. Legal Aspects of Development**

3-0-3. Prerequisite: graduate standing or permission of the instructor.

Development process from private and public perspectives: real estate law, construction contracts, income taxes, public and private finance, eminent domain, government project management.

**CP 6072. Community Facilities Planning**

3-0-3.

An examination of the various processes and methods for planning for and locating facilities within a region or city.

**CP 6074. Principles of Social Policy Planning**

3-0-3.

An introduction to the major social policy questions confronting local governments and the alternative policy responses to them.

**CP 6081. Negotiation and Conflict Management**

3-0-3. Prerequisite: graduate standing or permission of the instructor.

Offers practical instruction on techniques of negotiation and the theory and practice of conflict resolution; focuses on the sources of conflict and approaches to resolving differences in organizations and in the public policymaking arena.

**CP 6111. Urban Environmental Planning and Management**

3-0-3. Prerequisite: graduate standing or permission of the instructor.

The foundations of environmental planning, emphasizing the assessment of environmental quality, public policies designed to protect those qualities, and the impact of environmental policy on urban and regional planning.

**CP 6121. Environmental Impact Assessment in Urban Planning**

3-0-3. Prerequisite: graduate standing or permission of the instructor.

Analysis of noise, air, water, land, and spatial pollution, including field demonstration of impact assessment technology. Students identify, evaluate, and apply city planning solutions to environmental problems.

**CP 6124. Environmental Noise Management**

3-0-3.

Management and administration of environmental or community noise; analysis of noise impact; noise measurement; instrumentation; rating methods. Evaluation of laws and management programs.

**CP 6130. Stormwater Management Planning and Policy**

3-0-3.

Study of the planning, economic, financial, and engineering aspects of urban stormwater management. Development of site designs, basin plans, and laws and ordinances are included.

**CP 6141. Public Works Planning I**

2-3-3.

Study of the public works infrastructure, including sewer systems, water systems, stormwater management, water quality, solid and hazardous waste, and air and noise pollution.

**CP 6161. Environmental Law and Policy**

3-0-3. Prerequisite: graduate standing or permission of the instructor.

Environmental law and its role in shaping environmental quality. Topics include the policymaking process, the legal basis for environmental regulation, the impact of environmental policy, and implementation and enforcement strategies.

**CP 6170. Economics of Environmental Quality**

3-0-3. Prerequisite: CP 6211 or permission of the instructor.

Economic basis for environmental planning, with emphasis on externalities, public goods, and microeconomic analysis. Assessment of environmental planning and policy alternatives and their interrelationship with the market and political economies.

**CP 6180. Urban Spatial Management**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

Examines city as three-dimensional resource: aerial, ground, subterranean land uses. City planning methods of multiple use, joint use, and adaptive use are discussed.

**CP 6211. Microeconomic Analysis for Policy Planning**

3-0-3.

Public policy applications of microeconomic analysis; introduction to welfare economics; roles of the public sector in market economies; methods of program analysis; alternative economic paradigms.

**CP 6212. Project Planning and Economics**

3-0-3. Prerequisite: CP 6211 or consent of the instructor.

Introduction to cash-flow and discounting techniques. Application of present worth, annual cost, rate-of-return, and cost-benefit techniques to planning problems and applications. Application of project economic principles to cost allocation and life-cycle costing.

**CP 6215. Urban Economics and Policy Planning**

3-0-3. Prerequisite: CP 6211 or consent of the instructor.

Urban economics and its application to city and regional planning and public policy analysis. Theories, applications, and methods of spatial analysis.



## **CP 6221. Public Finance Policy and Planning**

3-0-3. Prerequisite: CP 6211.

Theory and practice of public finance, current issues in planning policy and public finance, current and capital budgeting, and fiscal impact assessment.

## **CP 6222. Fiscal Aspects of Urban Planning**

3-0-3. Prerequisite: CP 6211 or consent of the instructor.

Fiscal impacts of development on communities; role of planning in improving the fiscal base and shifting the incidence of fiscal costs and benefits.

## **CP 6224. State and Local Finance**

3-0-3. Prerequisite: CP 6211 or consent of the instructor.

Theory and practice of state and local public finance with focus on infrastructure finance, current issues in public finance, operations and capital budgeting, and fiscal impact assessment.

## **CP 6231. Foundations of Local Economic Development Planning**

3-0-3. Prerequisite: CP 6211 or consent of the instructor.

Theoretical explanations of the development of urban economies; global, national, and regional forces affecting development; analytical techniques used in the examination of local economic development.

## **CP 6232. Local Economic Development Planning and Policy**

3-0-3. Prerequisite: CP 6231 or consent of the instructor.

Strategies, programs, and processes for developing employment and investment opportunities in regional, state, and local economies.

## **CP 6234. Urban Development Policy Implementation**

2-3-3.

Institutional structures for planning and implementing development policy; business development finance; public and private criteria for project selection and evaluation.

## **CP 6281. International Development Planning**

3-0-3.

Examination of differing approaches to planning for comprehensive development in the less-developed countries. Analysis of interrelationships between developing and developed countries which affect planning.

## **CP 6310. Land Use Forecasting and Allocation**

3-0-3. Prerequisite: CP 6111 and 6550 or consent of the instructor.

Explores the formulation of community goals, location, and space requirements of various development types, land suitability analysis, and the design of comprehensive land use plans.

## **CP 6340. Growth Management**

3-0-3. Prerequisite: CP 6030 or consent of the instructor.

Exposes and analyzes goals and objectives of selected local and state growth management techniques and the multitude of federal land use policies.

## **CP 6390. Comprehensive Planning Implementation**

2-3-3. Prerequisites: all courses in the M.C.P. land planning track.

Implementation of comprehensive land use planning policy; evaluation of development proposals against planning policy; administration of planning policy.

## **CP 6411. Principles of Real Estate and Land Development**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

Location of cities and land uses within cities; land development; market analysis and economic feasibility studies; impact of changing tax laws on private sector developers.

## **CP 6421. Introduction to Real Estate Investment and Development**

3-0-3.

Introduction to principles of real estate investment and development, including appraisal, financing, market analysis, and feasibility analysis.

## **CP 6431. Urban Development Methods**

3-0-3. Prerequisite: CP 6421 or consent of the instructor.

Real estate development process; financial feasibility analysis of residential, retail, office, industrial, and mixed-use developments; role of public policy in stimulating development and redevelopment.

## **CP 6441. Applied Development Methods**

3-0-3. Prerequisites: CP 6421 and 6431.

Application of the development process, market and financial feasibility analyses, and public policy to large development projects. Extensive use of case studies involving professional developers.

## **CP 6481. Housing Economics and Policy**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

Detailed examination of the operation of local housing markets and national, state, regional, and local policies intended to influence those markets.

## **CP 6511. Introductory Quantitative Methods in Urban and Regional Planning**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

An introduction to various information collection, organization, analysis, and communication techniques that are essential in professional planning practice.

## **CP 6512. Intermediate Quantitative Methods in Urban and Regional Planning**

2-6-4. Prerequisite: CP 6511 or consent of the instructor.

Second of a three-course sequence, with an emphasis on data analysis techniques relevant to planning theory and practice.

## **CP 6513. Advanced Quantitative Methods in Urban and Regional Planning**

2-6-4. Prerequisite: CP 6512 or consent of the instructor.

A continuation of CP 6512, with emphasis on computer applications.

## **CP 6540. Methods of Policy Analysis and Planning**

1-6-3. Prerequisites: CP 6511, 6512, and 6513 or consent of the instructor.

Analytical methods used both in planning and in policy analysis are reviewed and placed in the context of practice. Students are then given a series of case problems to solve.

**CP 6550. Demographic Analysis in Policy Planning**  
2-3-3. Prerequisites: CP 6511, 6512, and 6513 or consent of the instructor.

This course uses forecasting as a vehicle for learning a variety of analytical methods drawn from demography but used in policy planning.

**CP 6560. Information Systems for Planning and Public Policy**

2-3-3. Prerequisite: basic knowledge of microcomputer operating systems and spreadsheets.

Design, development, and management of information systems for the public sector, including data base management, automated (macro) spreadsheets, and development of custom applications.

**CP 6565. Geographic Information Systems**

2-3-3. Prerequisite: CP 6560 or a basic knowledge of microcomputer operating systems.

Introduction to geographic information systems, including discussions of GIS hardware, software, data structures, data acquisition, analytical techniques, and implementation procedures.

**CP 6610. Urban Design Policy and Implementation**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

Urban design policymaking and its implementation, including an assessment of how decisions are made, the role of professionals in the process, and policies that promote good design.

**CP 6620. Design of Sites and Cities**

1-6-3. Prerequisite: graduate standing or consent of the instructor.

Explores methods of analyzing large-scale landscapes for complex development programs in public and private sectors. Case studies are used to illustrate the application of such methods.

**CP 6810. Introduction to Urban Transportation Planning**

3-0-3.

An introduction to urban transportation planning and policy analysis; planning and decision making; planning methods; programming and project implementation.

**CP 6820. Urban Transportation Planning Methods**

2-3-3. Prerequisite: CP 6810 or consent of the instructor.

This course examines some of the basic principles and methods underlying transportation planning. It focuses on the application of microcomputer technology to system planning, management, and maintenance.

**CP 6830. Urban Transportation Planning and Policy Analysis**

3-0-3. Prerequisites: CP 6810 and 6820.

An overview of public finance and transportation economics in urban transportation planning and policy analysis; synthesis of theory and methods related to understanding complex issues of urban transportation systems.

**CP 6910. Problems in Community Planning I**

1-12-5. Prerequisite: graduate standing or consent of the instructor.

Preparation of a series of sectoral plans for an existing urban area. Site visits and discussion with planners, citizens, and politicians of issues and plans.

**CP 6911. Problems in Community Planning II**

1-12-5. Prerequisite: CP 6910 or consent of the instructor.

An in-depth study of a specific urban or regional planning problem prepared for a client agency or citizens' organization.

**CP 6920. Professional Practice Seminar**

1-0-1. Prerequisites: first year of graduate planning program; completion of internship.

Examination of the historical evolution of professional planning institutions, requirements for professional certification, and professional ethics in practice. Analysis of internship experience.

**CP 6930. Introduction to Fields of Study in Planning**

1-0-1. Prerequisites: CP 6030 and 6041.

This course brings together planning practitioners and program faculty to discuss the intellectual foundations of and career opportunities in the various subfields of planning.

**CP 8100. Special Topics/Planning Process**

3-0-3.

**CP 8110. Special Topics/Environmental Policy and Planning**

3-0-3.

**CP 8120. Special Topics/Economic Development**

3-0-3.

**CP 8130. Special Topics/Land Use Planning**

3-0-3.

**CP 8140. Special Topics/Real Estate Development**

3-0-3.

**CP 8150. Special Topics/Planning Methods**

3-0-3.

**CP 8160. Special Topics/Urban Design**

3-0-3.

**CP 8180. Special Topics/Transportation**

3-0-3.

**CP 8190. Special Topics/Professional Practice**

3-0-3.

**CP 8600. Special Problems/Research Paper**

3-0-3.

**CP 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the College.

For graduate students holding graduate teaching assistantships.

**CP 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the College.

For graduate students holding graduate research assistantships.

## **CP 8999. Preparation for Doctoral Dissertation**

Credit to be arranged. Pass/fail only.

## **CP 9000. Doctoral Dissertation**

Credit to be arranged. Pass/fail only.

## **INDUSTRIAL DESIGN**

### **ID 1263. History of Design**

3-0-3.

A history of design, technology, and innovation, with emphasis on their influence in historic cultures. Open to all students.

### **ID 2001-2-3. Industrial Design I, II, III**

1-12-5 each. Corequisites: ID 2301-2-3.

Elements of industrial design, with stress on design procedures and problem solving.

### **ID 2301-2-3. Materials and Processes of Design I, II, III**

1-3-2 each.  
Use of materials and processes designers use to communicate their ideas. Graphic techniques. Use of hand and power tools with wood, metals, and plastics. Model making techniques. Use of working drawings.

### **ID 3001-2-3. Industrial Design I, II, III**

1-12-5 each. Prerequisite: ID 2003. Corequisites: ID 3301-2-3.

Lettering, typography, and package design and industrial design problems.

### **ID 3301-2-3. Materials and Processes of Design I, II, III**

1-3-2 each.  
Production methods and their relation to design. Includes the study of major mass production techniques involved in manufacturing products and packaging, through use of lectures, research, and field trips to production facilities.

### **ID 3911. Special Problems—Visual Communications—Industrial Design**

Variable.

### **ID 4002-3. Industrial Design II, III**

1-18-8 each. Prerequisite: ID 4101.

Advanced industrial design problems, accentuating individual work in special areas of concentration.

### **ID 4101. Industrial Design I**

1-12-5. Prerequisite: ID 3003.

Product development—advanced industrial design problems, emphasizing individual work in special areas of concentration.

### **ID 4451. Professional Practice of Industrial Design**

3-0-3.

Principles of consulting and corporate design office organization and project management relating to the practice of industrial design.

### **ID 4911. Special Problems—Visual Communications—Industrial Design**

Credit to be arranged.

### **ID 4951-2-3. Special Problems—Industrial Design**

Credit to be arranged.

## **Department of Music**

**Location: Couch Building**

**Telephone: 404-894-3193**

*Department Head and Director of Bands—*  
Bucky Johnson; *Director of Choral Activities—*  
Gregory Colson; *Associate Director of Bands—*  
Andrea Chapman; *Conductor of the Jazz Studies*  
*and Associate Director of Bands—*Ron Mendola.

### **General Information**

Music activities at Georgia Tech have traditionally centered around three enthusiastic and well-known performing groups: Band, Chorale, and Jazz Ensemble. Although the Institute does not offer a degree in music, participants earn academic credit that counts toward free-elective and humanities requirements. Recent expansions in course offerings allow additional musical opportunities. Specific offerings should be checked each quarter in the *On-line Student Computer-assisted Registration* booklet. The Department plans its events with awareness of other demands upon Tech students so that a great amount of musical experience is concentrated into a limited time. Financial assistance is available for students who serve the Department in various duties. The Music Department is housed in the Couch Building, located on the West Campus.

### **Band**

The Marching Yellow Jackets, Pep Band, Concert Bands, and Symphonic Band are all elements of the Georgia Tech Band Program. Since its inception in 1908, it has fulfilled two primary goals: to represent the Institute and to provide a musical outlet for Tech students. The Marching Band and Pep Band travel to several out-of-state events, including the ACC Tournament, NCAA Tournament, football games, and bowl appearances. These trips are financed by the Athletic Association. The Georgia Tech Marching Band is one of the most well known musical organizations at Georgia Tech. The band performs at football games and makes special appearances during the year. Tryouts for the Auxiliary units are held each spring and include flagline and majorettes. There is a band camp preparation the

week before the fall classes begin. Concert and symphonic bands meet during winter and spring quarters. Please contact the Music Department for further information.

### **Chorale**

The Chorale, a mixed singing group, undertakes an ambitious series of classical, sacred, and popular music performances on campus, in the Atlanta area, and in neighboring states on a spring-break tour. They have been featured in concerts of sacred masterworks with the Atlanta Symphony, in pops concerts with combos and the Jazz Ensemble, at Epcot and Walt Disney World, and in opera productions.

### **Jazz Ensemble**

The Georgia Tech Jazz Ensemble, a traditional 20-piece band, has established a strong reputation through numerous local appearances. After meeting the prerequisite of a satisfactory audition, members are involved in rehearsals, recording sessions, and performances. The level of performance achieved has won two jazz festivals and the respect of the Atlanta music community.

### **University Orchestra**

The University Orchestra is a joint orchestra with Georgia State University (GSU). Students travel to GSU two nights a week for rehearsals.

### **Introduction to Synthesized Computer Music**

Introduction to Synthesized Computer Music explores the basic theories of music composition and structure utilizing the computer and integrated synthesizers.

### **Vocal Ensemble**

The Vocal Ensemble, nicknamed the "Vocalities," is a select mixed vocal ensemble of 16 to 20 voices which performs a variety of music from Renaissance madrigals to contemporary popular songs.

### **Humanities Credit for Ensemble Participation**

Students are permitted to earn six hours of humanities credit for participating in ensembles in the Music Department provided the selection and concentration criteria are satisfied. Specifically,

the selection must satisfy Criterion 1, and the concentration must satisfy either Criterion 2 or Criterion 3.

**Criterion 1.** The ensemble is chosen from the following list: Brass Ensemble, Chamber Orchestra, Chorale, Concert Band, Jazz Ensemble, Symphonic Band, and Vocal Ensemble.

**Criterion 2.** The student earns at least six credits in one of the ensembles chosen from the list in Criterion 1.

**Criterion 3.** The student earns at least six credits in a combination of Symphonic Band and Concert Band.

### **Additional Information**

Other courses currently taught in the Department include Composers and Their Music and Music Theory. Further information is available from the Department of Music (404) 894-3193.

## **Courses of Instruction**

**MUSI 1111-4, 2111-4, 3111-4, 4111-4. Marching Band 0-6-2.** Prerequisite: past instrumental or auxiliary experience.

The Marching Band performs at football games and other special appearances and is offered to students with brass, wind, percussion, dance, flag, or majorette experience.

**MUSI 1102-3, 2102-3, 3102-3, 4102-3. Concert Band 0-3-1.**

Performing ensemble that covers both traditional and contemporary wind literature and is offered to all students with brass, wind, and percussion experience.

**MUSI 1112-3, 2112-3, 3112-3, 4112-3. Symphonic Band**

0-3-1. Prerequisite: permission of instructor may be necessary depending on the instrumentation requested at the beginning of the quarter.

Performing ensemble focusing on traditional symphonic and wind literature as well as transcriptions and contemporary popular music. Study of structure, harmony, and historical significance.

**MUSI 1201-2-3-4, 2201-2-3-4, 3201-2-3-4, 4201-2-3-4. Chorale—Mixed Singing Group**

0-3-1. Prerequisite: past vocal experience and consent of the director for the first course.

**MUSI 1211-2-3, 2211-2-3, 3211-2-3, 4211-2-3. Vocal Ensemble**

0-3-1. Prerequisite: Previous choral experience, audition, and consent of instructor.

**MUSI 1301-2-3, 2301-2-3, 3301-2-3, 4301-2-3. Jazz Ensemble**

0-3-1. Prerequisite: past instrumental experience and consent of the director for the first course.

## **MUSI 1601-2-3, 2601-2-3, 3601-2-3, 4601-2-3.**

### **University Orchestra**

0-3-1. Prerequisite: Permission of instructor may be necessary depending on the instrumentation requested at the beginning of the quarter.

## **MUSI 1701-2-3, 2701-2-3, 3701-2-3, 4701-2-3. Brass Ensemble**

0-3-1. Prerequisite: Instrumental experience with one of the following: trumpet, French horn, trombone, tuba, baritone, and permission of the instructor.

Performing ensemble exploring brass literature and transcriptions from the Renaissance to the present, supported by study of performance practice and evolution of styles with historical perspective.

## **MUSI 2600. Music Theory I**

2-0-2.

Fundamentals of music theory including notation, sight reading, ear training, keyboard harmony, melodic and rhythmic dictation, and analysis of basic compositional forms.

## **MUSI 3410. Composers and Their Music: 1500-1800**

A survey of historical periods of music with lectures, discussion, and recorded examples for outside listening.

## **MUSI 3420. Composers and Their Music: 1800 to Present**

2-0-2.

A survey of the historical periods of music with lecture, discussion, and recorded examples for outside listening.

## **MUSI 3500. Introduction of Synthesized Computer Music**

1-2-2. Prerequisite: basic music literacy and permission of instructor.

An introduction to theories of music composition and structure utilizing the computer and integrated synthesizers.

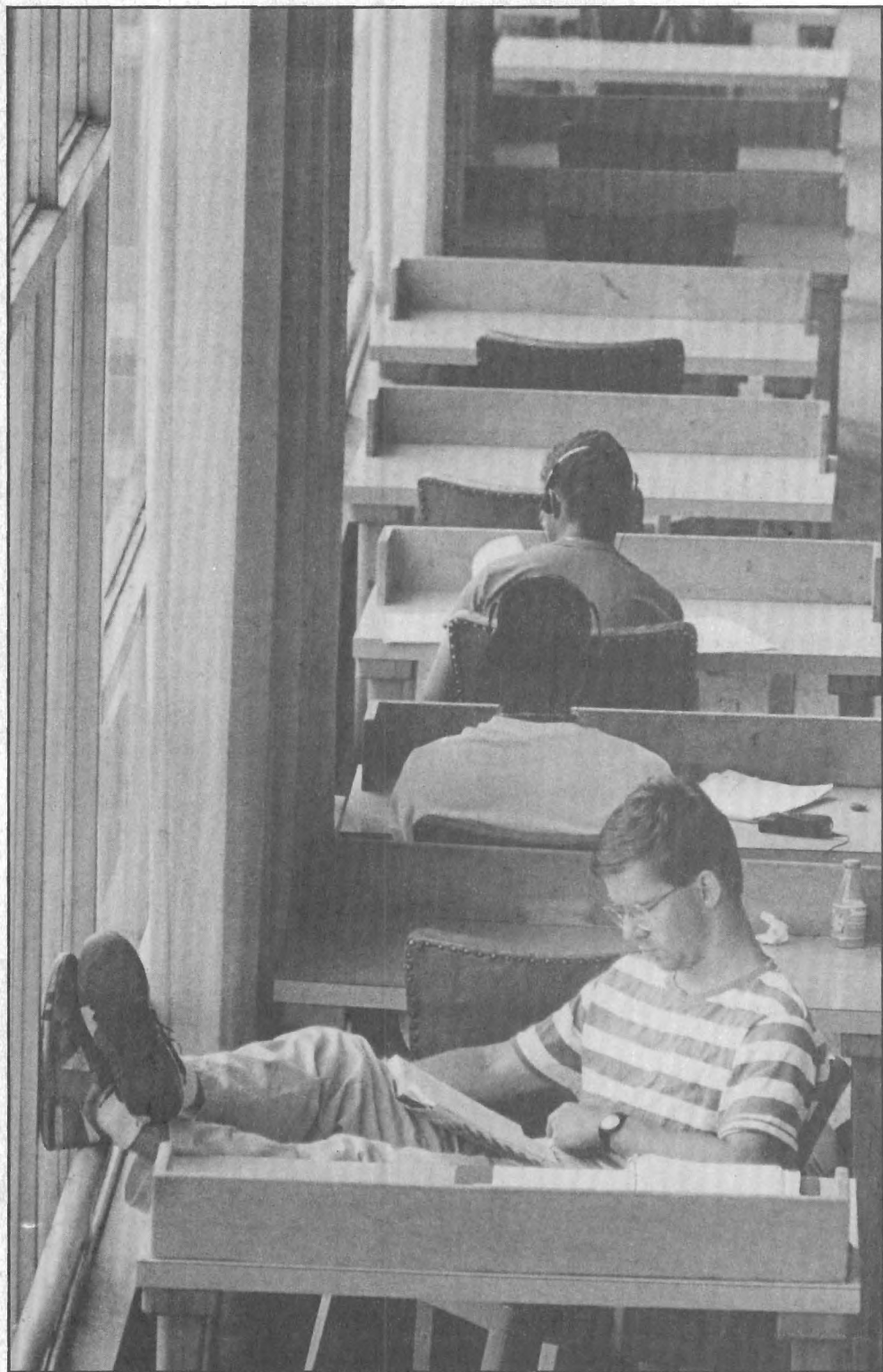
## **MUSI 3600. Music Theory II**

2-0-2. Prerequisites: permission of instructor or Music Theory I; contact music department office.

Advanced music theory including sight reading, dictation and ear training, with harmonic, melodic, and rhythmic analysis of various compositional forms.

## **MUSI 3800. Special Topics—Music**

0-2-1. Offered in various quarters.



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# COLLEGE OF COMPUTING

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**Established in 1963**

**Location: 801 Atlantic Drive**

**Telephone: 404-894-3152**

**URL: <http://www.cc.gatech.edu/>**

**e-mail: [inforequests@cc.gatech.edu](mailto:inforequests@cc.gatech.edu)**

*Dean and Professor*—Peter A. Freeman;

*Associate Dean and Professor*—Richard J.

LeBlanc, Jr.; *Professor and Director of Graphics,*

*Visualization & Usability Center*—James D.

Foley; *Professor and Director of the EduTech*

*Institute*—Janet L. Kolodner; *Professor and GRA*

*Eminent Scholar in Advanced*

*Telecommunications*—John O. Limb;

*Professors*—Albert N. Badre, Jay D. Bolter

(adjunct), Lucio Chiaraviglio (emeritus), Philip H.

Enslow, Jr., Richard M. Fujimoto, Robert E. Fulton

(adjunct), Alton P. Jensen (emeritus), Sham

Navathe, Nancy Neressian (joint), Karsten Schwan,

Vladimir Slamecka (emeritus), Craig A. Tovey

(joint), Pranas Zunde (emeritus); *Associate*

*Professors*—Mustaque Ahamad, Amihood Amir,

Mostafa H. Ammar, William F. Appelbe, Ronald C.

Arkin, Chris Atkeson, Dorrit Billman (adjunct);

Norberto F. Ezquerro, Ashok K. Goel, Larry F.

Hodges, Scott Hudson, Howard Karloff, Leo Mark,

Edward R. Omiecinski, Colin Potts, Ashwin Ram,

Umakishore Ramachandran, John T. Stasko, H.

Venkateswaran; *Assistant Professors*—Gregory

Abowd, Kenneth L. Calvert, Ann Chervenak,

Richard Catrambone (adjunct), John J. Goda, Jr.,

Mark Guzdial, Jessica Hodgins, Amarnath

Murkherjee, Stephen Schaal (adjunct), Leonard

Schulman, Russell Shackelford, Ellen Witte

Zegura; *Director of Administration*—Vicky

Jackson; *Director of Computing and Networking*

*Services*—David Leonard; *Director of External*

*Affairs*—Molly Ford Croft; *Director of Student*

*Services*—Kurt Eiselt; *Principal Research*

*Scientist*—W. Michael McCracken; *Senior*

*Research Scientist*—J. Spencer Rugaber;

*Research Scientist II and Associate Director of*

*Computing and Networking Services*—Dan

Forsyth; *Research Scientists II*—Richard A.

Billington, Melody Moore, Paul Manno, Jeanette

Myers, Elizabeth Mynatt, Noi Sukaviriya, Linda

Wills; *Research Scientists I*—Karen Barrett,

Randy Carpenter, Terry Countryman, J.K.

Muthukumarasamy, Peter Wan; *Instructors*—Jan

Crowe (part-time), William Friend (part-time),

James K. Greenlee, Dmitry Keselman (part-time),

Walter Saproonov (part-time); *Post Doctoral*

*Associates*—Jonathan Cameron, Cindi Hmelo,

Hari Nargyanan, Wendy Newstetter, Valery

Petrushin.

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## General Information

In recognition of the broad range of functions of computing, its crucial social roles, and the necessity of increasing the pace of its development, the Institute established the College of Computing as a focal point for the interdisciplinary advancement of computing. From its very inception, the College acquired the challenging mission of providing leadership for the creation of the human resources, technological advances, and scientific understanding required for twenty-first century computing.

The College awards bachelor's, master's, and doctoral degrees in Computer Science. The College offers an undergraduate Certificate in Information Systems that is offered jointly with the School of Management and a graduate Certificate in Cognitive Science that is offered jointly with the Schools of Psychology and Industrial and Systems Engineering. The College is also a sponsor of a multidisciplinary program in Algorithms, Combinatorics, and Optimization (ACO), an approved doctoral degree program at Georgia Tech.

The College offers strong instructional and research programs in many fields including algorithms and data structures, artificial intelligence and robotics, cognitive science, computer architecture, data bases, distributed systems, educational technology, human-computer interaction, graphics and visualization, information systems, networking and telecommunications, operating systems, parallel architectures, programming languages, software engineering, and the theories of algorithms, automata, and computation. The College conducts an increasing number of interdisciplinary research and instructional programs jointly with other campus units and has two centers of interdisciplinary research: the Graphics, Visualization & Usability (GVU) Center and the EduTech Institute.

The founding, in 1990, of the College of Computing caps a history that began in 1963 with the establishment of the School of Information Science. In 1972, this school was succeeded by the School of Information and Computer Science, the immediate predecessor of the current College of Computing.

### Computing Facilities

The College maintains a variety of computer systems in support of its academic and research activities. These include Sun systems used as file and computer servers, eight of which are quad-processor machines, and an Epoch file server with a read-write optical library unit. In addition, there are more than 200 workstation class machines from Sun, Digital, Hewlett-Packard, Silicon Graphics, and IBM, as well as numerous smaller systems and over 125 X Window terminals.

A number of specialized facilities augment the College's general-purpose computing capabilities. The Graphics, Visualization & Usability (GVU) Center houses a variety of graphics and multimedia equipment, including high-performance systems from Silicon Graphics, Pixar, Sun, Hewlett-Packard, Digital, Apple, and Intel, as well as extensive video and audio facilities for recording and editing. A Scientific Visualization Laboratory, with additional equipment from Digital and Silicon Graphics, is jointly operated by the GVU Center and the Institute's Office of Information Technology (OIT). The High-Performance and Parallel

Computation Experimentation Laboratory (HPPCEL), another joint operation between the College and OIT, serves as a focus for interdisciplinary research involving high-performance computer systems. Shared facilities include a Kendall Square Research KSR2 with 64 superscalar RISC processors, an 8-node IBM SP-2, a Cray Y/MP-EL dual-processor supercomputer, and a laboratory of IBM, Sun, and Silicon Graphics workstations. A 1,024-node MASPAR MP-2 SIMD multiprocessor is jointly operated with the School of Electrical and Computer Engineering, along with a laboratory of Hewlett-Packard workstations. Artificial intelligence activities are supported by Symbolics LISP, Mac/Ivory and Sun/Ivory systems, and a laboratory of IBM RS/6000 workstations. Other specialized laboratories support research in computer networking and communications systems, distributed computing, data bases, robotics, and software engineering.

All of the College's facilities are connected via local area networks which are in turn linked to a campuswide network, providing access to systems throughout the Georgia Tech community. As a NSFNET and SURAnet backbone site, the campus networking facilities provide a direct connection to the Internet, offering a means of high-speed communication with the scientific community worldwide.

Additional computing facilities are provided to the Georgia Tech campus by OIT, including several public-access clusters of Apple, IBM, Dell, and Sun workstations, a Sun SPARCcenter 2000 with 12 superscalar RISC processors, CDC Cyber 990 and IBM ES9000 mainframes, and public-access interactive terminals. All are connected to the campus network, which provides direct communication with the Internet, as well as BITNET and Usenet.

The College, along with the GVU Center and the EduTech Institute, is located in 40,000 square feet of the College of Computing Building, a structure completed in 1989.

### Undergraduate Program

With the explicit purpose of making the curriculum a model for the interdisciplinary academic computing programs of the twenty-first century, the undergraduate program has recently undergone significant reform.



The new program is designed to avoid the fragmentation of subject matter that is apparent in traditional computer science curricula. Rather than divide the aspects of computing expertise into isolated courses (which often obscures the connection between them), the new curriculum integrates the coverage of key aspects of computing. Each course in the first and second years is designed explicitly to teach methods and standards for the analysis, design, implementation, experimentation, and evaluation aspects of solving computational problems. All too often, many of these aspects are overlooked in academic education.

This program also guarantees that students experience computing as a field of both great challenge and broad applicability. The curriculum includes students from across the spectrum of science, engineering, and other disciplines, insuring that our students work in teams with students from other disciplines. By carefully tailoring the topics and problem sets of the freshman and sophomore level courses, students will realize how the application of computing relates to a broad set of interdisciplinary real-world problems. Students entering this program benefit from both a depth and breadth of educational experience that goes beyond what we or any other undergraduate program in computer science has yet offered.

At the freshman level, the first course, "Introduction to Computing," focuses on the concepts, ideas, methods, and results fundamental to the emerging science of computing. It emphasizes the development of theoretical and empirical skills in the design and analysis of algorithms and data structures. The second course, "Introduction to Programming," continues the study of algorithms and data structures, stressing algorithm implementation in a high-level structured programming language.

The new sophomore-level courses are designed to give students the opportunity to work in areas that are usually reserved for upperclassmen, such as artificial intelligence, systems programming, parallel computation, computer graphics, and human-computer interaction. Each sophomore-level course serves as a "gateway" to more advanced courses in a particular area in order to establish an early foundation, both in knowledge and in applied

experience. In addition, while many traditional programs emphasize experience with a particular programming language and environment, our sophomore-level courses provide hands-on training in three programming paradigms and at least four programming languages. This approach insures that our students will be able to adapt easily to the new languages, environments, and paradigms which they are certain to encounter.

In the junior year, undergraduates develop breadth in computational theory, software development, artificial intelligence, programming languages, systems software, and computer architecture. During the senior year, students pursue specialization in two areas of computer science, choosing from artificial intelligence, computer hardware design, computer systems, data management systems, software development, networking, and graphics, visualization, and usability.

Senior-level students also specialize in one area outside of computer science. This specialization may be in digital system design, engineering psychology, experimental psychology, modeling, organizational management theory, scientific computing, or technical communication. Finally, students undertake a capstone design project that allows them to integrate what they have learned in order to solve real-world problems in computing.

In addition to the standard four-year plan, a five-year cooperative plan is offered for students who wish to combine their academic education with industrial experience. The undergraduate program requires a total of 198 credit hours for graduation. With the exception of free electives, all bachelor of science degree course work must be taken on a letter-grade basis. Up to six hours of free electives may be taken on a pass/fail basis. See p. 30 for additional pass/fail restrictions.

# **Bachelor of Science in Computer Science Curriculum (Suggested Schedule)**

## **Freshman Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CS 1501</b>			
Intro. to Computing	3-3-4	...	...
<b>CS 1502</b>			
Intro. to Programming		3-6-5	...
<b>CS 1155</b>			
Understanding and Constructing Proofs	...	...	3-0-3
<b>CS 2250</b>			
Technical Information Resources	...	...	1-0-1
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	...
<b>Laboratory Science Electives</b>	...	4-3-5	4-3-5
<b>Humanities/Social Science Electives</b>	3-0-3	...	3-0-3
<b>TOTALS</b>	14-3-15	15-9-18	16-3-17

## **Sophomore Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CS 2360</b>			
Knowledge Representation and Processing	...	...	3-3-4
<b>CS 2390</b>			
Modeling and Design	...	3-3-4	...
<b>CS 2430</b>			
Control and Concurrency	3-3-4	...	...
<b>CS 2760</b>			
Intro. to Instruction Set Architecture and Machine Level Programming	...	3-3-4	...
<b>EE 1700</b>			
Computer and Digital Design Fundamentals	3-0-3	...	...
<b>ENGL 2110, 2201, 2301, or 2401</b>	...	...	3-0-3
<b>MATH 2501</b>			
Calculus and Linear Algebra	3-0-3	...	...
<b>MATH 2502</b>			
Elementary Difference and Differential Equations	...	3-0-3	...

## **MATH 2503**

Introduction to Algorithms and Optimization	...	...	3-0-3
<b>MATH 3012</b>			
Applied Combinatorics	...	...	3-0-3
<b>PHYS 2121</b>			
Particle Dynamics	4-3-5	...	...
<b>PHYS 2122</b>			
Electromagnetics	...	4-3-5	...
<b>PHYS 2123</b>			
Optics and Modern Physics	...	...	4-3-5
<b>Health and Performance Sciences</b>	3-0-3	...	...
<b>TOTALS</b>	16-6-18	13-9-16	16-6-18

## **Junior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CS 3156</b>			
Intro. to Automata	...	3-0-3	...
<b>CS 3158</b>			
Design and Analysis of Algorithms	...	...	3-0-3
<b>CS 3302</b>			
Intro. to Software Engineering	...	3-3-4	...
<b>CS 3361</b>			
Intro. to Artificial Intelligence	...	...	3-3-4
<b>CS 3411</b>			
Programming Language Concepts	...	...	3-0-3
<b>CS 3431</b>			
Operating Systems and Data Management	4-0-4	...	...
<b>CS 3760</b>			
Intro. to Computer Organization	3-0-3	...	...
<b>ENGL 3020</b>			
Technical Writing	...	...	3-0-3
<b>MATH 4215</b>			
Intro. to Probability	3-0-3	...	...
<b>MATH 4216</b>			
Intro. to Statistics	...	3-0-3	...
<b>Humanities/Social Science Electives</b>	6-0-6	6-0-6	3-0-3
<b>TOTALS</b>	16-0-16	15-3-16	15-3-16

## Senior Year

Course	1st Q.	2nd Q.	3rd Q.
<b>CS 4306</b>			
Senior Design I	...	0-9-3	...
<b>CS 4307</b>			
Senior Design II	...	...	0-9-3
<b>CS 4345</b>			
Computerization and Society	3-0-3	...	...
<b>CS Areas of Specialization</b>	X-X-6	X-X-6	X-X-6
<b>Non-CS Areas of Specialization</b>	X-X-3	X-X-3	X-X-3
<b>Humanities/Social Science Electives</b>	3-0-3	3-0-3	...
<b>Free Electives</b>	...	3-0-3	3-0-3
<b>TOTALS</b>	X-X-15	X-X-18	X-X-15

## SUMMARY

	TOTALS	1st Q.	2nd Q.	3rd Q.
<b>Freshman</b>	45-15-50	14-3-15	15-9-18	16-3-17
<b>Sophomore</b>	45-21-52	16-6-18	13-9-16	16-6-18
<b>Junior</b>	46-06-48	16-0-16	15-3-16	15-3-16
<b>Senior</b>	X-X-48	X-X-15	X-X-18	X-X-15
	X-X-198	X-X-64	X-X-68	X-X-66

Total Credit Hours Required for Graduation = 198

## Electives

### Humanities/Social Sciences Electives

ENGL 1001-2 and three credit hours of 2000-level English literature (2110, 2201, 2301, or 2401) apply toward satisfaction of the 18-hour humanities requirement. All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement and apply toward satisfaction of the 18-hour social sciences requirement. Other recommended social sciences electives include ECON 2000, ECON 2001, PSY 3303, and PSY 3304. The psychology courses are prerequisites to CS 4753 and 4754.

### Laboratory Science Electives

This requirement may be met by scheduling CHEM 1101 and 1102, or BIOL 1110, 1111, and 1112. Hours for biology in excess of 10 may be used as free electives.

## Health and Performance Sciences Electives

This requirement may be met by scheduling either HPS 1040 or 1061. A maximum of six credit hours of physical education may be applied toward the bachelor's degree. Credit hours in excess of three may be used as free electives.

## Free Electives

Free elective courses (six hours) may be taken any time during the course of study. Six hours of basic ROTC may be used as free elective credit toward the bachelor's degree. If basic ROTC is selected to satisfy these credit hours, it must be scheduled beginning the first quarter of the freshman year. Only three credit hours of physical education may be used as free electives. No course that covers the same material as other courses in a student's plan of study can be used as a free elective.

## Technical Electives and CS Areas of Specialization

Students are required to complete 18 hours of upper division computer science technical electives, which include two areas of specialization. Students will be required to complete a major and a minor area of specialization from the upper division CS electives listed below. To complete the major area of specialization, students must complete all the prescribed courses in one area. To complete the minor area of specialization, students must complete at least six hours of a second area. Additional computer science technical electives may be required to bring the total to 18. Students may petition to define other computer science areas of specialization to satisfy specific career objectives. A senior capstone design project is required. Students satisfy this requirement by (a) completing CS 4306 - Senior Design I and CS 4307 - Senior Design II or (b) completing CS 4310 and CS 4311 - Software Engineering Laboratory or (c) completing a research-oriented project that must be approved by the College.

**Computer Science Areas of Specialization****1. Artificial Intelligence**

Three courses among

**CS 4324** (3-3-4) Intelligent Robotics and Computer Vision

**CS 4331** (3-3-4) Problem Solving and Learning

**CS 4344** (3-6-5) Natural Language

Understanding by Computer

**CS 4361** (0-9-3) AI Design Project or

**CS/PSY 4754** (3-0-3) Models of Human

Information Processing

Must include at least two courses among **CS 4324**, **4331**, and **4344**.

**2. Computer Hardware Design**

**CS 3765** (2-3-3) Computer Organization Laboratory

**CS 4465** (3-3-4) Microprocessor System Design and either

**CS 4461** (3-3-4) Introduction to VLSI System Design or

**CS 4760** (3-0-3) Advanced Computer Architecture

**3. Computer Systems**

**CS 4410** (3-0-3) Introduction to Compilers

**CS 4430** (3-0-3) Introduction to Operating Systems

**CS 4760** (3-0-3) Advanced Computer Architecture

**4. Data Management Systems**

**CS 4351** (3-0-3) MIS Methodology

**CS 4450** (3-0-3) Introduction to Data Base Design

**CS 4753** (3-3-4) Human Factors in Software Development

**5. Graphics and Usability**

**CS 4390** (3-0-3) Computer Graphics

**CS 4391** (3-3-4) Advanced Computer Graphics Techniques

**CS 4753** (3-3-4) Human Factors in Software Development

**6. Networking**

**CS 4375** (4-0-4) Introduction to Telecommunication Systems

**CS 4380** (3-0-3) Data Communications

**CS 4381** (2-6-4) Principles of Data Communications

**7. Software Engineering**

**CS 4301** (3-3-9) Introduction to Software Engineering Project Management

**CS 4310** (0-9-3) Software Engineering Laboratory I

**CS 4311** (0-9-3) Software Engineering Laboratory II

**Non-CS Areas of Specialization**

The non-CS area of specialization electives (minimum of nine hours) must be recommended and approved by the College.

**Certificate in Information Systems**

The Information Systems Certificate is offered jointly by the College of Computing and the School of Management. (Management students are eligible to obtain this certificate, but computer science students are not.) The focus of the certificate is in data base and data base management applications, but additional course work dealing with the management of software projects and data communications is included as outlined below. Management students must take at least nine hours of management courses and at least 11 hours of computer science courses.

1. Students must take the following two courses:

**CS 2430**. Control and Concurrency  
(3-3-4)

**CS 3731**. Operating Systems and Data Management  
(3-3-4)

2. Students must take one of the following:

**CS 4351**. MIS Methodology  
(3-0-3)  
or

**MGT 3050**. Computer-based Management Systems  
(3-0-3)

3. Students must take one of the following:

**CS 3302.** Introduction to Software Engineering  
(3-3-4)  
or

**MGT 3052.** Systems Analysis and Design  
(3-0-3)

4. Students must take one of the following:

**CS 4450.** Introduction to Data Base Design  
(3-0-3)  
or

**ISyE 4750.** Data Base and Information Systems  
Development  
(3-0-3)  
or

**MGT 4750.** Data Base and Information Systems  
Development  
(3-0-3)

5. Students must take at least one of the following:

**CS 4301.** Software Engineering Project  
Management  
(3-3-4)

**CS 4380.** Data Communications  
(3-0-3)

**CS/PSY 4753.** Human Factors in Software  
Development  
(3-3-4)

**MGT 4051.** Expert Systems for Business  
Applications  
(3-0-3)

**MGT 4053.** Data Communications for  
Management  
(3-0-3)

**MGT 4054.** Data Base Applications in  
Management  
(3-0-3)

**MGT 4354.** Manufacturing Information Systems  
(3-0-3)

**TOTAL:** minimum of 20 hours

Several of these courses have prerequisites that are not included in the certificate program. Specifically, CS 1501 and 1502 are prerequisites to the computer science courses. MGT 3501 is a prerequisite to MGT 4354. MGT 2050 is a prerequisite to MGT 3050. CS 4375 is a prerequisite to CS 4380.

Students must petition either the School of Management or the College of Computing to obtain the Information Systems Certificate. The certificate application is available in SOM 103 or CoC 164. It should be submitted to Ms. Linda Bigham, SOM 330.

The certificate will be awarded once it has been verified that the requirements for the certificate have been satisfied. Both the School of Management and the College of Computing must approve the Information Systems Certificate.

## Master's Program

The Master of Science program prepares students for professional careers in technical and technical-managerial positions and for continued studies at the doctoral level. A student may earn the CS M.S. degree by either completing 50 quarter hours of approved course work, which may include a 9- to 12-hour project requirement, or 33 hours of approved course work and a thesis, credited as follows:

### Without Thesis

Total Course Credit Hours	50
Minimum Credit Hours in CS	36
Minimum Credit Hours (6000/8000 Level) in CS	27
Minimum Credit Hours (6000/8000 Level)	35

### With Thesis

Total Credit Hours	50
Thesis Hours (7000)	17
Total Course Credit Hours	33
Minimum Credit Hours in CS	24
Minimum Credit Hours (6000/8000 Level) in CS	18

Within the 50 total credit hours, students must include CS 6155, 6410, 6420, 6450, 6760, and 6751 as part of their approved program of study unless they have previously taken courses that cover this material.

Undergraduate courses required for the CS B.S. degree may not be used toward the CS M.S. degree. In addition, no graduate credit will be given for 3000-level courses or lower-level courses.

With the exception of thesis research, students must take all M.S. degree course work on a letter-grade basis. Students must earn a grade of *C* or better in any course applied toward the M.S. degree, and must maintain at least a 3.0 grade point average. The maximum total credit hours of Special Problems that may be applied toward the CS M.S. degree is five. Additional degree requirements as specified by the Institute are listed in the section, "Information for Graduate Students."

Students applying for admission to the master's degree program must have earned a bachelor's degree from an accredited institution, preferably in computer science. The M.S. degree program begins in the fall quarter of each academic year.

Applicants are selected for fall quarter admission only. The application deadline is May 1. However, all applicants are encouraged to apply as early as possible because the selection process may begin well before the May 1 deadline.

## **Doctoral Programs**

### **General Information**

The doctoral programs in the College of Computing prepare exceptionally qualified applicants for research careers. The degree of Doctor of Philosophy is granted for performance of original research resulting in significant contributions to the discipline's body of knowledge.

The doctoral program has three phases that normally require a minimum of four years to complete. At the end of the first phase, the student must be able to demonstrate basic knowledge of a spectrum of subject areas in computer science, as well as a high research potential. The second phase culminates in the formulation of a dissertation research proposal. Research and the dissertation defense complete the program.

Students applying for admission to the doctoral program should offer evidence of exceptional scholastic ability, intellectual creativity, research motivation, and a strong background in computer science, cognitive science, or other computing-related discipline represented in the College.

The doctoral program begins in the fall quarter of each academic year. The application deadline for the fall quarter is January 15.

### **Computer Science**

The computer science doctoral program usually requires four to six years to complete. In the first phase, which normally takes two years, the following requirements must be satisfied:

1. complete an Introduction to Graduate Studies course;
2. complete, during the first year, the core area requirement through exam or course work covering algorithms and data structures, computer organization, formal languages and automata theory, operating systems, and programming languages;
3. conduct research under faculty guidance from 3 to 12 credit hours per quarter after the first quarter in residence and up to qualifying for candidacy;
4. for the following 12 areas, complete at least two courses in three areas and at least one course in three other areas: AI and robotics; computer architecture; computer networks; data bases and information systems; graphics and scientific visualization; human computer interactions; numerical symbolic and scientific computation; performance evaluation; programming languages and compilers; software methodology and engineering; systems (including operating systems, distributed and parallel systems); theoretical computer science (including complexity, automata, and formal language theory); and
5. pass a depth exam in the fields of proposed research.

The second phase, which is dedicated to research leading to the dissertation, begins by successfully proposing a dissertation topic and being admitted to candidacy. This phase is completed with the successful defense and submission of the approved dissertation. Students are also required to complete a 15-hour minor outside the College. Inquiries concerning this program may be directed to the Office of Student Services, College of Computing.

### **Cognitive Science**

Doctoral students desiring to approach their graduate studies from the perspective of cognitive science are encouraged to obtain a Certificate in Cognitive Science in addition to the doctoral degree. Interested students will receive their degree from one of the participating units and follow an interdisciplinary curriculum tailored to their specific interests in cognitive science.

Although doctoral students from any unit on campus may receive a Certificate in Cognitive Science, the program is currently tailored to doctoral students in the College of Computing, the School of Psychology, and the School of Industrial and Systems Engineering. Students enter the certificate program after being admitted to one of the doctoral programs of the Institute.

In order to earn the Certificate of Cognitive Science, students fulfill the doctoral requirements in some unit of the Institute, have at least two members of their dissertation advisory committee from faculty affiliated with the cognitive science program, and take a series of core cognitive science courses consisting of at least three introductory cognitive science disciplinary courses, one methodology course outside their home discipline, a minimum of four topical courses and/or seminars, and participation in the continuing colloquium, Current Issues in Cognitive Science. Inquiries concerning this program may be directed to the Office of Student Services, College of Computing.

## **Algorithms, Combinatorics, and Optimization (ACO)**

The College of Computing is one of the sponsors of the multidisciplinary program in Algorithms, Combinatorics, and Optimization (ACO), an approved doctoral degree program at Georgia Tech. The other sponsoring units are the School of Industrial and Systems Engineering, and the School of Mathematics. The degree program is administered by an oversight committee drawn primarily from the sponsoring units.

The study of discrete structures is a rapidly growing area in computer science, applied mathematics, and operations research, most obviously in the analysis of algorithms, combinatorics, and discrete optimization. Collaborative work among the three traditionally separate disciplines is already common. The doctorate in algorithms, combinatorics, and optimization will prepare students for careers in this exciting and expanding new field.

Students are expected to be well-prepared in at least one of the three fields represented by the sponsoring units (computer science, mathematics, and operations research). Each student in the program is admitted through one of the three sponsoring units, which serves as the

home department. Course work is drawn from all three disciplines. The research adviser can be any member of the ACO Program Faculty, which is drawn from electrical and computer engineering, management, and other disciplines in addition to the three sponsoring units.

## **Research Centers in the College of Computing**

### **The EduTech Institute**

The EduTech Institute was created in January 1993 when the Woodruff Foundation awarded funds to Georgia Tech to investigate the application of technology to enhancing and facilitating scientific and technological education. Its emphasis is on applying what is known about how students learn to the development of effective environments for learning.

EduTech is committed to using technology in innovative ways to make education relevant and effective for all of our students and to prepare them for the workplace. EduTech primarily focuses on design education and science education for engineers.

### **Graphics, Visualization & Usability (GVU) Center**

The Graphics, Visualization & Usability (GVU) Center offers students an interdisciplinary environment for research and study. Center members teach courses and seminars in the principles and methods of computer graphics, visualization, and usability to members of the academic community ranging from undergraduate students to graduate students and other faculty. To participate in the program, students enroll in the college or school of a participating unit (Computing; Psychology; Industrial and Systems Engineering; Literature, Communication, and Culture; or any other unit with a participating faculty member), from which they receive their degree. A defined interdisciplinary minor program has been established (which still allows for

flexible, individual tailoring) for students from Computing, ISyE, LCC, Psychology, or other departments who want to concentrate in either graphics, visualization, or usability. For more information on this program, contact the Office of Student Services, College of Computing, and request a GVV brochure.

### **Recommended Minor Courses in GVV for Graduate Students**

Note: Non-CS graduate students who wish to pursue either the graphics or visualization track should already have the equivalent programming background of CS 1501, CS 1502, and CS 2390. That is, they should possess a good background in programming concepts, data structures, and the C programming language. Non-CS graduate students who do not have this computer science background could pursue the usability track.

### **Computer Science Major**

(15 quarter hours required for minor)

#### Graphics Track

TEX 4503  
PSY 6014  
ME 6175  
Math 6300  
Electives and Seminars

#### Visualization Track

TEX 4503  
PSY 6014  
MATH 4640  
MATH 4641  
Electives and Seminars

#### Usability Track

PSY 6014  
PSY 4409 or ISYE 6219  
PSY 6611 or ISYE 6400  
PSY 6613 or ISYE 6739  
Electives and Seminars

### **Industrial and Systems Engineering Major**

(15 quarter hours required for minor)

#### Graphics Track

CS 8113 (Graphics Seminar)  
CS 4390  
CS 4391 or CS 6490

Electives and Seminars

#### Visualization Track

CS 4390 and 7390  
CS 8113 (Visualization)  
PSY 6014  
LCC 6104  
LCC 8130B  
Electives and Seminars

#### Usability Track

LCC 6001, 6002, 6003, or 6004  
PSY 6014  
CS 6751  
CS 6752  
Electives and Seminars

### **Psychology Major**

(15 quarter hours required for minor)

#### Graphics Track

CS 8113 (Graphics Seminar)  
CS 4390  
TEX 4503  
CS 4391 or CS 6490  
Electives and Seminars

#### Visualization Track

CS 7321 and 7390  
CS 8113 (Visualization)  
LCC 6104  
LCC 8130B  
Electives and Seminars

#### Usability Track

LCC 6001, 6002, or 6004  
CS 6751  
CS 6752  
ISYE 6845  
Electives and Seminars

### **Literature, Communication, and Culture Major**

(15 quarter hours required for minor)

#### Graphics Track

CS 8113 (Graphics Seminar)  
CS 4390  
CS 4391 or CS 6490  
Electives and Seminars



## Visualization Track

CS 4390 and 7390

PSY 6014

CS 8113 (Visualization)

Electives and Seminars

## Usability Track

ISYE 6845

PSY 6014

CS 6751 and 6752

Electives and Seminars

## **Other Majors**

(At least 15 quarter hours required for minor)

## Graphics Track

CS 8113 (Graphics Seminar)

CS 4390

CS 4391 or 6490

Electives and Seminars

## Visualization Track

CS 4390

CS 7390

PSY 6014

CS 8113 (Visualization)

Electives and Seminars

## Usability Track

ISYE 6845

PSY 6014

CS 6751 and 6752

LCC 6001, 6002, 6003, or 6004

Electives and Seminars

## **Cooperative Programs**

### **Undergraduate Cooperative Program**

The College participates in the Undergraduate Cooperative Program administered by the Cooperative Division. Further details of this program are found in this catalog in the section, "Information for Undergraduate Students."

### **Graduate Cooperative Program**

The College participates in the Graduate Cooperative Program administered by the Office of Graduate Studies and Research. Further details of this program are found in this catalog in the section "Information for Graduate Students."

## **Courses of Instruction**

### **CS 1155. Understanding and Constructing Proofs** 3-0-3.

Introduction to the basic techniques of rigorous argumentation emphasizing the reading and writing of formal and informal proofs in discrete mathematics and computer science.

### **CS 1501. Introduction to Computing** 3-3-4.

An introduction to computing with a focus on the design and analysis of algorithms and data structures (not computer programming). Laboratory emphasis on computing resources and their applications, including campus facilities, the use of operating systems, and the application of standard tools.

### **CS 1502. Introduction to Programming** 3-6-5. Prerequisite: CS 1501.

A continuation of the study of algorithms and data structures, with a focus on algorithm implementation in a high-level, structured, programming language. Standards and methods of program design, programming style, and program documentation are emphasized.

### **CS 1700. Digital Computer Organization and Programming** 3-0-3.

Algorithmic processes of problem solving, properties of algorithms, development of algorithms for the solution of numerical and nonnumerical problems. The FORTRAN programming language. No credit for CS majors.

### **CS 1801-2-3-4-5-6. Special Topics**

Credit hours equal to the last digit of each course number. Prerequisite: consent of the College.

Courses of timely interest to the profession, conducted by resident or visiting faculty.

### **CS 2101. Computer Programming** 3-3-4. Prerequisite: CS 1700 or equivalent.

The programming language Pascal is introduced. Extensive use is made of programming examples and assignments to develop effective programming skills. Credit not allowed for both CS 1411 and 2101.

### **CS 2250. Technical Information Resources** 1-0-1.

Introduction to the literature and information services of science, engineering, and management. Effective uses of the Georgia Tech Library.

### **CS 2360. Knowledge Representation and Processing** 3-3-4. Prerequisite: CS 1502..

Algorithms, data structures, and problem solving techniques for computing with non-numeric information. Credit not allowed for both CS 2201 and 2360.

### **CS 2390. Modeling and Design** 3-3-4. Prerequisite: CS 1502.

Software specification and design techniques; object-oriented design and programming; discrete event simulation. Credit not allowed for both CS 2201 and 2390.

**CS 2430. Control and Concurrency**

3-3-4. Prerequisite: CS 1502.

Algorithms, data structures, and problem solving techniques for attacking and solving problems which are generic to concurrent systems. Emphasis on real-world problems, featuring case studies. Credit not allowed for both 2201 and 2430.

**CS 2760. Introduction to Instruction Set Architecture and Machine-level Programming**

3-3-4. Prerequisites: EE 1700 and one of the following: CS 1411, CS 1502, or CS 2101.

Machine instruction sets, emphasizing their relationship to high-level programming languages. Assembly-level programming used to illustrate architectural concepts. Laboratory exercises in assembly language programming.

**CS 2801-2-3-4-5-6. Special Topics**

Credit hours equal last digit of course number. Prerequisite: consent of the College.

Courses of timely interest to the profession, conducted by resident or visiting faculty.

**CS 3156. Introduction to Automata Theory**

3-0-3. Prerequisites: CS 1155 and MATH 3012.

Study of fundamental concepts in the formal theory of automata emphasizing finite state machines. Turing machines and computational power of machines.

**CS 3158. Design and Analysis of Algorithms**

3-0-3. Prerequisites: CS 1155 and either CS 2201 or one of the following: CS 2360, CS 2390, or CS 2430; and MATH 3012

Introduction to the mathematical analysis of computer algorithms, correctness, complexity, asymptotic lower bounds, efficient data structures, and combinatorial algorithms. NP-complete problems.

**CS 3302. Introduction to Software Engineering**

3-3-4. Prerequisites: CS 2201 or one of the following: CS 2360, CS 2390, or CS 2430; and junior standing.

Introduction to current techniques used in large-scale software development. Topics include requirements analysis, functional specification, systems design, implementation testing, and maintenance.

**CS 3361. Introduction to Artificial Intelligence**

3-3-4. Prerequisite: CS 2360.

Introduction to cognitive modeling, automatic problem solving, natural language processing, machine perception, and robotics.

**CS 3411. Programming Language Concepts**

3-0-3. Prerequisites: CS 2360, CS 2390, and CS 2430.

A study of the history, conceptual basis, and fundamental constructs of high-level programming languages and models.

**CS 3431. Operating Systems and Data Management**

4-0-4. Prerequisite: CS 2430.

Introduction to system design issues, focusing specifically on operating systems and data base systems. File systems, synchronization, deadlock, and memory management.

**CS 3760. Introduction to Computer Organization**

3-0-3. Prerequisites: EE 1300 and either CS 2760 or EE 3032.

Basic machine organization: instruction processing, register

transfer notation, data path design, bus and I/O organizations, control units, system timing, bit-slice processors, computer arithmetic, cache memories.

**CS 3765. Computer Organization Laboratory**

2-3-3. Prerequisites: EE 3360/3411 and CS 3760, or EE 3360/3411 and EE 3033.

Students will design and construct a simple digital computer using off-the-shelf SSI, MSI, and parts and memory components. Exercises in writing microcode are included.

**CS 3801-2-3-4-5-6. Special Topics**

Credit hours equal to last digit of course number. Prerequisite: consent of the College.

Courses of timely interest to the profession, conducted by resident or visiting faculty.

**CS 4158. Introduction to Computational Intractability**

3-0-3. Prerequisite: CS 3158

Introduction to the study of complexity classes, intractability, and general reduction strategies, approximations and probabilistic algorithms.

**CS 4301. Introduction to Software Engineering Project Management**

3-3-4. Prerequisite: CS 3302.

This course covers the organization, operation, and management of the information industry and, in particular, the management of software projects.

**CS 4306. Senior Design Project I**

0-9-3. Prerequisite: CS 3302.

Senior group software design project including definition, design, implementation, testing, and documentation of a significant software system.

**CS 4307. Senior Design Project II**

0-9-3. Prerequisite: CS 4306

Continuation of senior design project sequence (CS 4306).

Senior group software design project including definition, design, implementation, testing, and documentation of a significant software system.

**CS 4310. Software Engineering Laboratory I**

0-9-3. Prerequisite: CS 3302.

A project-oriented laboratory course used to familiarize students with software engineering methods in a realistic environment.

**CS 4311. Software Engineering Laboratory II**

0-9-3. Prerequisite: CS 4310.

Continuation of CS 4310. Students may take one, two, or three courses in the 4310-2 sequence.

**CS 4312. Software Engineering Laboratory III**

0-9-3. Prerequisite: CS 4311.

Continuation of CS 4311. Students may take one, two, or three courses in the 4310-2 sequence.

**CS 4324. Intelligent Robotics and Computer Vision**

3-3-4. Prerequisite: CS 3361 or equivalent.

Methodologies used for embedding artificial intelligence in robotic systems are presented. Robot task assembly planning, autonomous navigation, sensor-based robotic systems, supporting low-level visual processing, perceptual organization, and model based vision are among the topics covered.

## **CS 4331. Problem Solving and Machine Learning**

3-3-4. Prerequisite: CS 3361.

Fundamental concepts and methods in knowledge-based problem solving and learning, including representation and organization, planning, knowledge-based systems, knowledge acquisition, example-based learning, and explanation-based learning.

## **CS 4340. Introduction to Computer Law**

3-0-3. Prerequisite: senior standing.

Provide students with an introduction to copyrights, patents, trade secrets, trademarks, and commercial law pertaining to computer software and hardware.

## **CS 4341. Survey of Telecommunications and the Law**

3-0-3. Prerequisite: senior or graduate standing.

Overview of telecommunication regulation at the federal, state, and judicial levels; review of FCC policies, restrictions on Bell operating companies under the AT&T Consent Agreement.

## **CS 4344. Natural Language Understanding by Computer**

3-6-5. Prerequisite: CS 3361.

Methodologies for designing systems that comprehend natural language. Topics include lexical analysis, parsing, interpretation of sentences, semantic representation, organization of knowledge, and inference mechanisms.

## **CS 4345. Computerization in Society**

3-0-3. Prerequisite: senior level standing.

Examines computing as a social process with emphasis on ethical issues and the social impact of computerization on local and global organizations.

## **CS 4351. MIS Methodology**

3-0-3.

Methodology for the design and implementation of management information systems in industrial, business, and governmental organizations. Feasibility studies; system development, implementation, and evaluation. Project management.

## **CS 4361. Artificial Intelligence Design Project**

Prerequisites: CS 3361 and consent of instructor.

Independent-directed study with individual faculty members on specialized AI projects.

## **CS 4375. Introduction to Telecommunication Systems**

4-0-4. Prerequisites: CS 3430 or CS 3431, MATH 4215 and MATH 4216 or equivalent.

Introduction to telecommunication systems emphasizing the functional roles of component subsystems, their interactions, and mutual support. (Crosslisted with PUBP 6510, Telecommunications Technologies.)

## **CS 4380. Data Communications**

3-0-3. Prerequisite: CS 4375 or consent of the College.

An introduction to data communications for computers and computer terminals, including data transmission, communications software, protocols, switching, and simple networks.

## **CS 4381. Principles of Data Communication Systems**

2-6-4. Prerequisite: CS 4380.

A detailed coverage of the principles of data transmission and their performance, reinforced by laboratory exercises. Focuses on the three lowest layers: physical media, physical layer, and data link layer.

## **CS 4390. Computer Graphics**

3-0-3. Prerequisites: CS 2201 or CS 2390, MATH 2501 or MATH 2507 and experience programming in C.

Introductions to computer graphics: hardware, algorithms, and software organizations for graphics; two-dimensional and three-dimensional transformations; fundamentals of vector and raster graphics; programming project implementing a subset of the above.

## **CS 4391. Advanced Computer Graphics Techniques**

3-3-4. Prerequisite: CS 4390.

A study of computer graphics techniques emphasizing three dimensional imaging, transformations, projections, hidden surface removal, and illumination models.

## **CS 4410. Introduction to Compilers**

3-0-3. Prerequisites: CS 3410 or CS 3411, and CS 3430 or CS 3431.

Study of the basic techniques of compiler design and implementation, with consideration of the implementation characteristics of widely used programming languages.

## **CS 4430. Introduction to Operating Systems**

3-0-3. Prerequisite: CS 3430.

A qualitative introduction to operating systems, including multiprogramming concepts, resource allocation and management, other functions performed, and operating system implementation.

## **CS 4431. Advanced Operating Systems**

3-3-4. Prerequisites: CS 2760 and CS 3431.

Advanced undergraduate operating system concepts, specifically focusing on the application of CS concepts in parallel and distributed systems. A project concerning the construction of distributed and parallel OS functionality is included.

## **CS 4450. Introduction to Data Base Design**

3-0-3. Prerequisites: CS 3450 required, CS 3430 recommended.

Introduction to logical and physical structures of computer data base systems. Topics include data models, query languages, storage structures, and data base design.

## **CS 4461. Introduction to VLSI System Design**

3-3-4. Prerequisite: CS 3760 or EE 3033.

Design of very large scale integrated (VLSI) circuits emphasizing processor micro-architecture. System architecture, logic, IC layout, and rapid prototyping of VLSI systems. Design of a significant VLSI component is included.

## **CS 4465. Microprocessor System Design**

3-3-4. Prerequisite: CS 3765 or equivalent.

Microprocessors in general purpose and embedded systems. Laboratory exercises involve the construction of a microcomputer system with RAM, EPROM, and I/O devices.

## **CS 4730. LISP Programming for Artificial Intelligence**

2-3-3. Prerequisite: CS 1410, CS 1502 or equivalent or permission of instructor.

Students will learn methodologies for writing AI programs. Topics: an introduction to LISP, forward-backward chaining, frame systems, deductive systems. CS students may not take this course for credit.

**CS 4753. Human Factors in Software Development**

3-0-3. Prerequisites: CS 1411 or CS1502, PSY 3304.

Examines human factors in the software design and application process from initial requirements to testing and implementation, with emphasis on designing the user interface. Also listed as PSY 4753.

**CS 4754. Models of Human Information Processing**

3-0-3. Prerequisite: PSY 3304.

General and unified approaches to psychological and computer modeling of human information processes. Emphasis on neural, sensory, memory, semantic, and conceptual processing. Also listed as PSY 4754.

**CS 4760. Advanced Computer Architecture**

3-0-3. Prerequisites: CS 3430 or CS 3431 and either CS 3760 or EE 3033.

Instruction set analysis, high performance single-processor or computers, control unit and execution unit pipelining, instruction level parallelism, high-performance memory systems, RISC architecture, vector computers. (Also listed as CMPE 4760.)

**CS 4777. Vector and Parallel Scientific Computing**

3-0-3. Prerequisites: MATH 2503 or MATH 2508 and programming experience.

Scientific computational algorithms on vector parallel computers. Speedup, algorithmic complexity, interprocessor communication, synchronization, modern algorithms for linear systems, programming techniques, code optimization. (Also listed as MATH 4777.)

**CS 4801-2-3-4-5-6. Special Topics**

Credit hours equal last digit of course number. Prerequisite: consent of the College.

Courses of timely interest to the profession, conducted by resident or visiting faculty.

**CS 4901-2-3. Special Problems.**

Credit to be arranged. Prerequisite: consent of the College.

Individual investigation of significant areas of information and computer science. Guided study and research.

**CS 6130. Philosophy of Mind**

3-0-3.

Higher mental processes, including learning, concept formation, problem solving and perception, considered in relation to artificial intelligence. Linguistic and physiological models of human information processes.

**CS 6144-5. Information Systems Design I, II**

3-0-3 each.

Analysis and synthesis of information systems. Study of selected systems in areas such as data processing, management, command, and control.

**CS 6152. Theory of Automata**

3-0-3. Prerequisite: CS 3156.

Study of the significant results concerning finite automata, pushdown automata, linear-bounded automata. Turing machines, recognizers of the four Chomsky phrase-structure languages.

**CS 6153. Theory of Compiling and Translation**

3-0-3. Prerequisites: CS 3156, 4410.

A survey of theoretical topics related to compiler design and

implementation: deterministic parsing, table processing, code generation, syntax-directed compiling, global optimization.

**CS 6155. Analysis of Algorithms**

3-0-3. Prerequisite: CS 3158.

Basic techniques for analyzing and designing efficient algorithms: upper and lower time-space bounds for data structure, sorting and combinatorial problems, algebraic algorithms.

**CS 6156. Complexity of Computation**

3-0-3. Prerequisite: CS 6155.

Advanced techniques for analyzing the time-space complexity of natural computational problems; proving the tractability or intractability of problems from algebra, combinatorics, computer science, geometry, and number theory.

**CS 6157. Advanced Theory of Computability**

3-0-3. Prerequisite: CS 3156.

Advanced treatment of the theory of computability. Topics include recursive functions, recursively enumerable sets and relations, degrees of unsolvability, the recursion theorem and computational complexity.

**CS 6158. Graph Algorithms**

3-0-3. Prerequisite: CS 3158.

A consideration of efficient algorithms for graph problems such as maximum flow, maximum matching, planarity, and other NP-complete graph problems.

**CS 6347. Computer-aided Modeling**

3-0-3. Prerequisite: MATH 4216.

Principles of complex systems. Statistical and other methodological considerations. Mathematical, numerical, and other analysis. Modeling of computer-integrated systems.

**CS 6361. Artificial Intelligence**

3-6-5. Prerequisite: CS 3361 or graduate standing.

Advanced study of topics from problem solving, knowledge representation, expert systems, natural language processing, learning, and other current areas.

**Note: Students cannot get credit for CS 6361 and CS 6362.**

**CS 6362. Applications of Artificial Intelligence**

3-0-3. Prerequisite: graduate standing.

An introductory course to real-world applications of artificial intelligence. Robotics, computer vision, expert systems, neural networks, and other related topics are presented. (Note: This course is not for CS majors.)

**CS 6364. Hypermedia**

3-0-3. Prerequisite: programming experience.

Hypermedia is the nonlinear viewing and presentation of information (text, images, video, sound drawings, gestures). Topics: History and impact of hypermedia, hardware and software, authoring systems, user interfaces, knowledge representation, and navigation.

**CS 6380. Computer Networks**

3-0-3. Prerequisites: CS 4380, 4430.

In-depth examination of the design and operation of computer networks covering computer hardware and software functions and design requirements and communication subsystems.

**CS 6381. Computer Network Performance**

2-6-4. Prerequisite: CS 6380.

A detailed examination of the policies and mechanisms utilized by interconnection subsystems for routing, flow control, and congestion control, as well as end-to-end transport and session protocols.

**CS 6393. Visualization Techniques in Science and Engineering**

3-0-3. Prerequisites: graduate standing and permission of instructor.

Algorithms, software, and practical applications of visualization techniques. Includes color theory, visualization of multidimensional data, animation, interactive manipulation of data, and volume visualization methods.

**CS 6395. Principles of User Interface Software**

3-0-3. Prerequisite: CS 6751 or permission of the instructor.

Algorithmic and architectural principles for construction of modern user interfaces. I/O models, interaction techniques, window systems, tool kits, high-level specification, and implementation techniques.

**CS 6410. Computer Language Design**

3-0-3. Prerequisite: CS 3410 or 4410.

Description, structure, and design philosophies of high-level programming languages. Design aspects of names and types, data and control structures, and features for data abstraction and modularity.

**CS 6415. Compiler Construction**

3-3-4. Prerequisites: CS 4410, 6153.

Detailed study of compiler implementation techniques, with an emphasis on the design and use of tools that partially automate compiler construction.

**CS 6420. Computer Operating Systems**

3-3-4. Prerequisite: CS 4430.

A coverage of operating system architecture, functions, and implementation details. Involves concurrent processing, scheduling, storage, and device management. Also covers aspects of distributed system architecture. Includes a major implementation project.

**CS 6431. Design of Computer Operating Systems**

1-6-3. Prerequisite: CS 6420.

A major systems programming project involving the modification or extension of an existing operating system component and an evaluation of the results.

**CS 6432. High-performance Parallel Computing: Tools and Applications**

3-3-4.

Introduction to the fundamental principles of parallel computation, using textbook excerpts, research papers, and involving implementation and evaluation of programs on several parallel machines.

**CS 6436. Computer Systems Evaluation**

3-3-4. Prerequisites: CS 4380, 4430, MATH 4216.

Methods of evaluating performance of large-scale computer systems, with emphasis on performance analysis through simulation, queueing models, and measurement.

**CS 6450. Data Base Design**

2-3-4. Prerequisites: CS 3158, 4450.

Study of the state-of-the-art of data base design. Topics include data base theory, query optimization, concurrency control, and recovery methods.

**CS 6453. Principles of Distributed Data Base Systems**

3-0-3.

An introduction to the theory, algorithms, and methods that underly distributed data base management. Distributed data base design, query processing transaction management, and reliability are covered.

**CS 6490. Computer Graphics**

3-0-3. Prerequisites: CS 2201 and MATH 1509 or equivalent.

A study of 2-D and 3-D computer graphics including computer graphics hardware, line and polygon algorithms, transformations, clipping, hidden surface removal, illumination models, and ray tracing.

**CS 6555. Queuing Theory and Applications I**

3-0-3. Prerequisites: MATH 4216, CS 4430.

Queuing theory and its application in computer performance evaluation, operating systems design, telecommunications, and operations research.

**CS 6556. Queuing Theory and Applications II**

3-0-3. Prerequisite: CS 6555.

Continuation of CS 6555, emphasizing current research topics. Problems suitable for dissertation research are discussed.

**CS 6600. Advanced Small-scale Computer Systems**

1-6-3. Prerequisite: CS 3430.

The design and application of software and hardware for actual computer systems is introduced through hands-on laboratory experience with hardware modules, microcomputers, and interface subsystems.

**CS 6751. Human-Computer Interface**

3-3-4.

Human-computer interface is considered in terms of user-system compatibility. Concepts in human factors and interface design are covered in relation to capabilities of both humans and computers. Also listed as PSY 6751.

**CS 6752. Human-Computer Interface II**

3-0-3. Prerequisite: CS 6751.

The design process, and application of design principles to the design process. Additional design topics, such as help systems, interaction styles, and visual design principles. User interface prototyping and development tools.

**CS 6754. Engineering Data Base Management Systems**

3-0-3. Prerequisite: graduate standing or consent of instructor.

Modeling and managing and engineering information systems, integration of design and manufacture functions in engineering product development, with particular emphasis on data management, logical data models of engineering products and processes.

**CS 6760. Parallel Computer Architecture I**

3-0-3. Prerequisite: CS 3760 or EE 3033 required, CS 4760 recommended.

Parallel computer organization focusing on MIMD machines. Data dependence constraints, synchronization, multiprocessor scheduling, switching networks, shared

memory architectures, multiprocessor cache coherence, message-based multicomputers, data flow computers. (Also listed as EE 6760.)

**CS 6761. Parallel Computer Architecture II**

3-0-3. Prerequisite: CS 6760.

Parallel computer organization focusing on SIMD and special purpose machines. Word-parallel and bit-serial SIMD machine organization, skewed memory systems, reconfigurable architectures, VLSI computation, VLIW machines. (Also listed as EE 6761.)

**CS 6790. Computer Integrated Manufacturing Systems I**

3-0-3. Prerequisite: graduate standing (priority to CIMS students).

A broad overview of the functions, processes, and disciplines of computer integrated manufacturing.

**CS 6791. Computer Integrated Manufacturing Systems II**

3-0-3. Prerequisite: CS 6790.

An in-depth study of current issues, emerging technologies, and future developments in computer integrated manufacturing.

**CS 6792. Computer Integrated Manufacturing Systems Seminar**

1-0-1. Prerequisite: graduate standing.

Guest speakers on a broad range of CIMS-related topics: research, applications, and technology.

**CS 7000. Master's Thesis**

Credit to be arranged. Prerequisite: consent of the College.

**CS 7100. Overview of Graduate Studies in Computing**

3-6-5. Prerequisite: Graduate standing in Computing.

Research tools such as computer systems and languages, as well as fundamental problem-solving skills are introduced. Lectures on current computing research are presented and projects are required.

**CS 7321. Low Level Computer Vision**

3-0-3. Prerequisites: Linear Algebra, Linear Programming.

An introduction to computer vision and machine perception. Extracting symbolic and environmental information from images. Topics: paradigms, feature extraction, perceptual organization, perspective motion, stereo, color, texture.

**CS 7322. High Level Computer Vision**

3-0-3. Prerequisites: Linear Algebra, Linear Programming.

Machine vision systems using artificial intelligence and model-based techniques. Topics: architecture; object models; indexing and matching; hypothesis and uncertainty management; constraints; active sensing.

**CS 7323. Autonomous Robotics**

3-0-3. Prerequisite: CS 6361 or consent of instructor.

Designing intelligent autonomous robotic systems is the focal point of this course with special emphasis on neuroscientific and cognitive models of behavior.

**CS 7331. Problem Solving**

3-0-3. Prerequisite: CS 6361 or equivalent, or consent of instructor.

Fundamental concepts and methods in knowledge-based problem solving, including knowledge representation and organization; planning; inference mechanism; control architectures; explanation; and knowledge acquisition.

**CS 7332. Case-based Reasoning**

3-0-3. Prerequisite: CS 6361 or consent of instructor.

Topics include case representation, indexing and retrieval adaptation, interpretive CBR, the cognitive model, CBR implies and its implications for creativity, decision aiding, and education.

**CS 7341. Conceptual Information Processing**

3-0-3. Prerequisite: Graduate: CS 6361 or consent of instructor. Undergraduate: CS 3361 and consent of instructor.

In-depth introduction to the conceptual approach to artificial intelligence. Topics include: knowledge representation, inference, causality, natural language, story generation, explanation, memory, learning and integrated processing.

**CS 7342. Knowledge Structures for Machine Intelligence**

3-0-3. Prerequisite: CS 7341 or consent of instructor.

A study of the knowledge and inferences necessary for understanding and problem solving; knowledge organization; representation of episodes; question answering; reconstructive memory.

**CS 7343. Machine Learning**

3-0-3. Prerequisites: Graduate—CS 6361, CS 7341, or consent of instructor. Undergraduate—CS 3361 and consent of instructor.

This course covers fundamental issues in machine learning, including the algorithmic, psychological, philosophical, and methodological foundations of the field. We will cover topics in empirical or inductive learning, concept learning, learnability theory, analogical and case-based learning, and explanation-based learning.

**CS 7344. Natural Language Understanding by Computer**

3-3-4. Prerequisite: CS 6361 or consent of instructor.

Methodologies for designing systems that comprehend natural language. Topics include lexical analysis, parsing, interpretation of sentences, semantic representation, organization of knowledge and inference mechanisms.

**CS 7360. Advanced AI Systems Development**

3-3-4. Prerequisite: CS 6361.

Advanced study of AI programming methodologies including data-driven programming, agenda control, deductive information retrieval, discrimination nets, production systems, frames, chronological and dependency-directed backtracking.

**CS 7390. Software Visualization**

3-0-3. Prerequisite: CS 6490 or consent of instructor.

Study the use of visualization to assist program development and computer interaction. Topics include data structure display, algorithm animation, visual debugging, and program visualization.

**CS 7431. Distributed Computing**

3-0-3. Prerequisite: graduate standing; CS 4430 or equivalent recommended.

Introduction to fundamental concepts in distributed systems, including global states of distributed computations, logical clocks, and various failure models. Distributed algorithms for consensus, mutual exclusion, deadlock detection, and name resolution. Project work introduces distributed programming issues.

**CS 7490. Advanced Computer Graphics**

3-3-4. Prerequisite: CS 6490 or consent of instructor.

Introduction to advanced image synthesis. Antialiasing and signal processing, radiosity, ray tracing, scan conversion texture and bump mapping, texture synthesis motion blur, image warping.

**CS 7999. Preparation for Doctoral Qualifying Exams**

Credit to be arranged. Prerequisite: consent of the College.

**CS 8011-2-3-4-5-6. Seminar**

Credit hours equal last digit of course number. P/F or audit basis only. Prerequisite: consent of the College.

Group discussion of advanced topics in information and computer science. No credit toward the CS M.S. degree.

**CS 8050. Proseminar in Cognitive Science**

2-0-2.

An introduction to cognitive science emphasizing interdisciplinary attempts to address problems in cognition including memory, language understanding, problem solving and learning, perception, and action.

**CS 8051. Current Issues in Cognitive Science**

1-0-1. S/U basis only.

Students will be required to read research papers by leading cognitive scientists, attend their colloquia, and meet with them to discuss research.

**CS 8111-2-3-4-5-6. Special Topics**

Credit hours equal last digit of course number. Prerequisite: consent of the College.

Special topics of current interest. Treatment of new developments in various areas of information and computer science.

**CS 8501-2-3. Special Problems**

Credit to be arranged. Prerequisite: consent of the College.

Small-group or individual investigation of advanced topics in information and computer science. Guided study and research. Maximum of five credit hours allowed toward the CS M.S. degree.

**CS 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the College.

For graduate students holding graduate teaching assistantships.

**CS 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the College.

For graduate students holding graduate research assistantships.

**CS 8999. Doctoral Thesis Preparation**

Credit to be arranged. Audit only. Prerequisite: consent of the College.

**CS 9000. Doctoral Thesis**

Credit to be arranged. Prerequisite: consent of the College.





# COLLEGE OF ENGINEERING

*Dean*—John A. White; *Associate Deans*—J. Narl Davidson, Jack R. Lohmann, Carolyn W. Meyers; *Assistant Deans*—Lydia R. Howard, Jane G. Weyant; *Regents' Professor*—Satya N. Atluri; *Director of Continuing Engineering Education*—R. Dale Atkins; *Director of Special Projects*—Robert G. Haley.

## General Information

The College of Engineering comprises eight degree-granting schools of instruction and research. The schools offer programs of study and research leading to bachelor's, master's, and doctoral degrees. Some of the schools also offer programs in one or more subdisciplines or subspecialties. These degree offerings are summarized in an accompanying table.

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

## College of Engineering Degree Programs

Aerospace			
Engineering	B	M	Ph.D.
Bioengineering		M	Ph.D.
Ceramic Engineering	B	M	Ph.D.
Chemical Engineering	B	M	Ph.D.
Civil Engineering	B	M	Ph.D.
Computer			
Engineering	B		
Electrical Engineering	B	M	Ph.D.

Engineering Science and Mechanics		M	Ph.D.
Environmental			
Engineering		M	Ph.D.
Health Physics		M	
Health Systems		M	
Industrial			
Engineering	B	M	Ph.D.
Materials Engineering	B		
Mechanical			
Engineering	B	M	Ph.D.
Metallurgy		M	Ph.D.
Nuclear Engineering	B	M	Ph.D.
Operations Research		M	Ph.D.
Polymers		M	
Statistics		M	
Textile Chemistry	B	M	Ph.D.
Textile Engineering	B	M	Ph.D.
Textiles	B	M	

## Graduate Programs in Bioengineering

In response to the increased need for engineers and medical scientists with advanced training in bioengineering, Georgia Tech now offers Master's and Ph.D. degrees in Bioengineering. The purpose of bioengineering as a research discipline is to develop new and better physical and mathematical concepts and techniques which may be applied to problems in medicine and biology, to the development of new medical devices, and to the organization and delivery of cost-effective health care. Interdisciplinary in scope, the program offers advanced courses in engineering specialties, life sciences, and bioengineering combined with training in biomedical research.

These interdisciplinary graduate programs in bioengineering are offered by the College of Engineering in conjunction with the Bioengineering Center (in the Office of

Interdisciplinary Programs), the College of Sciences, and the College of Computing. The student will have a home school within the College of Engineering, which, upon completion of the student's requirements, will recommend the degree. This interdisciplinary approach has been approved by the faculty in the Schools of Aerospace Engineering, Chemical Engineering, Civil and Environmental Engineering (Engineering Science and Mechanics Program), Electrical and Computer Engineering, Materials Science and Engineering, Mechanical Engineering and Textile and Fiber Engineering, and by the deans of the Colleges of Engineering, Sciences, and Computing.

The program is for engineering graduates who wish to pursue a graduate degree in bioengineering rather than in a traditional field of engineering, or who have done bioengineering research in other disciplines. In addition, those interested students with nonengineering backgrounds (with degrees in such fields as computer science, physics, chemistry, biology or mathematics), who meet the admission requirements, will be admitted to the program. Applications from physicians with undergraduate degrees in engineering or the physical sciences will also be considered. All applications will be processed through the Bioengineering Center.

### Multidisciplinary Certificate Programs in Engineering

In addition to its degree programs, the College of Engineering provides opportunities for specialized study in engineering through its multidisciplinary certificate program offerings. Any student in good academic standing who is pursuing a degree in one of the participating schools of the College of Engineering or a participating school in any of the other colleges may select elective courses and the subjects of special problems to satisfy simultaneously both the requirements of his or her major degree program and those of a specialized multidisciplinary program. Upon graduation, the student receives both the degree in the major field of study and a certificate attesting to successful completion of the particular related multidisciplinary program.

The following table shows available program offerings and the degree levels of the programs.

### Multidisciplinary Programs

Program Area	Related Degree Areas		
Acoustical Engineering		M	Ph.D.
Bioengineering	B	M	Ph.D.
Composites Engineering	B	M	Ph.D.
Computer Integrated Manufacturing Systems		M	Ph.D.
Energy Engineering	B	M	Ph.D.
Fusion		M	Ph.D.
Geohydrology		M	Ph.D.
Materials Engineering	B	M	Ph.D.
Polymer Engineering	B	M	Ph.D.
Pulp and Paper Engineering	B		
Structures Engineering		M	Ph.D.

### General Requirements of Undergraduate Multidisciplinary Programs

The specific design of the multidisciplinary program of any participating undergraduate student, while individualized, must meet certain general requirements as well as requirements that are specific to that multidisciplinary area. The general (minimum) undergraduate multidisciplinary requirements are as follows:

- (1) the program must relate the student's major area to the given multidisciplinary area;
- (2) courses must be taken under more than one academic unit;
- (3) at least four courses and 12 credit hours (not required by name and number in the student's major) must be taken in a coherent program;
- (4) at least three of those courses and nine credit hours must be at the 3000 level or higher;
- (5) at least two of those courses and six credit hours must be outside the major field (cross-listed courses may be counted outside the student's major);
- (6) a grade of C or better must be earned in each course counting toward a multidisciplinary certificate.

### General Requirements of Graduate Multidisciplinary Programs

The specific design of the multidisciplinary program of any participating graduate student, while individualized, must meet certain general requirements as well as requirements that are specific to that multidisciplinary area. The general (minimum) graduate multidisciplinary

requirements are the same as those listed above for the undergraduate programs, with the following exceptions:

- (1) at least three of the coherent multidisciplinary program courses as well as nine credit hours must be at the 6000 level or higher;
- (2) a minimum grade of C must be earned in each course counting toward a multidisciplinary certificate. The overall grade point average for the program must be a 3.0 or higher;
- (3) students at the doctoral level must, on an individual basis, meet additional requirements specified by the student's doctoral committee, consistent with a program beyond the master's level whose objective is to develop a doctoral-level multidisciplinary program.

Interested students may obtain detailed information on the various undergraduate-level and graduate-level multidisciplinary programs from the main office of the school in which they are enrolled.

## Certificate Procedures

Petitions for multidisciplinary program certificates are processed as follows:

- (1) The student obtains a Petition for Multidisciplinary Certificate form from the academic adviser of his or her major school or from the chairperson of the relevant multidisciplinary committee. This form should be completed and submitted to the Office of the Dean of Engineering before the end of the third week of the quarter in which the student expects to graduate.
- (2) The dean will sign each acceptable completed petition.
- (3) The Office of the Dean will file a certificate containing all relevant information, except certifying signatures of the committee and the dean, with each acceptable petition.
- (4) At the end of the quarter, if the appropriate school director and the multidisciplinary committee certifies that the major program requirements and the special program requirements have been satisfactorily met, and the registrar has verified that all graduation requirements have been met,

each certificate will be signed by the respective committee chairperson and by the dean.

- (5) Multidisciplinary certificates are sent to recipients after graduation;
- (6) Certificate petitions are kept on file in the Office of the Dean of the College of Engineering as part of the student's official record.

## Computer Integrated

### Manufacturing Systems Program

The Computer Integrated Manufacturing Systems (CIMS) multidisciplinary program provides a broad curriculum addressing manufacturing issues from design through control. The certificate requirements include two core courses, 24 hours of electives (18 under the thesis option), a seminar series, and project experience.

Multidisciplinary, team-oriented activities are emphasized, and there are significant opportunities for interaction with industry. Financial support in the form of assistantships is available to highly qualified students.

## School of Aerospace Engineering

**Daniel Guggenheim School of Aeronautics, Established in 1930**  
**Location: Montgomery Knight Building**  
**Telephone: 404-894-3000**

*Director and Professor*—Robert G. Loewy;  
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## **General Information**

The School of Aerospace Engineering prepares students at the bachelor's, master's, and doctoral levels for a career in vehicle engineering, with primary emphasis on flight vehicles. The School is housed in four buildings having a floor space of 88,000 square feet, the majority of which is 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. The third and fourth years emphasize aerospace disciplines and related engineering sciences. 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 the theoretical, experimental, and design aspects of aerospace engineering. Courses do not have to be taken during the quarter indicated in the curriculum, but all prerequisites must be satisfied for a particular course. Advisement for registration is required.

A certain degree of specialization is available to undergraduate students through the proper choice of electives, certain substitutions for required courses, or a combination of both options, depending on the student's abilities and career objectives. Students should consult with their academic advisers for the availability of elective courses and recommended course sequences.

## **Graduate Programs**

The graduate programs at both the master's and doctoral levels are flexible so that students may tailor their course and research work to individual career objectives. A minimum of 50 credit hours is required for the master's degree. 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, and vibrational characteristics of vehicles.

### **Aerospace Systems Design**

Advanced design of conventional and V/STOL aircraft. Application of optimization and knowledge-based expert systems techniques to the aerospace systems design process. Computer-aided design (CAD) and its interface with computer-aided manufacturing (CAM) in the design of aerospace systems.

### **Flight Mechanics and Control**

Dynamic modeling, stability and control of conventional and V/STOL aircraft. Analog and digital methods for flight control system design using both classical and modern control theory. Attitude stabilization and active control of flexible space structures. Trajectory optimization and optimal control of air and space vehicles.

### **Fluid Mechanics**

Computational fluid dynamics, helicopter aerodynamics, laminar and turbulent flows, plasma and reacting gas dynamics, statistical theory of turbulence, and V/STOL aircraft.

### **Propulsion**

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

### **Structures**

Buckling and postbuckling of structures, composites, elastic and inelastic stress analysis, fracture mechanics, fatigue behavior, structural reliability and statistical methods of structural analysis, vibration and dynamic stability of

structural elements, wave propagation, and use of acoustic emission methods.

## Urban and Societal Engineering

Air pollution, biomechanics, fire research, and noise pollution.

Facilities for each of the above academic areas are housed in the aerospace laboratories and include low-speed and high-speed wind tunnels; an anechoic chamber; combustion chamber; combustion bomb; helicopter test stand; high- and low-temperature test machines; fatigue and creep machines; humidity chamber; environmental test chamber; a network of microcomputers and engineering workstations; analog computers and real-time simulators; data acquisition systems; time-series analyzers; a scanning electron microscope; laser-doppler velocimeter; and Raman spectroscopy equipment. These facilities are supported by a research staff and a well-equipped instrument lab and machine shop.

## Multidisciplinary Programs

See table on page 100.

## Bachelor of Aerospace Engineering Curriculum (Suggested Schedule)

### Freshman Year

Course	1st Q.	2nd Q.	3rd Q.
<b>AE 2350</b>			
Introduction to Aerospace Engineering	.....	.....	3-0-3
<b>CHEM 1101-2</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>EGR 1170</b>			
Visual Communication and Engineering Design	.....	2-3-3	.....
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>Health and Performance Sciences</b>			
HPS 1040 or 1061	.....	.....	X-X-3
<b>Free Elective</b>	3-0-3	.....	.....
<b>TOTALS</b>	15-3-16	14-6-16	X-X-16

### Sophomore Year

Course	1st Q.	2nd Q.	3rd Q.
<b>AE 2102</b>			
Introduction to Deformable Bodies	.....	.....	3-0-3
<b>ENGL 2101, 2201, 2301, or 2401</b>	3-0-3	.....	.....
<b>ESM 2201</b>			
Statics	3-0-3	.....	.....
<b>ESM 3201</b>			
Dynamics I	.....	3-0-3	.....
<b>HIST 1001 or 1002</b>			
U.S. History	3-0-3	.....	.....
<b>MATH 2507</b>			
Calculus IV	5-0-5	.....	.....
<b>MATH 2508</b>			
Calculus V	.....	3-0-3	.....
<b>MATH 3308</b>			
Ordinary Differential Equations	.....	.....	5-0-5
<b>ME 3322</b>			
Thermodynamics	.....	.....	3-0-3
<b>POL 1251 or 3200</b>			
U.S. Government	.....	3-0-3	.....
<b>PHYS 2122</b>			
Electromagnetism	4-3-5	.....	.....
<b>PHYS 2123</b>			
Optics and Modern Physics	.....	4-3-5	.....
<b>AE 1600</b>			
Computer Applications	.....	2-3-3	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	.....	.....	3-0-3
<b>Free Elective</b>	.....	.....	3-0-3
<b>TOTALS</b>	18-3-19	15-6-17	17-0-17

### Junior Year

Course	1st Q.	2nd Q.	3rd Q.
<b>AE 3003</b>			
Aerodynamics	3-0-3	.....	.....
<b>AE 3004</b>			
Compressible Flow	.....	.....	3-0-3
<b>AE 3005</b>			
Viscous Fluid Mechanics	.....	3-0-3	.....
<b>AE 3010</b>			
Aerodynamics Lab	.....	.....	1-3-2
<b>AE 3105</b>			
Fundamentals of Stress Analysis	3-0-3	.....	.....
<b>AE 3106</b>			
Structural Analysis by Virtual Work	.....	3-0-3	.....
<b>AE 3111</b>			
Structures Lab	1-3-2	.....	.....
<b>AE 3130</b>			
Vibrations and System Dynamics	4-0-4	.....	.....

<b>AE 3500</b>			
Flight Mechanics	.....	3-0-3	.....
<b>AE 3501</b>			
Aircraft Flight Control	.....	.....	3-0-3
<b>EE 3710</b>			
Intro. to Electronic Systems	3-0-3	.....	.....
<b>EE 3741</b>			
Electronic Systems Laboratory	.....	0-3-1	.....
<b>ENGL 3020</b>			
Technical Writing	.....	.....	3-0-3
<b>MATE 3702</b>			
Materials Engineering for			
Structural/Thermal Systems	.....	.....	3-0-3
<b>MATH 4582</b>			
Advanced Engineering			
Mathematics	.....	3-0-3	.....
<b>Humanities/Social</b>			
<b>Sciences/Modern</b>			
<b>Languages Electives</b>	3-0-3	3-0-3	3-0-3
<b>TOTALS</b>	17-3-18	15-3-16	16-3-17

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>AE 3510</b>			
Flight Mechanics Lab	1-3-2	.....	.....
<b>AE 4001</b>			
High-speed Aerodynamics	.....	3-0-3	.....
<b>AE 4103</b>			
Analysis of Thin-walled			
Structural Elements	3-0-3	.....	.....
<b>AE 4200</b>			
Vibration and Flutter	.....	.....	3-0-3
<b>AE 4251</b>			
Jet Propulsion	4-0-4	.....	.....
<b>AE 4350-1</b>			
Aerospace Engineering			
Design Project I, II	.....	2-6-4	2-6-4
<b>AE 4410</b>			
Vehicle Performance	3-0-3	.....	.....
<b>AE 4501</b>			
Orbital Mechanics			
or			
<b>AE 4502</b>			
Spacecraft			
Attitude Dynamics	.....	3-0-3	.....
<b>AE Electives</b>	X-X-3	X-X-3	X-X-3
<b>Humanities/Social</b>			
<b>Sciences/Modern</b>			
<b>Language Electives</b>	3-0-3	3-0-3	3-0-3
<b>Free Electives</b>	.....	3-0-3	3-0-3
<b>TOTALS</b>	X-X-18	X-X-19	X-X-16

**Total Credit Hours Required for Graduation=205**

### Requirements

A grade of *C* or better is required in each 1000-, 2000-, and 3000-level math and physics course. A

2.0 overall average is required to schedule AE 2102 or AE 3003. No more than two *D* grades are permitted in courses listed by number in the sophomore, junior, and senior years and in the aerospace engineering electives. Courses in which a *D* was earned may be repeated at any time with the approval of an adviser.

### Electives

#### Humanities/Social Sciences/Modern Languages Electives

Eighteen credit hours in humanities and 18 credit hours in social sciences are required for graduation. See p. 33 for a list of acceptable courses. Courses taken in humanities and social sciences must be scheduled on a letter-grade basis.

The courses selected to fulfill the humanities and social sciences requirements must provide both breadth and depth and should not be a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000/4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one of each. Students should see their academic adviser for course sequences that satisfy the depth requirement.

All students are required to pass examinations or courses in history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

### Free Electives

The free electives may be taken at any time during the course of study. If ROTC is elected, six credit hours of basic and six hours of advanced ROTC may be used to satisfy these electives. Physical education courses may not be applied toward the free electives. Health and performance sciences courses, except for HPS 1040 and 1061, may be applied toward the free electives. Only free electives may be taken pass/fail with a maximum of 12 hours allowed. Transfer students are restricted to fewer pass/fail hours.

### Aerospace Engineering Electives

These elective courses permit the student to study a particular aspect of aerospace engineering in depth. The courses must be chosen from the list in the aerospace engineering office and approved

by the student's adviser. These electives are normally scheduled in the senior year.

## Courses of Instruction

### AE 1600. Computers in Aerospace Engineering

2-3-3. Prerequisites: CS 1410 or CS 1700 or consent of the School. Pre- or corequisite: MATH 1507.

Introduction to the use of computers in aerospace engineering, basic word processing, use of spreadsheets; elementary graphics, communications and networking, elementary lab use, elementary computational algorithms.

### AE 2102. Introduction to Deformable Bodies

3-0-3. Prerequisites: ESM 2201, MATH 2507. Pre- or corequisite: AE 2350.

Introduction to the mechanics of deformable bodies. Elements of two-dimensional elasticity. Euler-Bernoulli beam theory. Beam analysis and design.

Text: at the level of Gere and Timoshenko, *Mechanics of Materials*.

### AE 2350. Introduction to Aerospace Engineering

3-0-3. Prerequisites: consent of the School.

Introduction to the field of aerospace engineering, discussion of the basic aerospace systems and disciplines, working vocabulary of the field.

Text: at the level of Anderson, *Introduction to Flight*.

### AE 2811-2-3-4-5. Special Topics

Last digit in each course number designates corresponding number of credit hours. Prerequisites: normally taken by sophomores with consent of School.

Course material devoted to special topics of current interest, treatment of new developments, in various areas of aerospace engineering.

### AE 2900-1-2-3. Special Problems

Credit to be arranged. Prerequisites: normally taken by sophomores with consent of School.

Research on a problem selected in consultation with a faculty member. A brief description, endorsed by the adviser, must be approved by the School director.

### AE 3003. Fundamentals of Aerodynamics

3-0-3. Prerequisites: AE 2350, MATH 2507.

Formulation and solution of problems in aerodynamics; similarity principle; two-dimensional, incompressible, irrotational flow about wings and bodies; generation of lift and drag.

Text: at the level of Anderson, *Fundamentals of Aerodynamics*.

### AE 3004. Elements of Compressible Flow

3-0-3. Prerequisites: AE 3003, ME 3322.

Principles of one-dimensional isentropic flows, flows with normal and oblique shocks, and flows with friction and heating.

Text: at the level of Johns, *Gas Dynamics*.

### AE 3005. Viscous Fluid Mechanics

3-0-3. Prerequisites: AE 3003, ME 3322, MATH 3308.

The physical equations of continuum flows and application of laminar and turbulent boundary layers for incompressible and compressible flow.

Text: at the level of Kuethe and Chow, *Foundations of Aerodynamics*.

### AE 3010. Aerodynamic Laboratory

1-3-2. Pre- or corequisite: AE 3004.

Experiments in aerodynamics and fluid mechanics with emphasis on measurement techniques and instrumentation.

### AE 3105. Fundamentals of Stress Analysis

3-0-3. Prerequisite: AE 2102. Pre- or corequisite: MATH 3308.

Deflections due to bending. Stresses in beams with unsymmetrical cross sections. Stability of beams and columns. Two-dimensional problems in elasticity.

Text: at the level of Megson, *Aircraft Structures for Engineering Students*.

### AE 3106. Structural Analysis by Virtual Work

3-0-3. Prerequisite: AE 2102. Pre- or corequisite: MATH 3308.

Principles of virtual displacements and virtual forces. Applications to structural analysis. Introduction to energy concepts.

Text: at the level of Megson, *Aircraft Structures for Engineering Students*.

### AE 3111. Aerospace Structures Laboratory

1-3-2. Prerequisite: AE 2102. Pre- or corequisite: AE 3105.

Introduction to mechanical measurements, instrumentation principles and practice, measurement of biaxial strain and stress, stability of simple columns, properties of composite structural materials.

### AE 3130. Vibrations and System Dynamics

4-0-4. Prerequisites: ESM 3201, MATH 3308.

Simple, damped, and forced vibrations of one-degree-of-freedom systems. Analogies with electrical and hydraulic aircraft control systems. Linear system analysis using Laplace transforms.

### AE 3500. Aircraft Flight Mechanics

3-0-3. Prerequisites: AE 3003, 3130, or consent of the School.

Principles of static longitudinal and lateral stability. Aircraft equations of motion and dynamic stability of uncontrolled motion. Design of aircraft stability augmentation systems.

Text: at the level of Nelson, *Flight Stability and Automatic Control*.

### AE 3501. Aircraft Flight Control

3-0-3. Prerequisite: AE 3500.

Dynamic response of linear systems and classical methods of feedback control system design. Applications to aircraft flight control system design.

Text: at the level of Franklin, et al., *Feedback Control of Dynamic Systems*.

### AE 3510. Flight Mechanics Laboratory

1-3-2. Prerequisite: AE 3501 or consent of the School.

Experiments in flight vehicle dynamics, stability, and control with emphasis on flight control system design.

### AE 3811-2-3-4-5. Special Topics

Last digit in each course number designates corresponding number of credit hours. Prerequisites: normally taken by juniors with consent of School.

Course material devoted to special topics of current interest, treatment of new developments in various areas of aerospace engineering.

### AE 3900-1-2-3. Special Problems

Credit to be arranged. Prerequisites: normally taken by juniors with consent of School.

Research on a problem selected in consultation with a faculty member. A brief description, endorsed by the adviser, must be approved by the School director.

### AE 4001. High-speed Aerodynamics

3-0-3. Prerequisite: AE 3004 or consent of the School.

Linearized compressible flow; supersonic airfoil theory; similarity rules; wings and bodies in supersonic flow. Method of characteristics. Introductory acoustics. Selected topics of current interest.

Text: at the level of Anderson, *Fundamentals of Aerodynamics*.

### AE 4010. Advanced Diagnostics in Fluid Dynamics

2-3-3. Prerequisites: AE 3004, 3005, 3010.

Concepts and techniques in experimental fluid dynamics. Flow visualization. Statistical methods. Pressure, velocity, temperature, density, and reaction rate measurements; interpretation and reporting.

### AE 4023. Theoretical Methods in Aerodynamics

3-0-3. Prerequisites: AE 3004, 3005.

Exact solutions in aerodynamics. Potential flow: transformation techniques, conformal mapping, Joukowski transformations. Viscous flow: exact solutions of Navier-Stokes and 2-D boundary layer equations.

### AE 4024. Hypersonic Flow and Heat Transfer

3-0-3. Prerequisite: AE 4001. Graduate credit not allowed for both AE 4024 and AE 6023.

An introduction to inviscid hypersonic flow theory, high-temperature gas effects, and elements of heat transfer at high Mach numbers.

### AE 4025. Advanced Viscous Flow

3-0-3. Prerequisite: AE 3005. Graduate credit not allowed for both AE 4025 and AE 6010-1.

Transition and turbulence models. Review of integral momentum equation. Account of compressibility in integral equation methods. Viscous-inviscid interaction.

### AE 4103. Analysis of Thin-walled Structural Elements

3-0-3. Prerequisite: AE 3105 or consent of the School.

Torsion of solid and cylindrical bars. Bending, shear, and torsion of closed thin-walled tubes. Analysis of built-up components.

Text: at the level of Megson, *Aircraft Structures for Engineering Students*.

### AE 4111. Advanced Structures Project Laboratory

2-3-3. Prerequisites: AE 3105, 3111.

Advanced experimental methods for structural testing and measurement. Laboratory project applications.

### AE 4120. Introduction to Composite Aerospace Structures

3-0-3. Prerequisite: AE 3105.

Introduction to composite structural systems. Principles of manufacturing. Structural mechanics of laminated composites. Aircraft applications. Damage tolerance.

### AE 4130. Introduction to Computational Structural Analysis

3-0-3. Prerequisite: AE 3106.

Deformation and force analysis of structures using matrix and finite element methods. Application of energy principles. Approximate methods of analysis. Basic theory and application of finite elements.

### AE 4200. Vibration and Flutter

3-0-3. Prerequisites: AE 3106, 3500. Pre- or corequisite: MATH 4582.

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

### AE 4251. Jet Propulsion

4-0-4. Prerequisite: AE 3004.

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

Text: at the level of Hill and Peterson, *Mechanics and Thermodynamics of Propulsion*.

### AE 4261. Introduction to Aerospace Combustion

3-0-3. Prerequisite: AE 3004. Graduate credit not allowed for both AE 4261 and AE 6261-2.

Flame types, stoichiometry, and the first and second laws applied to combustion. Premixed and diffusion flames. Explosions and reaction kinetics.

### AE 4350. Aerospace Engineering Design Project I

2-6-4. Prerequisite: AE 4410. Pre- or corequisites: AE 3501, 4001, 4251.

Conceptual design methodology developed and applied incorporating center of gravity, inertias, structural layout, materials, propulsion integration, stability and control, vehicle sizing, performance, and acquisition costs.

### AE 4351. Aerospace Engineering Design Project II

2-6-4. Prerequisites: sequent to AE 4350.

Design methodology further developed and applied. Teams formed to prepare competitive proposals in response to given mission requirements. Designs publicly presented and defended.

### AE 4352. Advanced Design Project

1-6-3. Prerequisite: AE 4351.

Advanced project in aerospace vehicle system design. Typically, a complete design is accomplished and documented.

### AE 4353. Design for Life-cycle Cost

3-0-3. Prerequisite: consent of the School.

Factors, formulas, and structures for aerospace system life-cycle costing (LCC). Development of LCC and its current status. Cost estimating relationships and LCC analysis.

### AE 4360. Fundamentals of Computer-aided Engineering and Design

3-0-3. Prerequisites: AE 1600, MATH 3308.

Introduction to the principles of geometric modeling, 2-D systems; 3-D wireframe, surface and solid representations; mathematical representation of curves, surfaces, solids; application to design problems.

### AE 4400. Introduction to Propeller and Rotor Theory

3-0-3. Prerequisite: AE 3003 and senior standing or consent of the School.



A study of the theory and equations used in the design of propellers and helicopter rotors.

Text: at the level of Gessow and Myers, *Aerodynamics of the Helicopter*.

## **AE 4410. Vehicle Performance**

3-0-3. Prerequisite: AE 3003.

A study of basic aerodynamic-vehicle performance including drag estimation, horsepower-thrust required and available, basic point and path performance, special performance items, maneuvers and resultant air loads.

Text: at the level of Anderson, *Introduction to Flight*.

## **AE 4501. Orbital Mechanics**

3-0-3. Prerequisites: ESM 3201 and MATH 3308.

The two-body problem, satellite orbits, Kepler's laws, Kepler's equations, orbital elements, satellite maneuvers, drag and earth oblateness effects, reentry and aerobraking, the space environment.

## **AE 4502. Spacecraft Attitude Dynamics**

3-0-3. Prerequisite: AE 3500.

Three-dimensional rigid-body dynamics, torque-free axisymmetric rigid bodies, general torque-free rigid bodies, satellite attitude control, gyroscopic instruments, stable platforms, inertial navigation.

## **E 4550. Instrumentation for Experimental Research I**

2-3-3. Prerequisite: consent of the School.

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

## **AE 4551. Instrumentation for Experimental Research II**

2-3-3. Prerequisite: AE 4550 or consent of the School.

Advanced treatment of laboratory instrumentation for research, analysis, and application of operational amplifiers, filters and signal conditioners, elementary digital circuits, computer systems for data acquisition.

## **AE 4600. Computational Fluid Dynamics**

3-0-3. Prerequisites: AE 1600, 4001 or equivalent.

Panel methods for subsonic flow. Finite difference approximations for Laplace's equation and relaxation methods. Integral boundary layer techniques and viscous/inviscid interaction. Subsonic airfoil design.

## **AE 4750. Fundamentals of Fiber-reinforced Composites I: Structural Mechanics**

3-0-3. Prerequisite: AE 2102 or ESM 3301.

Introduction to the mechanics of fiber-reinforced composite materials. Advantages and uses of composites. Property characterization methods. Lamina and laminate analysis. Failure mechanisms. Applications to structural components made of composites.

Text: at the level of Simitses, *Fundamentals of Fiber-reinforced Composites*.

## **AE 4760. Engineering Acoustics and Noise Control I**

3-0-3. Prerequisite: senior standing.

Study of acoustics related to noise and its control, acoustic terminology, wave propagation, solutions to the wave equation, instrumentation, sound field in large and small rooms, noise legislation. Also taught as ESM 4760, ME 4760.

## **AE 4761. Engineering Acoustics and Noise Control II**

3-0-3. Prerequisite: AE 4760 or equivalent.

Continuation of AE 4760, emphasizing techniques for the solution of noise problems. Vibration isolation, energy absorption, dissipative and reactive mufflers, enclosures, barriers, properties of materials, panel damping. Also taught as ESM 4761, ME 4761.

## **AE 4770. Structural Integrity and Durability**

3-0-3. Prerequisite: AE 2102 or ESM 3301.

Simple stress-concentration problems involving plastic deformation, residual stresses, hysteresis, creep, and relaxation. Introduction to fatigue and fracture mechanics. Crack-growth calculations and wearout models. (Also taught as ESM 4770.)

## **AE 4791. Mechanical Behavior of Composites**

3-0-3. Prerequisites: MATE 2301; AE 2102 or ESM 3301 or MATE 3463.

The stress-strain behavior of anisotropic composite structures and the elastic and plastic properties of matrix and reinforcing materials are covered for polymers, ceramics, and metals. Also taught as CE 4791, CHE 4791, ESM 4791, MATE 4791, ME 4791, and TEX 4791.

## **AE 4792. Fundamentals of Fiber-reinforced Composites I: Structural Mechanics**

3-0-3. Prerequisite: AE 2102 or ESM 3301.

Introduction to the mechanics of fiber-reinforced composite materials. Advantages and uses of composites. Property characterization methods. Lamina and laminate analysis. Failure mechanisms. Applications to structural components made of composites. Also taught as CE 4792, CHE 4792, ESM 4792, MATE 4792, ME 4792, and TEX 4792.

## **AE 4793. Composite Materials and Processes**

3-0-3. Prerequisites: CHEM 1102, PHYS 2123.

Basic principles of selecting component materials and manufacturing composites. Polymeric, metallic, and ceramic systems. Also taught as CE 4793, CHE 4793, ESM 4793, MATE 4793, ME 4793, and TEX 4793.

## **AE 4794. Laboratory in Composite Manufacturing and Testing**

2-3-3. Prerequisites: AE 4791 or 4792, AE 4793 or equivalent.

Major manufacturing processes and testing techniques involved in composites. Analysis, planning, and design of practical parts. Also taught as CE 4794, CHE 4794, ESM 4794, MATE 4794, ME 4794, and TEX 4794.

## **AE 4803-13-23-33-43-53. Special Topics**

3-0-3 each. Prerequisite: consent of the School.

Course material devoted to special topics of current interest, treatment of new developments in various areas of aerospace engineering.

## **AE 4804-14-24-34-44-54. Special Topics**

4-0-4 each. Prerequisite: consent of the School.

Course material devoted to special topics of current interest, treatment of new developments in various areas of aerospace engineering.

## **AE 4805-15-25-35-45-55. Special Topics**

5-0-5 each. Prerequisite: consent of the School.

Course material devoted to special topics of current interest, treatment of new developments in various areas of aerospace engineering.

**AE 4900-1-2. Special Problems in Aerospace Engineering**

Credit to be arranged. Prerequisites: third quarter junior or senior standing and approval of the director. Research on a problem selected in consultation with a faculty member. A brief description, endorsed by the adviser, must be approved by the School director.

**AE 6000. Foundations of Fluid Mechanics**

3-0-3. Prerequisite: consent of the School.

Development of the conservation equations of a multicomponent, reacting fluid from both the continuum and molecular viewpoints. Stress tensor, heat transfer, vector, and diffusion velocity.

Text: at the level of Vincenti and Kruger, *Physical Gas Dynamics*.

**AE 6010. Viscous Flow I**

3-0-3. Prerequisite: consent of the School. Graduate credit not allowed for both AE 4025 and AE 6010.

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.

**AE 6011. Viscous Flow II**

3-0-3. Prerequisite: AE 6010 or consent of the School. Graduate credit not allowed for both AE 4025 and 6011.

Transition from laminar to turbulent flow, equations of motion for turbulent flows, incompressible boundary layers, compressibility and heat transfer, semiempirical methods, wakes, and jets.

**AE 6020. Elements of Compressible Flow**

3-0-3. Prerequisite: consent of the School.

Defining equations for inviscid compressible flows, method of characteristics for unsteady one-dimensional and steady two-dimensional and axially symmetric flows, nozzle design, conical flow.

**AE 6021. Advanced Compressible Flow Theory I**

3-0-3. Prerequisite: consent of the School.

The linearized potential equation, thin airfoil theory, similarity rules, linear theory for axially symmetric and three-dimensional flows.

**AE 6022. Advanced Compressible Flow Theory II**

3-0-3. Prerequisite: consent of the School.

Mixed subsonic-supersonic flows, transonic similarity rule, two-dimensional and axially symmetric bodies in transonic flow, selected topics.

**AE 6023. Hypersonic Flow Theory**

3-0-3. Prerequisite: consent of the School. Graduate credit not allowed for both AE 4024 and AE 6023.

Hypersonic similarity rule, hypersonic small disturbance theory, Newtonian flow theory and other approximate methods, boundary layer interaction, the blunt body problem.

**AE 6030. Advanced Potential Flow I**

3-0-3. Prerequisite: AE 3003.

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.

**AE 6031. Advanced Potential Flow II**

3-0-3. Prerequisite: AE 6030.

Formulation of aerodynamic influence coefficients, solutions to subsonic, supersonic, and hypersonic flow problems of wings and bodies experiencing oscillatory and arbitrary motions.

**AE 6050. High-temperature Gas Dynamics I**

3-0-3. Prerequisite: AE 6260 or consent of the School.

Real gas effects. Equilibrium properties and rate processes of high-temperature gases. Equilibrium and frozen flows, normal and oblique shocks, nozzle flows, Prandtl-Meyer flows.

**AE 6051. High-temperature Gas Dynamics II**

3-0-3. Prerequisite: AE 6050.

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

**AE 6100. Advanced Structural Analysis I**

3-0-3. Prerequisite: AE 3106 or consent of the School.

Stability of mechanical models, elastic bars, and frames by kinetic and energy approaches, approximate methods for critical loads, dynamic stability, and inelastic effects.

**AE 6101. Advanced Structural Analysis II**

3-0-3. Prerequisite: AE 6100 or ESM 6361 or consent of the School.

Buckling of plates, torsional instability of thin open section columns, lateral buckling of beams, beams on elastic foundations, further discussion of dynamic stability.

**AE 6102. Advanced Structural Analysis III**

3-0-3. Prerequisite: AE 6100 or ESM 6361, ESM 6372, or consent of School.

Stability of plates, cylindrical shells, edge effects, complete spheres and shallow spherical caps, recent developments.

**AE 6103. Advanced Structural Analysis IV**

3-0-3. Prerequisite: AE 3106 or consent of the School.

Principle of virtual work. Concepts of potential energy and complementary energy, weighted residuals, applications in approximate solutions. Discussion of Hookean material, including thermal strains.

**AE 6104. Advanced Structural Analysis V**

3-0-3. Prerequisite: AE 6103 or consent of the School.

Introduction to finite element analysis, with emphasis on the displacement analysis of structures. Applications to static equilibrium, vibration and stability, nonlinear formulation, solution techniques.

**AE 6105. Aerospace Structures Laboratory**

1-6-3. Prerequisite: AE 6104 or consent of the School.

Development of practical methods for experimental mechanics, design and execution of experiments, measurement of displacement, strain, force, acceleration, temperature, design of transducers, and instrument systems.

**AE 6120. Thermal Effects in Structures I**

3-0-3. Prerequisite: MATH 4582.

Analysis of heat transfer in structural elements, development, and use of approximate numerical and analytical solution procedures.

**AE 6121. Thermal Effects in Structures II**

3-0-3. Prerequisite: ESM 6321 or consent of the School.

Analysis of thermally induced stresses in beams, plates, and shells, thermally induced instability in columns and plates, reduction in torsional rigidity.

## **AE 6122. Thermal Effects in Structures III**

3-0-3. Prerequisite: ESM 6321 or consent of the School.

Phenomenological and mechanistic interpretations of mechanical behavior of solids. Formulation and solution of problems involving elastic, plastic, linear and nonlinear viscoelastic and viscoplastic behavior.

## **AE 6130. Structural Dynamics I**

3-0-3. Prerequisites: AE 3105, AE 3130.

Single and multiple degree-of-freedom systems, damping effects, Duhamel superposition integral. Normal modes and equations of motion, Lagrange's equations, methods of obtaining normal modes.

## **AE 6131. Structural Dynamics II**

3-0-3. Prerequisite: AE 6130.

Vibrations of continuous elastic systems. Stodola and Rayleigh-Ritz methods. Timoshenko beam, longitudinal vibrations. Elastic and plastic waves, analysis of complex structures by modal coupling.

## **AE 6200. Advanced Aeroelasticity I**

3-0-3. Prerequisite: AE 6130.

Static aeroelastic analyses of flight vehicles, lifting surface and panel flutter analyses with applications. Dynamic response and load studies of flight vehicles using modal techniques.

## **AE 6201. Advanced Aeroelasticity II**

3-0-3. Prerequisite: AE 6200.

Formulation of aeroelastic analyses associated with discrete and normal dynamic loads, aerodynamic and structural instabilities of fixed- and rotating-wing flight vehicles.

## **AE 6202. Experimental Aeroelasticity**

3-0-3. Prerequisite: AE 6200.

Flexibility influence coefficient measurements. Vibration testing for modal identification. Unsteady aerodynamic load measurements. Wind tunnel and inflight flutter tests including model scaling and construction.

## **AE 6203. Special Topics in Aeroelasticity I**

3-0-3. Prerequisite: AE 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.

## **AE 6204. Special Topics in Aeroelasticity II**

3-0-3. Prerequisite: AE 6200.

Continuation of AE 6203. Advanced problems in aeroelasticity, unsteady aerodynamics, or structural dynamics.

## **AE 6205. Helicopter Dynamics and Aeroelasticity I**

3-0-3. Prerequisites: AE 4400 or 6400 or permission of the instructor.

Review of blade element/momentum theory; elementary blade dynamics; harmonic balance and trim; perturbation methods; Floquet theory; advanced aerodynamic models for aeroelasticity.

## **AE 6206. Helicopter Dynamics and Aeroelasticity II**

3-0-3. Prerequisites: AE 6130 and ESM 6201.

Flap-lag dynamics in vacuo, flap-lag stability, ground resonance; elastic blade bending, modes of elastic blades, calculation of stress resultants, general nonlinear elastic blade analysis.

## **AE 6250. Rocket Propulsion I**

3-0-3. Prerequisites: AE 4251 and AE 6020.

Flight mechanics, performance of the ideal rocket engine. Properties and performance characteristics of chemical propellants, nozzle designs, and losses.

## **AE 6260. Thermodynamics of Gases**

4-0-4. Prerequisite: consent of the School.

Thermodynamics of reacting gases. Introductory quantum theory, statistical thermodynamics, and chemical kinetics.

## **AE 6261. Combustion I**

3-0-3. Prerequisite: AE 6260 or consent of the School.

Graduate credit not allowed for both AE 4261 and AE 6261.

Introductory chemical kinetics, explosions, Schvab-Zeldovich formulation. Rankine-Hugoniot relations, detonations, and deflagrations.

## **AE 6262. Combustion II**

3-0-3. Prerequisite: AE 6261. Graduate credit not allowed for both AE 4261 and AE 6262.

Laminar diffusion flames and droplet burning. Laminar flame propagation in premixed gases, turbulent flames, ignition quenching, and flammability limits. Chemical reactions in boundary layers.

## **AE 6350. Design Optimization**

3-0-3. Prerequisite: consent of the School.

An introduction to optimization and constraint propagation techniques useful in the design of complex advanced technology aerospace systems.

## **AE 6351. Aerospace Systems Design I**

3-3-4. Prerequisites: AE 4400, 6350, or consent of the School.

Conceptual design of an aerospace system; builds on design optimization techniques; addresses how a variety of concepts are achieved through synthesis to meet specified needs.

## **AE 6352. Aerospace Systems Design II**

2-6-4. Prerequisite: AE 6351.

Preliminary design of an aerospace system; builds on conceptual design alternatives; addresses how a team of design specialists contribute to the preliminary design of an aerospace system.

## **AE 6360. Expert Systems**

3-3-4. Prerequisite: consent of the School.

Analyzes expert systems by exploring knowledge representation, control strategies, evidential reasoning, and truth maintenance. Topics are reinforced by student programming projects using GEST.

## **AE 6400. Aerodynamics of the Helicopter I**

3-0-3. Prerequisite: AE 4400.

Forward flight performance, derivation and study of the induced velocity relations and the flow field associated with helicopter rotors.

## **AE 6401. Aerodynamics of the Helicopter II**

3-0-3. Prerequisite: AE 6400.

Vortex-wake theories for rotors with a finite number of blades.

**AE 6460. Aerodynamic Noise**

3-0-3. Prerequisite: AE 6761.

Jet, boundary layer, combustion, propeller, and fan noise. Sonic boom, noise propagation from engines, and attenuation techniques.

**AE 6500. Advanced Stability and Control**

3-0-3. Prerequisites: AE 3500-1.

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.

**AE 6501. Aircraft Dynamics and Control I**

3-0-3. Prerequisite: AE 6511 or EE 6100 or ME 6424 or consent of the School.

General equations of motion in body and wind axis frames. Small disturbance theory. Transfer function representations and design of flight control systems.

**AE 6502. Aircraft Dynamics and Control II**

3-0-3. Prerequisite: AE 6501.

Modern control methods for design of multivariable flight control systems. Topics include tracking and model following control, matrix singular values, loop transfer recovery.

**AE 6503. Helicopter Stability and Control**

3-0-3. Prerequisite: AE 4400.

Helicopter general equations of motion, rotor forces, and moments helicopter stability and control characteristics, handling quality criteria, flight control system design.

**AE 6511. Optimal Guidance and Control I**

3-0-3. Prerequisite: AE 3501 or consent of the School.

Calculus of variations; Pontryagin's maximum principle; Euler-Lagrange formulation; Hamilton-Jacobi approach; systems with quadratic performance index; time, fuel, and energy optimal systems.

**AE 6512. Optimal Guidance and Control II**

3-0-3. Prerequisite: AE 6511 or consent of the School.

Numerical solution of optimal programming and control problems; singular solutions; applications to aerospace systems; introduction to differential games.

**AE 6520. Advanced Flight Dynamics**

3-0-3. Prerequisite: graduate standing or consent of the School.

Reference frames and transformations, general equations of unsteady motion, application to fixed-wing, rotary-wing and space vehicles, stability characteristics, flight in turbulent atmosphere.

**AE 6541. H-infinity and Mu Control Analysis**

3-0-3. Prerequisite: AE 3501 or consent of the School.

H-infinity and mu analysis theory of multivariable control systems including uncertainty, nominal and robust control, nominal and robust performance, structured singular values, real and complex mu values.

**AE 6542. H-infinity and Mu Control Synthesis**

3-0-3. Prerequisite: AE 6541 or consent of the School.

H-infinity and mu synthesis theory of multivariable control systems: coprime matrix factorization, Youla parameterization, Hamiltonian matrix, Riccati operator, H-infinity and mu compensators, four block problem.

**AE 6543. H-infinity and Mu Control Design**

3-0-3. Prerequisite: AE 6542 or consent of the School.

H-infinity and mu analysis and synthesis design of compensators for practical multivariable control systems including aircraft control, missile autopilot, and spacecraft flexible structural systems.

**AE 6760. Engineering Acoustics I**

3-0-3. Prerequisite: consent of the School.

Introductory analytical methods, stochastic processes, the wave equation in a compressible fluid, and problems in the radiation of sound. Also taught as ESM 6760 and ME 6760.

**AE 6761. Engineering Acoustics II**

3-0-3. Prerequisite: AE 6760.

Sound reflection and refraction, scattering and diffraction, sound radiation, and duct acoustics. Also taught as ESM 6761 and ME 6761.

**AE 6762. Engineering Acoustics III**

3-0-3. Prerequisite: AE 6761.

Advanced duct acoustics, wave dispersion and attenuation, acoustics in moving media, geometrical acoustics, nonlinear acoustics. Also taught as ESM 6762 and ME 6762.

**AE 6763. Noise Reduction and Control (Industrial Applications)**

3-0-3. Prerequisites: AE 4760 or equivalent and 6760.

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. Also taught as ESM 6763 and ME 6763.

**AE 6800. Numerical Fluid Dynamics I**

3-0-3. Prerequisite: AE 6010 or consent of the School.

Finite-difference and finite-element methods for the numerical solution of fluid dynamic equations. Current methods for the numerical solution of potential flow and boundary layer problems.

**AE 6801. Numerical Fluid Dynamics II**

3-0-3. Prerequisite: AE 6800.

Numerical methods of solution of boundary layer equation and Navier-Stokes equations for time-dependent and steady flows. Accuracy, stability, and computational efficiency.

**AE 7000. Master's Thesis**

**AE 7600. Perturbation Methods in Engineering Analysis**

3-0-3. Prerequisite: consent of the School.

Regular and singular perturbation theory, WKBJ method, and the method of weighted residuals. Problems drawn from fluid mechanics and structures.

**AE 7791. Damage and Failure in Composites**

3-0-3. Prerequisite: AE 4120 or AE, ChE, CE, ESM, ME, MATE, TFE 4791 or 4792.

Methods for analysis and failure of fiber reinforced composite material systems. Treatment of mechanisms of toughening, multiple cracking mechanisms. Failure in woven fabric, braided and special geometry composites. Cross-listed with ChE, CE, ESM, ME, MATE, TFE 7791.

**AE 7792. Mechanics of Composites**

3-0-3. Prerequisites: AE 4120 or AE, ChE, CE, ESM, ME, MATE, TFE 4792, ESM 6321 or ESM 4351, or equivalent.

## School of Chemical Engineering

**Established in 1901**

**Location: Bunger-Henry Building**

**Telephone: 404-894-2865**

Anisotropic elasticity, hygrothermal behavior stress analysis of laminated composites including 3-D effects, stress concentrations, free-edge effects, thick laminates, adhesive and mechanical connections, fracture of composites. Cross-listed with ChE, CE, ESM, ME, MATE, TFE 7792.

### **AE 7793. Manufacturing of Composites**

Prerequisite: AE, ChE, CE, ESM, ME, MATE, TFE 4793

Major manufacturing techniques for metal-ceramic-, and polymer-matrix composites. Modeling of processes with emphasis on fundamental mechanisms and effects. Cross-listed with ChE, CE, ESM, ME, MATE, TFE 7793.

### **AE 7999. Preparation for Doctoral Qualifying Exams**

Noncredit. Prerequisite: consent of the director.

### **AE 8000. Seminar**

1-0-1.

### **AE 8103-13-23-33-43-53. Special Topics**

3-0-3 each. Prerequisite: consent of the School.

Special topics of current interest, treatment of new developments in various areas of aerospace engineering.

### **AE 8104-14-24-34-44-54. Special Topics**

4-0-4 each. Prerequisite: consent of the School.

Special topics of current interest, treatment of new developments in various areas of aerospace engineering.

### **AE 8105-15-25-35-45-55. Special Topics**

5-0-5 each. Prerequisite: consent of the School.

Special topics of current interest, treatment of new developments in various areas of aerospace engineering.

### **AE 8106-16-26-36-46-56. Special Topics**

6-0-6 each. Prerequisite: consent of the School.

Special topics of current interest, treatment of new developments in various areas of aerospace engineering.

### **AE 8500-1-2. Special Problems in Aerospace Engineering**

Credit to be arranged. Prerequisite: consent of the School.

### **AE 8503-4-5. Special Problems in Aerospace Engineering**

Credit to be arranged. Prerequisite: consent of the School.

### **AE 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

### **AE 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

### **AE 8999. Preparation for Doctoral Dissertation**

Non credit. Prerequisite: consent of the director

### **AE 9000. Doctoral Thesis**

Noncredit. Prerequisite: consent of the director.

*Director and Professor*—Ronald W. Rousseau; *Associate Director and Associate Professor*—F. Joseph Schork; *Associate Director and Regents' Professor*—Aryn S. Teja; *J. Erskine Love Institute Chair in Engineering*—Charles A. Eckert; *Parker H. Petit Distinguished Chair for Engineering in Medicine*—Robert M. Nerem; *Regents' Professor*—Ajit Yoganathan; *Professors*—Agaram S. Abhiraman, Yaman Arkun, William R. Ernst, Charles L. Liotta, Michael J. Matteson, John D. Muzzy, Gary W. Poehlein, Robert J. Samuels, A. H. Peter Skelland, Jude T. Somerfield, Arnold F. Stancell, Mark G. White, Jack Winnick; *Professors Emeriti*—Charles W. Gorton, John E. Husted, Clyde Orr, Jr., Henderson C. Ward, Waldemar T. Zeigler; *Associate Professors*—Pradeep K. Agrawal, Sue A. Bidstrup Allen, Larry J. Forney, Jeffrey S. Hsieh, Paul A. Kohl, Ronnie S. Roberts, D. William Tedder, Timothy M. Wick; *Assistant Professors*—Peter Ludovice, Matthew Realf, Mary Rezac, Thanassis Sambanis; *Adjunct Professors*—Charlene W. Bayer, Elliott L. Chaikof, Michael Kocurek.

## 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. Industries that employ substantial numbers of chemical engineers include petroleum, petrochemical, pulp and paper, plastics, metallurgical, fiber, fertilizer, nuclear energy, space, rubber, food, photographic, heavy and fine chemical, mineral, pharmaceutical, textile, electronic, and dye. Energy problems and environmental and pollution control activities also require an increasing number of chemical engineers.

The School of Chemical Engineering offers programs leading to the Bachelor of Chemical

Engineering, Master of Science in Chemical Engineering, and Doctor of Philosophy. Interdisciplinary programs and undesignated degrees are also available.

The following curriculum leads to the Bachelor of Chemical Engineering and seeks to train students not only for positions immediately upon graduation but also for additional study leading to the master's and doctoral degrees.

It is a regulation of the School of Chemical Engineering that any student who accumulates a total of three or more grades of *F*, *D*, or *W* in required chemical engineering courses will not be permitted to enroll in any more chemical engineering courses and/or will not be certified for graduation by the School. Exceptions to this regulation will be permitted only after the affected student submits a specific written petition for exemption from this regulation and approval of said petition by the faculty of the School of Chemical Engineering. Also, a grade of *D* is not an acceptable passing grade for each of the six required mathematics courses (MATH 1507, 1508, 1509, 2507, 2508, and 3308).

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

Students whose previous academic backgrounds differ substantially from that of Georgia Tech are strongly advised to consider lightened academic loads during their first several quarters at Georgia Tech. Such students may also wish to audit one or two of the first sophomore courses in chemical engineering (CHE 2207 and 2208) before electing these required courses for credit.

The School of Chemical Engineering recommends that all of its students have a working knowledge of the FORTRAN or PASCAL programming language before scheduling any sophomore-level courses.

## Graduate Programs

The School of Chemical Engineering offers a graduate program of advanced study and research in chemical engineering. Chemical

engineering graduate work can lead to the Master of Science and the Doctor of Philosophy degrees, both involving a combination of advanced-level courses and independent research or design work.

Master's degree candidates must complete a research or design thesis. Course selection for both the master's and doctoral degrees is quite flexible with individual plans of study developed for each student.

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

In response to the need for scientists and engineers with advanced training in polymers, the Schools of Chemical Engineering and Textile Engineering at Georgia Tech both offer M.S. and Ph.D. programs in polymers. The core requirements for the polymer program are the same in each School. This core is designed to provide a balanced treatment of the chemistry, physics, and engineering of polymeric materials. At the same time the wide range of elective courses and research projects available permits students to develop their in-depth knowledge in a particular area of polymer science or engineering. The School of Chemical Engineering participates with several other schools in offering the M.S. in bioengineering.

## Bachelor of Chemical Engineering Curriculum (Suggested Schedule)

### Freshman Year

Course	1st Q.	2nd Q.	3rd Q.
<b>CHEM 1101</b>			
General Chemistry	4-3-5	.....	.....
<b>CHEM 1112</b>			
General Chemistry	.....	4-3-5	.....
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>CHE 2207</b>			
Chemical Process Principles	.....	.....	3-0-3
<b>English Elective</b>			
ENGL 2101, 2201			

2301, or 2401	.....	.....	3-0-3
<b>PHYS 2121</b>			
Physics	.....	.....	4-3-5
<b>MATH 1507-8-9</b>			
Calculus	5-0-5	5-0-5	5-0-5
<b>Freshman Engineering Elective</b>	.....	X-X-3	.....
<b>Health and Performance Sciences</b>			
HPS 1040 or 1061	.....	X-X-3	.....
<b>Electives</b>	3-0-3	.....	.....
<b>TOTALS</b>	15-3-16	X-X-19	15-3-16
<b>Total = 51 hours</b>			

## Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHE 2208</b>			
Chemical Process Principles	3-0-3	.....	.....
<b>CHE 2210</b>			
Chemical Engineering Analysis	.....	3-0-3	.....
<b>CHE 2310</b>			
Fluid Mechanics	.....	.....	3-0-3
<b>ESM 2211</b>			
Mechanics of Solids I	3-0-3	.....	.....
<b>MATH 2507-8</b>			
Calculus	5-0-5	3-0-3	.....
<b>CHE 3320-1</b>			
Chemical Engineering Thermodynamics	.....	3-0-3	3-0-3
<b>MATH 3308</b>			
Differential Equations	.....	.....	5-0-5
<b>PHYS 2122-3</b>			
Physics	4-3-5	4-3-5	.....
<b>CHEM 3411-2</b>			
Physical Chemistry	.....	3-0-3	3-0-3
<b>EE 3710</b>			
Introduction to Electronic Systems	.....	.....	3-0-3
<b>Elective</b>	3-0-3	.....	.....
<b>TOTALS</b>	18-3-19	16-3-17	17-0-17
<b>Total = 53 hours</b>			

## Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHE 3311</b>			
Heat Transfer	3-0-3	.....	.....
<b>CHE 3302-3</b>			
Transport Phenomena Laboratory I, II	0-3-1	0-3-1	.....
<b>CHE 3312</b>			
Mass Transfer	.....	3-0-3	.....
<b>CHE 3313</b>			
Stagewise Operations	.....	.....	3-0-3
<b>CHE 4415</b>			
Reactor Design	.....	.....	3-0-3
<b>CHEM 3311-2</b>			

Organic Chemistry	3-0-3	3-0-3	.....
<b>Chemistry Elective/</b>			
CHEM 3313, 3511, or 3343	.....	.....	3-0-3
<b>CHEM 3413</b>			
Physical Chemistry	.....	3-0-3	.....
<b>CHEM 3481</b>			
Physical Chemistry Laboratory	0-6-2	.....	.....
<b>CHEM 3381</b>			
Organic Chemistry Laboratory	.....	0-6-2	.....
<b>CHEM 3281</b>			
Instrumental Analysis for Engineers	.....	.....	3-3-4
<b>EE 3741</b>			
Electronic Systems Laboratory	...	.....	0-3-1
<b>MATE 3703</b>			
Materials Engineering for Electronic, Magnetic, and Electro-optic Systems	3-0-3	.....	.....
<b>Electives</b>	6-0-6	3-0-3	3-0-3
<b>TOTALS</b>	15-9-18	12-9-15	15-6-17
<b>Total = 50 hours</b>			

## Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHE 3309-10</b>			
Unit Operations Laboratory I, II	0-3-1	0-3-1	.....
<b>CHE 4431</b>			
Chemical Engineering Economics	3-0-3	.....	.....
<b>CHE Design Elective</b>			
CHE 4433 or 4449	.....	2-3-3	.....
<b>CHE 4436</b>			
Plant Design	.....	.....	1-9-4
<b>CHE 4417-8</b>			
Process Control	3-0-3	2-3-3	.....
<b>CHE 4420</b>			
Chemical and Process Safety	.....	2-0-2	.....
<b>Electives</b>	9-0-9	6-0-6	12-0-12
<b>TOTALS</b>	15-3-16	12-9-15	13-9-16
<b>Total = 47 hours</b>			
<b>Total Credit Hours Required for Graduation=201</b>			

## Substitutions

CHEM 1112, advanced-level chemistry, is required for all chemical engineering majors. Students transferring into chemical engineering from other curricula not requiring the advanced-level chemistry will be allowed to substitute CHEM 1102 for CHEM 1112 if taken prior to transferring.

## Electives

The chemical engineering curriculum contains 45 hours of electives to be chosen from three groups in the normal distribution indicated to satisfy the requirements of the School of Chemical Engineering—undesignated humanities electives (nine), social sciences (18), and free (18). Up to 12 hours of these electives may be taken on a pass/fail basis. Transfer students are restricted to fewer pass/fail hours. In addition, nine hours of designated English electives are required as listed below.

### English Electives

ENGL 1001-2 and ENGL 2XXX, with the latter course to be selected from ENGL 2101, 2201, 2301, or 2401, are required for all chemical engineering majors and satisfy nine hours of the total humanities requirement of 18 hours.

Students transferring into chemical engineering from other curricula not requiring these specific English courses or students granted advanced placement for these courses will be allowed to substitute any nine hours of humanities for these English requirements. International students may substitute FL 1031-2-3 for these English requirements and six hours of electives; only FL 1032 and 1033 may be used to help satisfy the humanities requirement.

### Freshman Engineering Elective

Any of the following courses are acceptable for credit as freshman engineering electives: CHE 1110, EGR 1170, CERF 1010, CS 1410, CS 1700, ESM 1101, NE 1010, 1100, NS 1002, 1003, or TEX 1100. CHE 1110 is strongly recommended.

### Humanities and Social Sciences Electives

Eighteen credit hours of humanities and 18 credit hours of social sciences are required. See p. 33 for a list of acceptable courses.

The courses selected to fulfill the humanities and social sciences requirement must provide both breadth and depth and should not be a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one of each. Students should see their academic adviser for course sequences that satisfy

the depth requirement.

All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

A modern language is recommended for students considering graduate work.

### Free Electives

Eighteen hours of free electives are provided so that a student will be able to pursue specific interests. See the ROTC and Health and Performance Sciences credit sections for the maximum hours in these areas that may be applied toward degree requirements. If six credit hours of basic ROTC are elected, they should be scheduled beginning the first quarter the student is enrolled. No course covering the same material as other courses in a student's plan of study can be used as a free elective.

### Multidisciplinary Programs

See table on page 100.

## Courses of Instruction

### CHE 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.

### CHE 1110. Elements of Chemical Engineering Design 2-3-3. Prerequisite: for freshmen only or with consent of the School.

An introduction to chemical engineering design in which simplified problems of current interest are used as a basis for a design project. Basics of FORTRAN programming.

Text: at the level of Rudd, Watson, and Sirola, *Process Synthesis*, and Ageloff and Mojena, *Applied FORTRAN*, 77.

### CHE 2207. Chemical Process Principles I 3-0-3. Prerequisites: MATH 1509 and CHEM 1112.

The material balance is developed. Gas behavior, systems of units, and material and thermodynamic properties are discussed. Emphasis is on the application of material balances to steady-state physical and chemical processes.

Text: at the level of Felder and Rousseau, *Elementary Principles of Chemical Processes*, 2nd Edition.

### CHE 2208. Chemical Process Principles II 3-0-3. Prerequisite: CHE 2207.

A continuation of CHE 2207. The energy balance is developed. Thermophysical and thermochemical concepts are discussed. Emphasis is on the application of combined material and energy balances to steady- and unsteady-state physical and chemical processes.



Text: at the level of Felder and Rousseau, *Elementary Principles of Chemical Processes*, 2nd Edition.

## **CHE 2210. Chemical Engineering Analysis**

3-0-3. Prerequisite: CHE 2208.

Quantitative analysis of chemical engineering processes. Numerical methods are introduced and applied to the solution of chemical engineering problems. Emphasis is placed on solving problems by digital computer.

## **CHE 2310. Fluid Mechanics**

3-0-3. Prerequisite: CHE 2208.

Fundamental principles and applications of momentum transfer. The analysis of chemical engineering processes and operations involving fluid flow.

Text: at the level of Geankoplis, *Transport Processes and Unit Operations*, 2nd Edition.

## **CHE 3302. Transport Phenomena Laboratory I**

0-3-1. Prerequisite: CHE 2310.

Laboratory experiments in momentum and energy transfer.

## **CHE 3303. Transport Phenomena Laboratory II**

0-3-1. Prerequisite: CHE 3302, 3311.

Laboratory experiments in heat and mass transfer.

## **CHE 3309. Unit Operations Laboratory I**

0-3-1. Prerequisite: CHE 3302, 3313.

Laboratory experiments in stagewise operations.

## **CHE 3310. Unit Operations Laboratory II**

0-3-1. Prerequisite: CHE 3302, 3312 Corequisite: CHE 4415.

Laboratory experiments in diffusional processes.

## **CHE 3311. Heat Transfer**

3-0-3.

Fundamental principles and applications of energy transfer. The analysis of chemical engineering processes and operations involving heat transfer.

Text: at the level of Incropera and DeWitt, *Fundamentals of Heat Transfer*.

## **CHE 3312. Mass Transfer**

3-0-3. Corequisites: CHE 2310, 3320, 3311.

Fundamental principles and applications of mass transfer. The analysis of chemical engineering processes and operations involving mass transfer.

Text: at the level of Treybal, *Mass Transfer Operations*, 3rd Edition.

## **CHE 3313. Stagewise Operations**

3-0-3. Prerequisite: CHE 2208 and 3321.

Topics in stagewise operations.

Text: at the level of Henley and Seader, *Equilibrium Stage Separation Operations in Chemical Engineering*.

## **CHE 3320. Chemical Engineering Thermodynamics I**

3-0-3. Prerequisite: CHE 2208.

Principles of thermodynamics with industrial applications. Applications of first and second laws, engines, air conditioning, turbines, equations of state, fluid properties, corresponding states.

Text: at the level of Reynolds and Perkins, *Engineering Thermodynamics*, 2nd Edition.

## **CHE 3321. Chemical Engineering Thermodynamics II**

3-0-3. Prerequisite: CHE 3320.

Principles of thermodynamics with industrial applications. Phase equilibria, fugacity, activity, mixtures, non-ideal solutions, gas solubility, reaction equilibria.

Text: at the level of Van Ness and Abbott, *Classical Thermodynamics of Nonelectrolyte Solutions*.

## **CHE 3750. Introduction to Biofluid Dynamics**

3-0-3. Prerequisite: MATH 2309, PHYS 2123, or consent of instructor.

Study of blood flow in the cardiovascular system, with emphasis on the modeling of such flows and the potential of flow studies for clinical research applications. Also taught as ESM 3750 and ME 3750.

## **CHE 4111. Mineral Engineering: Fossil Fuels**

3-0-3.

An introductory course in fossil fuels. Gives majors in engineering a background in fuels and raw materials.

## **CHE 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 Work and Warner, *Air Pollution—Its Origin and Control*.

## **CHE 4415. Reactor Design**

3-0-3. Prerequisites: CHE 3321, 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 semibatch reactors.

Text: at the level of Levenspiel, *Chemical Reaction Engineering*.

## **CHE 4417. Process Control I**

3-3-4. Prerequisite: EE 3710. Corequisite: CHE 4415.

Dynamics of chemical processes and theory of control techniques. Mathematics using primarily Laplace transforms is applied with instrumentation and process constraints to system design.

Text: at the level of Stephanopoulos, *Chemical Process Control*.

## **CHE 4418. Process Control II**

2-3-3. Prerequisite: CHE 4417.

Theory of digital control. Applications to the process industries. Laboratory experiments in system dynamics and analog and digital control.

Text: at the level of Stephanopoulos, *Chemical Process Control*.

## **CHE 4420. Chemical and Process Safety**

2-0-2. Prerequisite: CHE 3320.

This course discusses the fundamental sources of chemical hazards and degree of risk. Process design and hazard avoidance are used to reduce risk.

## **CHE 4431. Chemical Engineering Economics**

3-0-3. Prerequisite: CHE 3312. Corequisite: CHE 3313.

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*.

### **CHE 4433. Chemical Process Synthesis, Design, and Optimization**

2-3-3. Prerequisites: CHE 2208, 3313.

Principles of chemical flowsheet creation and integration with recognized design constraints. Applications of heuristic rules, dynamic programming, and multivariate state optimization to minimize processing costs.

Text: at the level of Rudd and Watson, *Strategy of Process Engineering*.

### **CHE 4436. Design of Chemical Plants**

1-9-4. Prerequisites: All required CHE courses.

Complete design of a chemical process and plant, incorporating concepts of unit operations, reactor design, economics, and process control.

### **CHE 4449. Computer-aided Process Design**

2-3-3. Prerequisites: CHE 2210, 3313, 3321.

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 *PROCESS Input Manual*.

### **CHE 4750. Polymer Science and Engineering I**

3-0-3. Prerequisites: CHEM 1102, PHYS 2123.

An introduction to the chemistry and structure of polymers. Polymerization processes, major polymer systems, and methods of polymer identification are presented. Also taught as TEX 4750.

Text: at the level of Rodriguez, *Principles of Polymer Systems*.

### **CHE 4751. Polymer Science and Engineering II**

3-0-3. Prerequisites: CHEM 1102, PHYS 2123.

An introduction to the physical states and transitions, fabrication processes, and mechanical properties of polymers. Also taught as TEX 4751.

Text: at the level of Rodriguez, *Principles of Polymer Systems*.

### **CHE 4752. Silicon Integrated Circuit Processing Laboratory**

1-6-3.

This course covers the six chemical processes used in the fabrication of integrated circuits. Each student fabricates and characterizes a silicon wafer of PMOS transistors.

### **CHE 4760. Polymer Science and Engineering Laboratory**

1-6-3. Corequisite: CHE 4751.

Experiments in polymerization, processing, and property evaluation of polymers. Also taught as TEX 4760.

### **CHE 4771. Pulp and Paper Processes I**

3-0-3. Prerequisite: consent of School.

A survey of the processes in a kraft pulp mill necessary to convert raw material to sulfate pulp. Wood preparation, wood chemistry, and morphology. The chemical and mechanical characteristics of kraft pulping and chemical recovery processes. Also taught as ME 4771.

### **CHE 4772. Pulp and Paper Processes II**

3-0-3. Prerequisite: consent of the School.

The major pulping processes other than kraft pulping. General knowledge of the various factors affecting each pulping process and pulp bleaching. The unique advantages and disadvantages of each pulping and bleaching process. Also taught as ME 4772.

### **CHE 4773. Paper Formation and Properties**

3-0-3. Prerequisite: consent of the School.

The processes in the fabrication of paper and paper products from pulp. The effects on paper properties of chemical and mechanical pretreatment of pulp. The measurement of paper properties. Also taught as ME 4773 and TEX 4773.

Text: at the level of Casey, *Pulp and Paper: Chemistry and Chemical Technology*, Vol. 2.

### **CHE 4791. Mechanical Behavior of Composites**

3-0-3. Prerequisites: MATE 2301 or equivalent, ESM 3301, MATE 3463, or AE 2201.

The basic principles governing the stress-strain behavior of anisotropic composite structures are emphasized. Elastic and plastic properties of matrix and reinforcing materials are covered and include polymeric, ceramic, and metallic materials. Also taught as MATE 4791, TEX 4791, AE 4791, and ME 4791.

### **CHE 4792. Fundamentals of Fiber-reinforced Composites I**

3-0-3. Prerequisite: AE 2102 or ESM 3301.

The course is designed to familiarize engineering students with fiber-reinforced composite materials. Also taught as AE 4792, ME 4792, MATE 4792, and TEX 4792.

### **CHE 4793. Composite Materials and Processing**

3-0-3. Prerequisites: CHEM 1102 and PHYS 2123.

Basic principles of selecting component materials and manufacturing composites are presented. Polymeric, metallic, and ceramic systems are considered. Also taught as ME 4793, AE 4793, MATE 4793, TEX 4793, CE 4793, and ESM 4793.

### **CHE 4794. Laboratory in Composite Manufacturing and Testing**

2-2-3. Prerequisites: ME/CHE/MATE/TEX/CE/ESM/AE 4791 or 4792 and 4793.

Covers major manufacturing processes and testing techniques involved in composites. Analysis, planning, and design of practical parts will also be covered. Also taught as ME 4794, AE 4794, MATE 4794, TEX 4794, CE 4794, and ESM 4794.

### **CHE 4801-2-3-4-5-6. Special Topics**

1 through 6 credit hours, respectively. Prerequisite: consent of the School.

Topics relevant to chemical engineering not currently covered in the undergraduate curriculum are presented as demand or interest warrants.

### **CHE 4901-2-3. Special Problems**

Credit to be arranged. Prerequisite: CHE 3311.

The student is given an opportunity to develop initiative and to apply fundamental principles by doing semioriginal laboratory or theoretical investigation of a chemical engineering problem.

## **CHE 6001. Biochemical Engineering I**

3-0-3. Prerequisite: consent of the instructor.

Engineering aspects of enzyme systems. Transport phenomena in biological systems and elementary biological reactor design.

## **CHE 6002. Biochemical Engineering II**

3-0-3. Prerequisite: consent of the School.

Advanced biological reactor design. Analysis of complex biological systems.

## **CHE 6301. Polymerization Reaction Engineering**

3-0-3. Prerequisite: CHE 4415 or consent of the School.

Polymerization processes are analyzed with regard to reaction mechanism, kinetics, and reactor design. Control of polymer structure during polymerization is emphasized.

## **CHE 6417. Advanced Process Control I**

3-0-3. Prerequisite: CHE 4418.

Fundamentals of multivariable control systems as applied to chemical processes. State-space and frequency domain representations, principles of feedback, analysis and synthesis of robust control systems. Application of alternative methods using computer-aided design.

## **CHE 6418. Advanced Process Control II**

3-0-3. Prerequisite: CHE 4418.

Techniques of system identification, state estimation and optimal, adaptive, and pole placement control of chemical process systems. Both continuous and discrete systems are discussed.

## **CHE 6449. Computer-aided Batch Process Design**

2-3-3. Prerequisite: CHE 4449.

A study of discrete-event and continuous systems for the simulation of batch chemical processes as a design tool. Generalized (GPSS, SLAM) and dedicated (BATCHES) systems are investigated.

Text: at the level of Pritsker, *Introduction to Simulation and SLAM II*, 3rd Edition.

## **CHE 6601. Chemical Engineering Thermodynamics I**

3-0-3. Prerequisite: CHE 3321 or consent of the School.

The laws of thermodynamics with application to pure substances and mixtures. Calculation of thermodynamic properties. Elements of molecular thermodynamics and potential functions. The corresponding states principle and its applications. Equations of state. Phase equilibrium calculations at high pressures.

Text: at the level of Prausnitz, *Molecular Thermodynamics of Fluid Phase Equilibria*.

## **CHE 6602. Chemical Engineering Thermodynamics II**

3-0-3. Prerequisite: CHE 6601 or consent of the School.

Thermodynamics of solutions. Ideal and non-ideal nonelectrolyte solutions. Phase equilibria involving gas, liquid, and solid phases. Molecular properties of liquids and liquid mixtures. Engineering applications.

Text: at the level of Prausnitz, *Molecular Thermodynamics of Fluid Phase Equilibria*.

## **CHE 6607. Thermochemical Conversion**

3-0-3. Prerequisite: CHE 4436 or consent of the School.

Thermochemical conversion to fuels or chemical feedstocks with emphasis on feed materials of solid wastes and biomass.

## **CHE 6610. Aerosol Technology**

3-0-3. Prerequisite: consent of the School.

Presents basic concepts describing the behavior of dispersed particles. Includes generation, sampling and size analysis, diffusion, coagulation, settling, kinetics and dynamics, electrostatic and optical properties.

Text: at the level of Mercer, *Aerosol Technology*.

## **CHE 6611. Industrial Emission Control**

3-0-3. Prerequisite: consent of the School.

Air quality criteria, ambient and emission standards, and industrial sources are analyzed. Recovery and utilization of waste gaseous and particulate matter are presented.

Text: at the level of Crawford, *Air Pollution Control Theory*.

## **CHE 6612. Atmospheric Reactions**

3-0-3. Prerequisite: consent of the School.

The principles of atmospheric chemical and photochemical reactions, including primary and derived air pollutants, sources and sinks of carbon, nitrogen, sulfur, and oxygen compounds.

Text: at the level of Seinfeld, *Air Pollution, Physical and Chemical Fundamentals*.

## **CHE 6613. Technology of Fine Particles**

3-0-3. Prerequisite: CHE 3311 or consent of the School.

An examination of the properties of finely divided materials. Size, surface, pores are treated in relation to reactivity, absorptivity, catalytic behavior, and process engineering operations.

Text: at the level of Allen, *Particle Size Measurement*.

## **CHE 6615. Transport Phenomena I**

3-0-3. Prerequisite: CHE 3311 or consent of the School.

Advanced theory and applications of momentum transport.

Text: at the level of Bird, Stewart, and Lightfoot, *Transport Phenomena*.

## **CHE 6616. Transport Phenomena II**

3-0-3. Prerequisite: CHE 6615 or consent of the School.

Advanced theory and applications of energy transport.

Text: at the level of Bird, Stewart, and Lightfoot, *Transport Phenomena*.

## **CHE 6617. Transport Phenomena III**

3-0-3. Prerequisite: CHE 6616 or consent of the School.

Advanced theory and applications of mass transport.

Text: at the level of Bird, Stewart, and Lightfoot, *Transport Phenomena*.

## **CHE 6619. Chemical Engineering Calculations I**

3-0-3. Prerequisites: CHE 3313, MATH 2508.

A study of the application of classical mathematical methods (including Laplace transforms and Bessel functions) to the solution of typical chemical engineering problems.

Text: at the level of Jensen and Jeffries, *Mathematical Methods in Chemical Engineering*, 2nd Edition.

## **CHE 6620. Chemical Engineering Calculations II**

3-0-3. Prerequisite: CHE 6619 or consent of the School.

A study of the application of modern mathematical techniques (including numerical methods and optimization procedures) to the solution of typical chemical engineering problems.

Text: at the level of Jensen and Jeffries, *Mathematical Methods in Chemical Engineering*, 2nd Edition.

**CHE 6622. Advanced Reactor Design**

3-0-3. Prerequisite: CHE 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*.

**CHE 6635. Advanced Unit Operations III**

3-0-3. Prerequisite: CHE 3313.

Vapor-liquid equilibrium and separation by distillation of binary and multicomponent mixtures. Factors influencing design and performance of fractionating equipment. Application of azeotropic and extractive distillation.

Text: at the level of Robinson and Gilliland, *Elements of Fractional Distillation*.

**CHE 6753. Surface Science and Technology Laboratory**

3-18-9. Prerequisite: consent of the 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 PHYS 6753.

**CHE 6754. Electrochemistry**

3-0-3. Prerequisite: consent of the School.

A study of electrochemical instrumentation; the thermodynamics, structure, absorption of the electrical double layer, and the kinetics of simple and complex electrode processes. Also taught as CHEM 6754.

Text: at the level of Bockris and Reddy, *Modern Electrochemistry*, Vol. 2.

**CHE 6755. Polymer Structure and Mechanical Properties**

3-0-3. Prerequisite: CHE 4751.

Fundamental aspects of the development and analysis of structure, and molecular and phenomenological models of mechanical behavior of solid-like polymers are presented. Also taught as TEX 6755.

**CHE 6756. Mechanical Properties of Polymers**

3-0-3. Prerequisite: CHE 4751.

Mechanics of deformation of anisotropic polymers; anisotropy and critical phenomena such as yield, breaking, and fatigue in the mechanical behavior of polymers; engineering applications. Also taught as TEX 6756.

**CHE 6757. Rheology of Non-Newtonian Polymer Fluids**

3-0-3. Prerequisite: CHE 4751 or consent of the School.

Linear and nonlinear models for non-Newtonian viscous and viscoelastic behavior of polymer fluids are presented. Theoretical predictions are compared with experimental response of polymer fluids. Also taught as ME 6757 and TEX 6757.

**CHE 6787. Heterogeneous Catalysis**

3-0-3. Prerequisite: CHE 6622 or consent of instructor.

Physics and chemistry of surfaces, thermodynamics, kinetics and mechanism of chemisorption and surface reactions; industrial catalysts.

Text: at the level of White, *Heterogeneous Catalysis*.

**CHE 7000. Master's Thesis**

Credit to be arranged.

**CHE 7751. Energetics**

3-0-3. Prerequisite: consent of the School.

Energetics applied to polymers and fibers using Newtonian mechanics, thermodynamics, statistical thermodynamics, and quantum mechanics to relate macroscopic and molecular descriptions of processes and materials. Also taught as TEX 7751.

**CHE 7752. Kinetics**

3-0-3. Prerequisite: consent of the School.

Kinetics applied to polymers and fibers including fluid flow, viscoelasticity, heat transfer, diffusion, electrical conductivity, rates of chemical reactions and phase changes, and irreversible thermodynamics. Also taught as TEX 7752.

**CHE 7777. Polymer Solutions and Surfaces**

3-0-3. Prerequisite: consent of the School.

Study of polymer solutions, adsorption, sorption, plasticization, average molecular weights and distributions, and interfacial phenomena using thermodynamics, statistical mechanics, information and fluctuation theories, and relaxation methods. Also taught as TEX 7777.

**CHE 7999. Preparation for Doctoral Qualifying Examinations**

Noncredit. Prerequisite: consent of the 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.

**CHE 8021-22-23. Seminar**

1-0-1. Pass/Fail only. Advanced.

Presentation of advanced research and design topics in chemical engineering.

**CHE 8069. Heterogeneous Catalysis Seminar**

1-0-1. Audit only. Prerequisite: consent of the instructor.

Presentation of advanced research and development topics relating to heterogeneous catalysis.

**CHE 8101-2-3-4-5-6. Special Topics in Chemical Engineering**

1 through 6 credits, respectively. Prerequisite: consent of the School.

Topics relevant to chemical engineering not currently covered in the graduate curriculum are presented as demand or interest warrants.

**CHE 8500. Special Problems in Chemical Engineering**  
Credit to be arranged.

Lectures, laboratory, and library work on special problems of current interest in chemical engineering.

**CHE 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**CHE 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**CHE 9000. Doctoral Thesis**

Credit to be arranged.



## School of Civil and Environmental Engineering

**Established in 1896**

**Location: Mason Building**

**Telephone: 404-894-2205**

*Interim Director and Professor*—Michael D. Meyer; *Associate Director for Graduate Programs and Associate Professor*—Kenneth M. Will; *Associate Director for Undergraduate Programs and Associate Professor*—Laurence J. Jacobs; *Associate Director for Research and Associate Professor*—Aris Georgakakos; *Regents' Professor*—George F. Sowers; *Professors*—Appiah Amirtharajah, Richard D. Barksdale, Edward S. K. Chian, G. Wayne Clough, Leroy Z. Emkin, Barry J. Goodno, James S. Lai, Roberto Leon, C. Samuel Martin, David J. McGill, Peter S. Parsonson, Philip J. W. Roberts, William M. Sangster, F. Michael Saunders, Charles E. S. Ueng, Wan-Lee Yin; *Associate Professors*—Mustafa M. Aral, Donald G. Berghaus, Hyland Y.L. Chen, J. David Frost, Lawrence F. Kahn, Roozbeh Kangari, Emir J. Macari, Paul W. Mayne, Oliver G. McGee, Spyros G. Pavlostathis, Shahrokh Rouhani, Terry W. Sturm, Jorge Vanegas, Abdul-Hamid Zureick; *Assistant Professors*—Riyad Aboutaha, Nelson C. Baker, Paul Chinowsky, Janice Daniel, Randall Guensler, John D. Leonard, James A. Mulholland, Glenn J. Rix, Christine L. Tiller, Sotira Yiaccoumi; *Senior Research Engineer*—Michael H. Swanger; *Research Engineers II*—Catherine Lee, Hamid Zand; *Research Scientists II*—Tim Dodd, Joseph P. Gould, Stacy V. Stringer; *Engineer I*—Robert S. Abernathy.

### General Information

The School of Civil and Environmental Engineering offers courses in civil engineering, environmental engineering, engineering science and mechanics, as well as engineering computer graphics and programs leading to the degrees Bachelor of Civil Engineering, Master of Science in Civil Engineering, Master of Science in Engineering Science and Mechanics, Master of Science in Environmental Engineering, Master of Science (undesignated), and Doctor of Philosophy. Also offered is a two-year program

leading to the degrees Master of Science in Civil Engineering or Master of Science (undesignated), major in transportation engineering, and Master of City Planning.

### Multidisciplinary Programs

See table on page 100.

### Bachelor of Civil Engineering

The four-year curriculum leading to the Bachelor of Civil Engineering enables the graduate to enter professional practice as an engineer or to continue his or her studies in programs leading to advanced degrees in the following broad fields of specialization: construction management, environmental engineering, environmental hydraulics, geotechnical engineering, hydrology, materials, structural and engineering mechanics, transportation, and water resources planning and management. The graduate of the B.C.E. curriculum may function in the areas of planning and design, construction, research and development, operations, and maintenance. The Bachelor of Civil Engineering degree is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. 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 listed here. Although students do not have to take the courses during the quarter indicated, they must satisfy all prerequisites for a particular course.

In addition to campuswide academic requirements for graduation with a bachelor's degree, the following are also required for the B.C.E. degree.

(a) A grade of C or better must have been earned in MATH 1507-8-9, PHYS 2121, BIOL 1720, CHEM 1101 and ESM 2201.

(b) The number of quality points earned in civil engineering courses taken toward the degree must be at least twice the number of credit hours in those courses. If a course is repeated, the latest grade will be included in applying this rule. No CE course may be repeated for the purpose of satisfying this rule if the original grade was a C or higher.

(c) Only CE 4411 and 9 hours of free electives may be taken on a pass-fail basis.

Students who complete both the bachelor's and master's degrees in the School of Civil and Environmental Engineering may use up to nine credit hours of graduate level course work (CE 6000 or higher) in the major discipline for both degrees. In order to qualify for this option, the student must complete the undergraduate degree with a cumulative grade point average of 3.5 or higher and complete the master's degree within two years after the award date of the bachelor's degree.

## Bachelor of Civil Engineering Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 1101</b>			
Inorganic Chemistry	4-3-5	.....	.....
<b>BIOL 1720</b>			
Biological Principles	.....	.....	4-3-5
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>EGR 1170</b>			
Visual Communications	2-3-3	.....	.....
<b>CS 1501</b>			
Introduction to Computing	.....	3-3-4	.....
<b>PHYS 2121</b>			
Physics	.....	.....	4-3-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	.....	3-0-3	3-0-3
<b>Health and Performance Sciences</b>			
(requirements, p. 311)	.....	3-0-3	.....
<b>TOTALS</b>	14-6-16	17-3-18	16-6-18

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>PHYS 2122</b>			
Physics	4-3-5	.....	.....
<b>PHYS 2123</b>			
Physics			
or			
<b>CHEM 1102</b>			
Inorganic Chemistry	.....	4-3-5	.....
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....

### MATH 3308

Differential Equations	.....	.....	5-0-5
<b>ESM 2201</b>			
Statics	3-0-3	.....	.....
<b>ESM 3201</b>			
Dynamics	.....	3-0-3	.....
<b>CE 2213</b>			
Mechanics of Deformable Bodies	.....	.....	3-0-3
<b>CE 2274</b>			
Spatial Data Analysis and Surveying	3-3-4	.....	.....
<b>CE 2523</b>			
Struc. Computer Programming	.....	.....	3-0-3
<b>EE 3710</b>			
Introduction to Electronic Systems	.....	.....	3-0-3
<b>EAS 2501</b>			
Geology I	.....	.....	3-0-3
<b>EAS 2102</b>			
General Geology Laboratory	.....	.....	0-3-1
<b>Humanities/Social Sciences/Modern Languages Electives</b>	.....	3-0-3	.....
<b>Free Electives</b>	.....	3-0-3	.....
<b>TOTALS</b>	15-6-17	16-3-17	17-3-18

### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ECON 2000</b>			
Economics	3-0-3	.....	.....
<b>CE 3224</b>			
Structural Analysis I	3-3-4	.....	.....
<b>CE 3533</b>			
Stochastic Methods	3-0-3	.....	.....
<b>CE 3309</b>			
Materials of Construction	.....	3-3-4	.....
<b>CE 3053</b>			
Fluid Mechanics I	3-0-3	.....	.....
<b>CE 3063</b>			
Fluid Mechanics II	.....	3-0-3	.....
<b>CE 3061</b>			
Fluid Mechanics Lab.	.....	0-3-1	.....
<b>ISYE 4725</b>			
Engineering Economy	.....	.....	3-0-3
<b>CE 4204</b>			
Metal Structural Comp. or			
<b>CE 4214</b>			
Concrete Structural Comp.	.....	.....	3-3-4
<b>EE 3741</b>			
Electronic Sys. Lab.	0-3-1	.....	.....
<b>ENGL 3020</b>			
Technical Writing	.....	3-0-3	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	.....	3-0-3

**CE 4100**

Environmental Eng. Systems	.....	4-0-4	.....
<b>CE Elective</b>	.....	.....	X-X-3
<b>Free Elective</b>	.....	.....	X-X-3
<b>TOTALS</b>	15-6-17	13-6-15	X-X-16

**Senior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CE 4164</b>			
Intro. to Geotechnical Engineering	3-3-4	.....	.....
<b>CE 4003</b>			
Construction	2-3-3	.....	.....
<b>CE 4304</b>			
Transportation Engineering I	.....	3-3-4	.....
<b>CE 4411</b>			
CE Ethics, Risk, and Responsibility	.....	.....	1-0-1
<b>CE 4404</b>			
Senior Design Project	.....	.....	3-3-4
<b>Humanities/Social Sciences/Modern Languages</b>			
<b>Electives</b>	3-0-3	3-0-3	6-0-6
<b>Elective</b>	X-X-3	X-X-3	X-X-3
<b>Elective</b>	X-X-3	X-X-3	X-X-3
<b>Free Elective</b>	.....	X-X-3	.....
<b>TOTALS</b>	X-X-16	X-X-16	X-X-17

**Total Credit Hours Required for Graduation = 201**

**Electives**
**Humanities/Social Sciences/Modern Languages Electives**

Eighteen credit hours of humanities and 18 credit hours of social sciences are required. See p. 33 for a list of acceptable courses.

The courses selected to fulfill the humanities and social sciences requirements must provide both breadth and depth and not be limited to a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one of each. Students should see their academic adviser for course sequences that satisfy the depth requirement.

All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement. All Humanities/Social Sciences/Modern Languages electives must be taken on a letter-grade basis.

**Free Electives**

These free elective courses may be taken at any time during a student's course of study. Physical education courses may not be used to satisfy this requirement, except for HPS 3100, which may be used as a free elective.

**Electives**

Twenty-one hours of technical electives are required from 4000-level CE courses. To fulfill this requirement, students may choose one of five suggested optional tracks:

**1. Structural Systems**
**CE 3214**

Mechanics of Deformable Bodies II  
(4)

**CE 3232**

Structural Timber Design  
(2)

**CE 4173**

Foundation Engineering  
(3)

**CE 4204 or CE 4214**

Metal Structural Components or Concrete Structural Components  
(4)

**CE 4213**

Structural Analysis II  
(3)

**CE 4223**

Structural Design  
(3)

**CE 4232**

Structural Masonry Design  
(2)

**TOTAL: 21 hours**

**2. Environmental Systems**
**CE 4110**

Water Quality Engineering  
(3)

**CE 4120**

Hazardous Substance Engineering  
(3)

**CE 4130**

Environmental Engineering Facilities Design  
(3)

**CE 4353**



Hydrology

(3)

**CE 4383 or CE 4060**

Groundwater Hydrology or Environmental  
Hydraulics

(3)

**CE 4363 or CE 4053**

Applied Hydrology or Applied Hydraulics

(3)

**CE 4183 or CE 4193**

Introduction to Environmental Geotechnics or  
Hazardous Waste Site Assessment

(3)

TOTAL: 21 hours

### 3. Infrastructure Systems

**CE 4313**

Transportation Engineering II

(3)

**CE 4323**

Computer-aided Site Engineering and Road Design

(3)

**CE 4353**

Hydrology

(3)

**CE 4013**

Design of Construction Operations

(3)

**CE 4138**

Environmental Monitoring and Impact Assessment

(3)

**CE 4110**

Water Quality Engineering

(3)

**CE 4153**

Nondestructive Testing and Evaluation of  
Infrastructure

(3)

TOTAL: 21 hours

### 4. Construction

**CE 4013**

Design of Construction Operations

(3)

**CE 4023**

Design and Construction of Building Systems

(3)

**CE 4033**

Construction Equipment and Methods

(3)

**CE 4043**

Basic Planning and Estimating Methods

(3)

**CE 4073**

Computer Applications in Construction

(3)

**CE 4083**

Advanced Planning and Estimating Methods

(3)

**CE 4173**

Foundation Engineering

(3)

TOTAL: 21 hours

### 5. General Civil Engineering

**CE 3232 or CE 4232**

Structural Timber Design or

Structural Masonry Design

(2)

**CE 4173**

Foundation Engineering

(3)

**CE 4204 or CE 4214**

Metal Structural Components or

Concrete Structural Components

(4)

**CE 4110**

Water Quality Engineering

(3)

**CE 4353**

Hydrology

(3)

**CE 4313**

Transportation Engineering II

(3)

**CE 4013**

Design of Construction Operations

(3)

TOTAL: 21 hours

Alternatively, a student may plan and pursue a special program of 21 hours of 3000- and 4000-level elective courses in civil engineering. Such a

program must be developed under the supervision of the academic adviser and have the approval of the School of Civil and Environmental Engineering. It must contain at least nine hours of engineering design credits.

## **Master of Science**

Three master's degrees are available within the civil engineering program: Master of Science in Civil Engineering, Master of Science in Environmental Engineering, and the undesignated Master of Science. Common requirements for these degrees, in addition to those specified in the section "Information for Graduate Students," are listed below.

1. A minimum of 50 hours of course work, none of which was used to satisfy requirements for a previous degree, is required with the approval of the student's adviser and the director (see exceptions below).
2. Up to 15 of the 50 hours can be in 3000- or 4000-level courses. Courses required for the B.C.E. degree cannot be used to satisfy this requirement; other 3000- or 4000-level courses may be used with the approval of the adviser and director (see exceptions below).
3. Up to six of the 50 hours may be taken on a pass/fail basis with the approval of the adviser and director.
4. Each M.S. student must either (a) complete 50 hours of course work or (b) write an M.S. thesis and schedule at least 17 hours of CE 7000. No more than 17 hours of CE 7000 may count 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 not writing a thesis must take at least 27 hours of course work in their major field.

Only those students who have previously earned the B.C.E. or its equivalent may receive the Master of Science in Civil Engineering. The School awards the Master of Science in Environmental Engineering only to those students who have previously earned the B.C.E. 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. Students who do not meet the above requirements but satisfy all prerequisites for the courses in their M.S. program receive the undesignated Master of Science degree.

A wide range of M.S. programs is available in fields such as construction management, environmental engineering, fluid mechanics, geotechnical engineering, hydraulics, hydrology, soil mechanics, materials, structures, transportation, and water resources planning and management. The School encourages latitude in the selection of courses in an M.S. program provided the resulting program leads to a definable goal.

The degree Master of Science in Environmental Engineering (MSEnE) is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. Programs of study are available in water quality and treatment, wastewater reclamation and disposal, solid and hazardous waste management, air quality and pollution control, groundwater management, water resources management, and environmental sciences. The undesignated Master of Science is available for nonengineering students who have completed two years of calculus through differential equations, and courses in fluid mechanics. Holders of this degree may not be licensed as professional engineers unless they have an ABET accredited bachelor's degree in engineering.

Students who complete both the bachelor's and master's degrees in the School of Civil and Environmental Engineering may use up to nine credit hours of graduate-level course work (6000 or higher level courses) in the major discipline for both degrees. In order to qualify for this option, the student must complete the undergraduate degree with a cumulative grade point average of 3.5 or higher and complete the master's degree within two years after the award date of the bachelor's degree.

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

Noncitizens seeking admission to graduate study are required to submit a minimum TOEFL score of

550 or to have been in residence at a United States university for a full academic year.

## Doctor of Philosophy

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

## Program in Engineering Science and Mechanics

Established in 1959, the engineering science and mechanics (ESM) program consists of graduate programs leading to the degrees Master of Science, Master of Science in Engineering Science and Mechanics, and Doctor of Philosophy.

Graduate study and research in engineering science and mechanics include work in modern continuum mechanics, stress analysis, stability, structures, dynamics, vibrations, space mechanics, fracture mechanics, finite element methods and other computational techniques, fluid mechanics, biomechanics, acoustics, wave propagation, applied stochastic processes, optimization techniques, materials science, and experimental stress analysis. The ESM graduate student will also find a great number of related courses in the other schools of the Institute. The program encourages flexibility and interdisciplinary interests in the planning of individual programs of study.

## Graduate Degrees in Engineering Science and Mechanics

### Master of Science

The requirements for the master's degree are (1) a B.S. in engineering or the physical sciences, and (2) either a minimum of 30 credit hours plus a master's thesis (15 hours credit for thesis) or a

minimum of 45 hours including a six-hour master's report. In either case, nine hours of mathematics are required. All students must have credit for the following prerequisite courses or their equivalents: Dynamics (ESM 3201), Mechanics of Deformable Bodies (ESM 3301), and Fluid Mechanics (ESM 3501).

## Doctor of Philosophy

A Ph.D. student will normally complete at least 84 hours of graduate work including credit for the M.S. thesis or report. The program of study must include a minimum of six graduate credit hours in each of the following three areas: solid mechanics; fluid mechanics; and dynamics and vibrations.

The student must successfully pass the qualifying examination, comprehensive examination, and thesis defense examination.

## Multidisciplinary Certificate Programs

See table on page 100.

## Courses of Instruction

### CIVIL ENGINEERING

#### CE 1600. Microcomputers in Civil Engineering 3-0-3.

Introduction to use of personal computers in civil engineering. Operating systems, word processing, spreadsheets, equation solvers, graphics, communications, and networking. Some BASIC programming.

#### CE 2213. Mechanics of Deformable Bodies I 3-0-3. Prerequisites: ESM 2201, MATH 2508.

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.

#### CE 2274. Spatial Data Analysis 3-3-4. Prerequisite: EGR 1170.

Application of modern plane surveying techniques and advanced technologies in the collection and analysis of spatial data.

#### CE 2523. Structured Computer Programming for Engineers 2-3-3. Prerequisites: CS 1501, MATH 2507.

Developing analytical problem solving skills and implementing these techniques via computer programs in a civil engineering setting.

#### CE 3053. Fluid Mechanics I 3-0-3. Prerequisite: ESM 3201.

Elementary mechanics of fluids with emphasis on analysis,

fluid kinematics, equations of motion, momentum and energy principles, surface and form resistance.

**CE 3061. Fluid Mechanics Laboratory**

0-3-1. Prerequisite: CE 3063.

Experiment, demonstration, and analysis of basic fluid phenomena and exercises in laboratory techniques.

**CE 3063. Fluid Mechanics II**

3-0-3. Prerequisite: CE 3053.

Elementary mechanics of fluids with emphasis on engineering applications. Similitude and hydraulic models, flow in open channels and closed conduits, fluids machinery, environmental hydraulics.

**CE 3214. Mechanics of Deformable Bodies II**

4-0-4. Prerequisites: CE 2213.

Beam deflections, torsion, unsymmetrical bending, shear centers for beams, introduction to energy methods and failure theories.

**CE 3224. Structural Analysis I**

3-3-4. Prerequisite: ESM 2213.

Determination of internal forces and deflections in statically determinate trusses, beams, and frames. Introduction to analysis of statically indeterminate structures and to formulation of influence lines.

**CE 3232. Structural Timber Design**

2-0-2. Prerequisite: CE 2213; corequisite: CE 3224.

A structural design course, introducing concepts of load paths for vertical/horizontal forces in structural systems, and stress-based design of tension, compression and flexural members.

**CE 3309. Materials of Construction**

3-3-4. Prerequisites: CE 2213, EAS 2501, 2102.

Basic principles of the properties of materials. Physical, chemical, and mechanical properties of metals, concrete, timber, masonry, and asphalt. The laboratory period is for tests, demonstrations, and writing reports.

**CE 3533. Stochastic Methods and Applications in Civil Engineering**

3-0-3. Prerequisite: MATH 2508.

Identification and modeling of nondeterministic problems in civil engineering and treatment thereof relative to engineering design and decision making. Probability and simulation models in the various areas of civil engineering.

**CE 4003. Construction**

2-3-3. Prerequisite: ISYE 4725.

The construction industry, contracts, and forms of construction company organization. Financing, equipment, manpower, and materials. Time and cost control methods are introduced.

**CE 4013. Design of Construction Operations**

3-0-3. Prerequisite: junior standing.

Modeling and analysis of construction operations at the job site level. Productivity calculations and allocation of construction resources.

**CE 4023. Design and Construction of Building Systems**

3-0-3.

Technical and management aspects of planning, design, and

construction of facilities with special emphasis on the basic design criteria, system components, and constructibility issues of the principal building systems.

**CE 4033. Construction Equipment and Methods**

3-0-3.

Overview of construction equipment and methods in heavy and building construction, with emphasis on earthwork and excavation, concrete, wood, steel, and masonry.

**CE 4043. Basic Planning and Estimating Methods**

3-0-3.

Principal methods, tools, and techniques used to develop building construction project estimates, with primary emphasis on estimate planning and organization, quantity takeoffs, and pricing.

**CE 4053. Applied Hydraulics**

3-0-3. Prerequisites: CE 3063, 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.

**CE 4060. Environmental Hydraulics**

3-0-3. Prerequisite: CE 3061.

Fluid mechanical aspects of the water environment as applied to lakes, rivers, estuaries, and coastal zones. Mechanisms of transport processes and flushing. Practical engineering applications.

**CE 4063. Introduction to Environmental Fluid Mechanics**

3-0-3. Prerequisite: CE 3063.

Introduction to fluid mechanical aspects of the water environment as applied to lakes, rivers, estuaries, and coastal zones. Mechanisms of transport processes and flushing. Practical engineering applications.

**CE 4073. Computer Applications in Construction**

3-0-3.

Overview of computer technology and construction engineering, management, and administration computer applications. Examination of application planning, development and management issues, and selected application development tools.

**CE 4083. Advanced Planning and Estimating Concepts**

3-0-3. Prerequisite: CE 4043.

Overview of advanced quantitative concepts in estimating construction projects, with an emphasis on the use of computers and numerical methods.

**CE 4100. Environmental Engineering Systems**

4-0-4. Prerequisites: MATH 2508, CHEM 1101, BIOL 1720.

An introduction to the field of environmental engineering issues associated with water, air, and land pollution. In addition to air and water quality issues, current topics such as hazardous wastes, risk assessment, groundwater contamination, global climate change, ozone depletion, acid deposition, and sustainable technologies are included.

**CE 4110. Water Quality Engineering**

3-0-3. Prerequisite: CE 4100; corequisite: 3063.

Introduction to reclamation of water and wastewater for potable and industrial uses, groundwater remediation. Principles of physical, chemical, and biological treatment

processes such as coagulation, sedimentation, softening, filtration, secondary biological treatment, and reactor design.

**CE 4120. Hazardous Substance Engineering**

3-0-3. Prerequisite: CE 4100; corequisite: CE 3063.

A senior-level course providing an introduction to the technical aspects of hazardous waste and toxic substance management. Topics include: legislation; exposure and risk assessment; procedures for conducting remedial investigation/feasibility studies; waste treatment methods; basics of solute transport; on-site treatment methods; landfill design; waste minimization, recycling, and reuse.

**CE 4130. Environmental Engineering Facilities Design**

2-3-3. Prerequisite: CE 4110. Fall quarter.

Design of water, wastewater, hazardous and solid waste, or air quality facilities. Supervised design problems and inspection trips.

**CE 4133. Engineering Aspects of Environmental Health**

3-0-3. Prerequisite: CE 4100.

Environmental engineering in public health administration and control of environmental health problems.

**CE 4138. Environmental Monitoring and Impact Assessment**

3-0-3. Prerequisite: consent of the instructor.

An introduction to techniques of monitoring and assessing the impacts of engineering systems on environmental quality.

**CE 4142. Environmental Microbiology Laboratory**

1-3-2. Corequisite: CE 4148.

Basic laboratory exercises and discussions for the understanding of fundamental and applied microbiological principles in environmental engineering.

**CE 4145. Civilization, Society, and the Environment**

3-0-3.

On population, resources, wastes, and health as related to development of science and technology.

**CE 4148. Application of Microbiology in Environmental Engineering**

3-0-3.

Introduction to fundamental and applied microbiological principles in environmental engineering, with emphasis on microbial growth and metabolism in biological processes.

**CE 4153. Nondestructive Testing and Evaluation of Infrastructure**

2-3-3. Prerequisite: CE 2213.

Introduction to the use of nondestructive testing methods to evaluate the condition of civil engineering infrastructure.

**CE 4164. Introduction to Geotechnical Engineering**

3-3-4. Prerequisites: CE 3309, EAS 2501, EAS 2102.

Introduction to principles of soil mechanics. Discussion and experimental exercises ranging from basic identification tests to advanced procedures for determining permeability, consolidation, and strength characteristics.

**CE 4173. Foundation Engineering**

3-0-3. Prerequisite: CE 4164.

Application of soil mechanics principles in the design of foundation systems, including shallow and deep foundations, natural and man-made slopes and retaining structures.

**CE 4183. Introduction to Environmental Geotechnics**

3-0-3. Prerequisite: CE 4164.

Environmental geotechnics problems and solutions in waste management. Design of containment systems, hydraulic conductivity of liners, use of geosynthetics, risk analysis.

**CE 4193. Hazardous Waste Site Assessment**

2-3-3. Prerequisite: CE 4164.

Design of hazardous waste site assessment programs. Operation and interpretation of devices for assessing type and extent of contamination in air, soil, and water.

**CE 4204. Metal Structural Components**

3-3-4. Prerequisites: CE 3309, 3224.

Principles of behavior of tension and compression members, beams, and connections with application to the design of elementary structures.

**CE 4213. Structural Analysis II**

3-0-3. Prerequisite: CE 3224.

Advanced statically indeterminate structural analysis using classical techniques. Emphasis is on flexibility techniques, approximate analysis, influence lines, large deflection nonlinear analysis, and moment distribution. Introduction to matrix formulation.

**CE 4214. Concrete Structural Components**

3-3-4. Prerequisites: CE 3309, 3224.

Principles of behavior of reinforced concrete beams, columns, and slabs, with application to the design of elementary structures.

**CE 4223. Structural Design**

2-3-3. Prerequisites: CE 4204, 4214, 4164.

Design of structures in metal and concrete with emphasis on buildings and bridges.

**CE 4232. Structural Masonry Design**

2-0-2. Prerequisite: CE 4214.

An introduction to structural design of building systems, unreinforced and reinforced walls, using masonry construction materials and techniques.

**CE 4233. Design in Timber and Prestressed Concrete**

2-3-3. Corequisite: CE 4214.

Principles of behavior of timber and of prestressed concrete structural members, application to the design of elementary structures.

**CE 4304. Transportation Engineering I**

3-3-4. Prerequisite: CE 3309.

Planning, design, and construction of streets and highways. Computer-oriented laboratory problem acquaints student with modern highway design techniques and criteria.

**CE 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.

**CE 4323. Computer-aided Site Engineering and Road Design**

3-0-3. Prerequisites: CS 1501, CE 2274. Corequisite: CE 4304.

Use of personal computers in the design and layout of project sites, highways, and intersections. Coordinate geometry, auto-contouring, and earthwork calculations. Use of mouse, digitizer, and plotter.

**CE 4353. Hydrology**

3-0-3. Prerequisite: CE 3063.

Occurrence and movement of water of the earth, hydrologic measurements, elementary meteorology, precipitation, evapotranspiration and runoff, groundwater, frequency analysis.

**CE 4363. Applied Hydrology**

3-0-3. Prerequisites: CE 3063, 4353.

Applications of hydrology in the design of hydraulic structures for water supply, irrigation, power, drainage, and flood control facilities.

**CE 4373. Water Resources Development**

2-2-3. Prerequisite: CE 4353.

Comprehensive planning for water resources management, identification of needs, problems and issues, alternative creative solutions, economic and financial evaluation, institutional settings, and public participation.

**CE 4383. Groundwater Hydrology**

3-0-3. Prerequisites: CE 4353, EAS 2501.

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.

**CE 4411. Civil Engineering Ethics, Risk, and Responsibility**

1-0-1.

Investigate professional ethics and responsibilities of civil engineers through case studies, construction laws, forensic engineering, and quality management. Review consequences of failure and sustainable technologies.

**CE 4404. Senior Design Project**

3-3-4. Prerequisites: to be announced by instructor.

An interdisciplinary civil engineering design experience. Preparation of proposals, data acquisition, and analysis. Evaluation of alternatives. Preliminary and final design; presentation of project results.

**CE 4791-2-3-4. Composites**

See ESM 4791-2-3-4.

**CE 4801-2-3-4-5-6. Special Topics**

Credit hours equal last digit of course number.

**CE 4811-4823. Special Topics**

Credit hours equal last digit of course number.

**CE 4900. Special Problems.**

Credit hours to be arranged.

**CE 6003. Construction Administration**

2-3-3. Fall quarter.

Management tools used to carry out administrative aspects of construction project management. Estimating and bid control. Quantity takeoff procedures, cost accounting, insurance, bonding, finance, and safety.

**CE 6013. Civil Engineering Management I**

2-3-3. Corequisite: ISYE 6739. Winter quarter.

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.

**CE 6023. Civil Engineering Management II**

2-3-3. Prerequisite: CE 6013. Corequisite: ISYE 6734.

Spring quarter.

Continuation of CE 6013. Additional topics include linear and dynamic programming, queueing models and simulation as applied to construction project management.

**CE 6033. Construction Risk Analysis**

3-0-3. Fall quarter.

Formulation and evaluation of major uncertainty factors in a complex construction project. Modeling competitive construction bidding and risk sharing. Methods of information processing and decision making.

**CE 6043. Construction Economics**

3-0-3.

Major economic problems of the construction industry. Technical-economic relations between products and inputs. Time trends of productivity in construction. Economic analysis of construction equipment.

**CE 6051. Intermediate Fluid Mechanics I**

3-0-3. Prerequisite: CE 3063. Fall quarter.

Basic analytical techniques of fluid mechanics; kinematics and dynamics of fluid flows; conservation of mass, momentum, and energy; Bernoulli and Navier-Stokes equations; potential flow.

**CE 6052. Intermediate Fluid Mechanics II**

3-3-4. Prerequisite: CE 6051. Winter quarter.

Low Reynolds number flow. Turbulent flow. Laminar and turbulent boundary layers, boundary layer controls. Lift and drag, cavitation.

**CE 6054. Engineering Hydrodynamics**

3-0-3. Prerequisites: CE 6051, MATH 4320. Fall quarter.

Irrotational flow, potential and stream functions, principles of continuity, energy, and momentum. Hydrodynamic singularities, conformal transformations, discontinuous flows, and free-stream-line solutions. Analytic and approximate methods.

**CE 6061. Environmental Fluid Mechanics I**

3-0-3. Prerequisite: CE 3063. Spring quarter.

Basic analytical techniques for predicting pollutant transport in various hydrologic situations. Diffusion in laminar and turbulent flows and shear flows. Mechanics of jets and plumes.

**CE 6062. Environmental Fluid Mechanics II**

2-3-3. Prerequisite: CE 6061. Summer quarter.

Practical application of basic principles to engineering situations. Mixing in rivers, lakes, reservoirs, estuaries; the use of numerical and physical models.

**CE 6071. Flow Through Porous Media I**

3-0-3. Prerequisite: CE 6051 or consent of the instructor. Winter quarter.

Darcy's Law and fundamental equations of groundwater flow. Mathematical models and analytical solutions to elementary groundwater flow problems. Mechanics of dispersion diffusion in groundwater flow. Fundamentals of saturated and unsaturated flow.

**CE 6072. Flow Through Porous Media II**

3-0-3. Prerequisite: CE 6071. Spring quarter.

Multiphase flow. Salt water intrusion problems. Groundwater management. Approximate methods of solution. Finite element and boundary element solution of groundwater flow problems.

**CE 6081. Flow in Open Channels I**

2-3-3. Prerequisites: CE 3063, 3061. Fall quarter.

Flow of liquids with free surfaces in natural and artificial channels. Application of energy and momentum principles, analysis of flow resistance, computation of gradually varied flow profiles.

**CE 6082. Flow in Open Channels II**

2-3-3. Prerequisites: CE 3063, 3061. Winter quarter.

Flow of liquids through open channel transitions and controls including weirs, free overfalls, spillways, expansions, contractions, and culverts. Analysis of steady, spatially varied flow and treatment of unsteady flow in open channels.

**CE 6084. Transient Flow in Enclosed Conduits**

2-3-3. Prerequisite: CE 3063. Spring quarter.

Unsteady flow of compressible and incompressible fluids in conduits, pressure wave propagation, one-dimensional wave equations, method of characteristics, pulsating flow, water hammer, hydraulic machinery, column separation.

**CE 6086. Sediment Transport**

3-0-3. Prerequisite: CE 3063. Spring quarter.

Sediment properties, initiation of sediment motion by flowing water, suspended sediment discharge, bed load discharge, bed form mechanics, hydraulic resistance to flow. Reservoir sedimentation.

**CE 6091. Coastal Engineering**

3-0-3. Prerequisite: CE 6051. Winter quarter.

Application of hydrodynamic principles to coastal zones: mechanics of wave motion, wave refraction, diffraction and reflection, equilibrium theory of tides, harbor resonance, harmonic analysis of waves and tides.

**CE 6102. Physical Principles in Environmental Engineering**

4-0-4. Prerequisite: consent of the instructor. Fall quarter.

Analysis of the physical principles of water quality control, such as sedimentation, flocculation, filtration, inertial separation, gas transfer, and principles of reactor design.

**CE 6103. Aquatic Chemistry**

3-0-3. Prerequisite: CE 6136. Winter quarter.

Formation behavior, degradation, fate, and modeling of significant organic compounds in aquatic systems. Advanced methods for representing and analyzing inorganic equilibrium chemistry of aquatic systems.

**CE 6105. Application of Instrumental Analysis in Environmental Engineering**

2-3-3. Prerequisites: CE 6136, 6137. Spring quarter.

Theory, design, sensitivity, and limitations of environmental analytical instruments. Spectrometric, electrochemical, and chromatographic methods of analysis of solid and hazardous wastes, waters, and wastewaters.

**CE 6109. Environmental Engineering Design I**

3-3-3. Prerequisite: consent of the instructor. Spring quarter.

Theory and design of structures for capture, purification, conditioning, and distribution of public water supplies.

**CE 6115. Hazardous Waste Management**

2-3-3. Prerequisite: consent of the instructor. Fall quarter.

Introduction to hazardous waste management with special emphasis on identification of sources, characteristics, transportation requirements, and treatment and disposal methods.

**CE 6116. Environmental Engineering Processes Laboratory**

1-6-3. Prerequisites: CE 6140, 6141, and 6142. Summer quarter.

Laboratory evaluation of various physical-chemical and biological processes that form the basis of many water quality control operations, including coagulation, thickening, adsorption, gas transfer, membrane separations, filtration, dewatering, and biological oxidation.

**CE 6118. Solid Waste Technology I**

2-3-3. Prerequisite: consent of the instructor. Winter quarter.

An introduction of the fundamentals of solid waste characterization, handling and disposal systems, physical and chemical methods of solid waste analysis.

**CE 6119. Environmental Engineering Design II**

3-3-4. Prerequisites: CE 6140, 6141. Spring quarter.

Theory and design of physicochemical and biological systems for treatment, disposal, and reuse of municipal and industrial waste waters.

**CE 6120. Treatment and Disposal of Residues**

3-0-3. Corequisites: CE 6140, 6141. Winter quarter.

Characterization, stabilization, conditioning, thickening, dewatering, conversion, recovery, transportation, and disposal of air, water, and wastewater treatment residues.

**CE 6125. Industrial Waste Treatment and Disposal**

3-0-3. Prerequisite: consent of the instructor. Spring quarter.

Evaluation of industrial waste problems, characteristics of wastes produced from industry, and application of engineering principles and processes for waste treatment, recovery, and disposal.

**CE 6126. Introduction to Air Pollution**

3-0-3. Winter quarter.

Sources of primary and secondary air pollution. Application of thermodynamics and kinetics to production of air pollutants from combustion processes and atmospheric photochemical reactions. Dispersion and control.

**CE 6127. Analysis of Air Pollutants**

2-3-3. Winter quarter.

Principles of air sampling and sampling trains. Techniques of sampling inorganic gases and aerosols. Evaluation of data.

**CE 6128. Solid Waste Technology II**

2-3-3. Prerequisite: CE 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.

**CE 6130. Environmental Processes in Surface Water Systems**

3-0-3. Prerequisite: CE 4120. Winter quarter.

Analysis of chemical, physical, and biological processes occurring in natural water systems such as streams, lakes, and estuaries.

**CE 6136. Applications of Chemistry in Environmental Engineering**

3-0-3. Prerequisite: consent of the instructor. Fall quarter.

Kinetic and equilibrium relationships controlling the chemical behavior of the aquatic environment. Distribution and behavior of chemical species in dilute aqueous systems.

**CE 6137. Fundamentals of Chemical Analysis in Environmental Engineering**

1-3-2. Corequisite: CE 6136. Fall quarter.

Basics of wet chemical analysis of aqueous samples. Titrametric and spectrometric techniques of importance in sanitary and environmental engineering as well as general laboratory methods.

**CE 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.

**CE 6140. Environmental Engineering Processes I**

4-0-4. Prerequisites: CE 3063, 4120, 6102, and 6136. Winter quarter.

Theory and application of the physical and chemical processes of coagulation, flocculation, sedimentation, and filtration in water and wastewater treatment.

**CE 6141. Environmental Engineering Processes II**

4-0-4. Prerequisites: CE 4120, 4148, 6102, and 6136. Winter quarter.

Theory, modeling, and application of biological processes employed in water and wastewater treatment systems. Biological growth kinetics, nutrient removal, biological reactor configurations including activated sludge, packed towers, and lagoons.

**CE 6142. Environmental Engineering Processes III**

3-0-3. Prerequisite: CE 6102. Spring quarter.

Advanced treatment processes in environmental

engineering, including membrane separation, adsorption, ion exchange, and gas stripping.

**CE 6146. Field Methods in Environmental Engineering**  
0-15-5. Summer quarter.

Organization and conduct of water quality surveys and field studies for natural waters.

**CE 6148. Advanced Microbiology of Water and Wastes**

2-3-3. Prerequisites: CE 4148, 6103, 6141. Spring quarter.

Biodegradation and biotransformation of natural and man-made organic compounds and biological, biochemical, and environmental factors affecting these transformations. Physiology of environmentally important bacteria; nitrifying and denitrifying bacteria; hydrogen-, sulfur-, and iron-oxidizing bacteria; sulfate-reducing bacteria; and fermentative bacteria.

**CE 6150. Engineering Properties of Soils**

3-0-3. Prerequisites: CE 4164 or equivalent. Fall quarter.

Shear strength, failure criteria, total and effective stresses, and stress paths. Strength and deformation properties of sands and clays. Analysis of total settlement and time rate of settlement using analytical and numerical solutions.

**CE 6151. Laboratory Testing of Soils I**

2-3-3. Prerequisites: CE 4164 or equivalent. Fall quarter.

Theory and practice of geotechnical laboratory tests. Index, compaction, and permeability tests. Test instrumentation, procedure effects, data presentation, analysis, and interpretation.

**CE 6152. Geosynthetics in Civil Engineering**

3-0-3. Prerequisites: CE 4173 or equivalent. Fall quarter.

Use of geotextiles, geogrids, geonets, and geomembranes for applications requiring separation, reinforcement, stabilization, filtration, and drainage of natural materials. Geosynthetics properties and testing.

**CE 6158. Soil and Rock Formations**

2-0-2. Prerequisites: CE 4164 or equivalent. Fall quarter.

Geologic dynamics, water deposited soils, aeolian deposits, glacial deposits, volcanic formations, tropical soils, waste fills, igneous, metamorphic, and sedimentary rocks.

**CE 6159. Rock Mechanics**

3-3-4. Prerequisite: CE 4164. Fall quarter.

Geomorphology, rock mineralogy, and rock types and formations. Properties of intact rock and rock foundations and tunnels in rock.

**CE 6160. Constitutive Modelling of Soils**

3-0-3. Prerequisites: CE 6150 or equivalent. Winter quarter.

Stress-strain behavior of soils in terms of elastic, plastic, elasto-plastic, and incremental plasticity models. Concepts of yield surfaces, stress space, failure criteria, plastic potential, normality, and anisotropy. Applications of upper and lower bound limit plasticity, cavity expansion, and limit equilibrium methods.

**CE 6161. Laboratory Testing of Soils II**

2-3-3. Prerequisites: CE 6151 or equivalent. Winter quarter.

Theory and practice of geotechnical laboratory tests. Consolidation and strength tests. Test instrumentation, procedure effects, data presentation, analysis, and interpretation.



**CE 6162. In Situ Testing and Site Characterization**

3-0-3. Prerequisites: CE 6150 and CE 6151 or equivalents.  
Winter quarter

Applications of in situ testing for determination of soil properties and site characterization. Test procedures and interpretive methods for standard penetration tests, cone penetration tests, piezocone, dilatometer, vane shear, and pressuremeter tests.

**CE 6165. Soil Dynamics**

3-0-3. Prerequisite: CE 4164 or equivalent. Winter quarter.

Vibrations of single and multiple degree of freedom systems. Vibrations of foundations. One dimensional wave propagation theory with applications to resonant column tests, dynamic pile capacity analyses, and nondestructive integrity tests. Propagation of elastic waves in layered media including in situ seismic methods.

**CE 6170. Computational Soil Elasto-Plasticity**

3-0-3. Prerequisite: CE 6160 or equivalent. Fall quarter.

Development of finite element based elasto-plastic formulations. Prediction of soil response. Evaluation of integration schemes.

**CE 6175. Geotechnical Earthquake Engineering**

3-0-3. Prerequisite: CE 4164 or equivalent. Spring quarter.

Response of soils to dynamic earthquake loading. Earthquake source mechanisms and attenuation of strong ground motion. Dynamic soil properties, site amplification, and soil-structure interaction. Laboratory and in situ tests to evaluate liquefaction susceptibility.

**CE 6176. Hazardous Waste Site Assessment**

2-3-3. Prerequisite: CE 4164 or equivalent. Spring quarter.

Regulations and safety issues. Site characterization using intrusive and non-intrusive measurements. Air quality monitoring. Environmental drilling. Groundwater sampling.

**CE 6177. Foundation Systems**

3-0-3. Prerequisites: CE 4173 and CE 6150 or equivalents.  
Spring quarter.

Analysis and design of shallow and deep foundations. Bearing capacity, stress distribution, settlement, and angular distortion of shallow foundations. Pile dynamics, group effects, and wave equation analyses.

**CE 6178. Landfills and Embankments**

3-0-3. Prerequisite: 6150 or equivalent. Winter quarter.

Design of landfills and embankments. Compaction control. Short- and long-term behavior. Waste containment systems. Hydraulic conductivity of clay liners. Dynamic analysis of embankments.

**CE 6179. Earth Retaining Structures**

3-0-3. Prerequisites: CE 4173 and CE 6150 or equivalent.  
Spring quarter.

Earth pressure theory and retaining wall design. Design and construction of anchored bulkheads, reinforced soil, excavation bracing. Soil nailing and slurry walls.

**CE 6184. Soil Stabilization and Site Improvement**

3-0-3. Prerequisite: CE 6150 or equivalent. Winter quarter.

Mechanical, chemical, and reinforcing methods for improving the engineering properties of soils. Grouting, vibroflotation, dynamic compaction, blasting, vitrification, and vertical drains.

**CE 6203. Structural Planning**

3-0-3. Prerequisite: CE 3224.

Introduction to planning aspects of structural design, economic proportions, erection procedures, comparison of determinate and indeterminate structures, stress control, normal and hybrid behavior.

**CE 6204. Reinforced Concrete Structures I**

4-0-4. Prerequisite: CE 4214. Winter quarter.

Advanced behavior and design of reinforced concrete members: ductility and inelastic response; deep beams, corbel and torsion design; column slenderness and biaxial bending; shearwalls; moment redistribution; and serviceability considerations including effects of creep and shrinkage.

**CE 6209. Reinforced Concrete Structures II**

4-0-4. Prerequisite: CE 4214. Spring quarter.

Principles and practice of prestressed concrete. Analysis and design of statically determinate and indeterminate beams, and one-way and two-way slabs; precast pretensioned, post-tensioned, and segmental systems; service load, ultimate strength, and load balance techniques. Application to both buildings and bridges.

**CE 6213. Experimental Analysis I**

3-0-3.

Data acquisition from models. Stress analysis through strain measurements. Transducers, their circuitry and related indicating and recording equipment. Motion measurement, equivalent circuits.

**CE 6219. Matrix Methods of Structural Dynamics**

4-0-4. Prerequisites: CE 6229, 6248. Spring quarter.

Linear and nonlinear dynamic matrix analysis of multidegree-of-freedom structural systems. Substructuring techniques. Analysis and design for wind and earthquake. Computer programming.

**CE 6229. Principles of Matrix Structural Analysis**

4-0-4. Prerequisite: CE 3224. Winter quarter.

Matrix formulation of the governing equations of framed structures, linear elastic behavior, physical and geometrical nonlinearities, force and displacement methods, nonlinear analysis.

**CE 6234. Advanced Structural Mechanics**

4-0-4. Prerequisite: MATH 2508. Fall 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.

**CE 6238. Finite Element Method of Structural Analysis**

3-0-3. Prerequisite: CE 6229. Winter quarter.

Introduction to finite element method, matrix formulation. Plates in plane stress, plane strain, and bending. Three-dimensional solids and shells. Static and dynamic, linear and nonlinear analysis.

**CE 6239. Advanced Structural Steel Design**

4-0-4. Spring quarter.

Strength, behavior, and design of steel structures according to working stress and load and resistance factor design. Plate grinders, composite steel-concrete beams, bolted and welded connections, beam-columns, and members under torsion.

**CE 6244. Plastic Design in Steel**

4-0-4. Prerequisite: CE 4204.

Analysis and design procedures based on ultimate load capacity are applied to steel beams, frames, and their connections.

**CE 6248. Structural Dynamics**

3-0-3. Prerequisite: consent of the School. Fall quarter.

Vibration and dynamic response of simple linear and nonlinear structures to periodic and general disturbing forces. Response analysis of multidegree-of-freedom systems. Wind and earthquake effects.

**CE 6249. Reinforced Concrete Structures III**

4-0-4. Prerequisites: CE 6204, 6209. Summer quarter.

Analysis and design of two-way slab systems, structural walls, and complex building configurations. Equivalent frame analysis, strip and yield-line technique, application of finite element method to design of slab systems.

**CE 6250. Earthquake Engineering**

3-0-3. Prerequisite: CE 6248. Summer quarter.

Analysis and design of civil engineering structures for earthquake resistance; building code requirements; case studies.

**CE 6303. Pavement Design**

3-0-3. Prerequisites: CE 3309 or equivalent. Spring quarter.

Theory of flexible and rigid pavement behavior, stress condition and deflection, climate effects, pavement design methods, and evaluation of pavement performance.

**CE 6305. Advanced Transportation Planning**

2-3-3. Prerequisite: CE 6344.

Examination of advanced methods and problems in transportation planning, land use models, the Urban Transportation Planning System (UTPS), and evaluation of transportation plans; computer modeling.

**CE 6308. Concrete Technology**

2-3-3. Prerequisites: CE 3309 or equivalent. Fall quarter.

Design theories for concrete mixes for specific conditions of workability, density, strength, admixtures, and air entrainment. Preparation and testing of concrete mixtures.

**CE 6313. Airport Planning and Design**

2-3-3. Prerequisite: CE 4304. Fall quarter.

Airport site selection, runway length and orientation, traffic control, drainage and lighting, long-range planning, government responsibility for air transportation.

**CE 6315. Computerized Traffic Surveillance and Control**

3-0-3. Prerequisite: CE 6333.

Real-time monitoring and control of traffic on streets and freeways. Detectorization, computer strategies and software, communications, signals, implementation. TRANSYT program for optimal signal timing.

**CE 6318. Asphalt Technology**

2-3-3. Prerequisite: CE 3309 or equivalent. Winter quarter.

Theory of asphalt mix design. Preparation of asphaltic mixes for stability, durability, economy. Use of various materials and grades of asphalt in bituminous concrete pavements.

**CE 6323. Transportation Administration**

2-3-3. Fall quarter.

Advanced study of national transportation policies, financial problems, administrative procedures relating to development of transportation facilities.

**CE 6328. Mass Transit Planning**

3-0-3. Prerequisite: consent of the School. Spring 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.

**CE 6333. Traffic Engineering**

2-3-3. Prerequisite: CE 4304. Fall quarter.

Characteristics of drivers and vehicles, traffic studies, capacity, signal systems, engineering solution of traffic movement problems. Supervised traffic engineering studies.

**CE 6338. Advanced Traffic Operations**

2-3-3. Prerequisite: CE 6333. Winter quarter.

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.

**CE 6343. Design of Highways and Transit Facilities**

2-3-3. Prerequisite: CE 6333. Spring quarter.

Geometric configurations of streets, expressways, busways, railways, and their terminals to meet characteristics of vehicle performance and operator limitations.

**CE 6344. Urban Transportation Planning**

3-3-4. Corequisite: CE 6333. Fall quarter.

Planning of urban transportation facilities, mathematical models for prediction of traffic flow, assignment, interrelationship of land use and trips, parking and the transportation problem.

**CE 6353. Economic and Financial Aspects of Public Works Planning**

3-0-3.

Discounting techniques for public works planning. Microeconomics in project formulation. Applications from welfare economics, capital formation theory, input-output analysis.

**CE 6363. Economics of Water Resources Development**

2-2-3. Prerequisite: CE 6353.

Principles of resource allocation, benefit-cost analysis, water-resources project formulation, justification, allocation of joint costs in multipurpose developments.

**CE 6371. Statistical Hydrology**

2-3-3. Prerequisite: consent of the instructor. Winter quarter.

Probability distributions applicable to hydrologic events; analysis of extreme events, floods and droughts, regression and correlation analysis of hydrologic variables.

**CE 6372. Stochastic Hydrology**

3-0-3. Prerequisite: CE 6371. Spring quarter.

Stochastic modeling of hydrologic processes. Problems of model specification, parameter identification, and validation. Application to forecasting and synthetic events.

## **CE 6373. Flood Management**

3-0-3.

Hydrology and hydraulics of flood management measures. Analysis of flood control and flood damage abatement: levees, floodways, channel improvements, reservoirs.

## **CE 6374. Physical Hydrology**

3-0-3. Prerequisite: CE 4353. Fall quarter.

Study of physical processes governing occurrence, movement, and distribution of water; atmospheric transport processes and circulation; precipitation; evaporation; transpiration; snowmelt; infiltration; groundwater flow; and catchment morphology.

## **CE 6381. Watershed Models I**

3-0-3. Prerequisite: CE 4353.

Development of deterministic watershed simulation concepts including surface runoff, overland flow, streamflow, flood routing, reservoir routing. Linear catchment models. Data preparation techniques for watershed models.

## **CE 6382. Watershed Models II**

2-3-3. Prerequisite: CE 6381.

Characterization of existing deterministic watershed simulation models, model selection, calibration techniques, simulation techniques. Students will calibrate several representative models to measured data.

## **CE 6384. Urban Hydrology**

3-0-3. Prerequisite: CE 4353.

Effects of urbanization on storm runoff, sedimentation, water quality, and water supply. Modeling of urban runoff. Urban watershed in planning and design. Legal, institutional, and economic framework.

## **CE 6399. Water Resources Systems I**

3-0-3. Prerequisite: ISYE 6734 or equivalent, or consent of the instructor. Spring quarter.

Review and application of operations research methodologies, including classical optimization, linear programming, nonlinear programming and dynamic programming, to planning and design of water resource systems.

## **CE 6513. Probability in Civil Engineering Design**

3-0-3. Prerequisite: CE 3533.

Outlines the extent of uncertainties under which civil engineering designs and decisions are made. Theory and application. First step toward developing a risk-based design format.

## **CE 6518. Risk Analysis and Decision Theory in Civil Engineering**

3-0-3. Prerequisite: CE 6513.

Advanced topics in risk-based engineering design. Methods available, advantages, and disadvantages. System reliability concepts. Statistical decision theory and its application in civil engineering.

## **CE 6775. Advanced Engineering Programming Methods**

3-3-4. Prerequisite: CE 3513 or equivalent. Winter quarter.

Advanced engineering programming concepts and their implementation on digital computers. Top-down program

development using formal data structures and algorithms for programming static and dynamic engineering programs.

## **CE 7000. Master's Thesis**

Credit hours to be arranged.

## **CE 7791. Damage and Failure in Composites**

3-0-3. Prerequisites: AE/ChE/CE/ESM/ME/MATE/TFE 4791 or 4792 or AE 4120.

Methods for analysis and failure of fiber reinforced composite material systems. Treatment of mechanisms of toughening, multiple cracking mechanisms. Failure in woven fabric, braided and special geometry composites. Cross-listed with AE/ChE/ESM/ME/MATE/TFE 7791.

## **CE 7792. Mechanics of Composites (ESM 7201 will become "Inactive")**

3-0-3. Prerequisites: AE/ChE/CE/ESM/ME/MATE/TFE 4792, or AE 4120, ESM 6321 or ESM 4351, or equivalent.

Anisotropic elasticity, hygrothermal behavior stress analysis of laminated composites including 3-D effects, stress concentrations, free-edge effects, thick laminates, adhesive and mechanical connections, fracture of composites. Cross-listed with AE/ChE/ESM/ME/MATE/TFE 7792.

## **CE 7793. Manufacturing of Composites**

3-0-3. Prerequisite: AE/ChE/CE/ESM/ME/MATE/TFE 4793

Major manufacturing techniques for metal- and polymer-matrix composites. Modeling of processes with emphasis on fundamental mechanisms and effects. Cross-listed with AE/ChE/ESM/ME/MATE/TFE 7793.

## **CE 7999. Doctoral Examinations Preparation**

Credit hours to be arranged.

For students preparing for the doctoral qualifying examination.

## **CE 8002. Seminar in Environmental Engineering**

0-2-1. Prerequisites: graduate standing and consent of the instructor. Fall, winter, and spring quarters.

Developments in environmental engineering science and technology, current research, and special topics related to environmental quality assessment and control.

## **CE 8003. Research Seminar in Environmental Engineering**

1-0-1. Prerequisites: CE 4148, 6136, and graduate status.

Discussions of current research topics in environmental engineering. Emphasis on critical in-depth review of published research results and those presented by doctoral students.

## **CE 8031. Seminar in Soil and Rock Mechanics**

0-2-1. Corequisites: CE 6154 and consent of the School. Winter quarter.

Case histories of design and construction problems involving soil and rock mechanics, including excavations, drainage, dams, retaining structures, and slope stability.

## **CE 8041. Seminar in Foundation Engineering**

1-0-1. Prerequisite: CE 6154. Corequisite: CE 6164. Spring quarter.

Case histories of design, construction, and performance of foundations. Special topics such as machine foundations, foundations in seismic regions.

### **CE 8051. Seminar in Transportation Engineering**

1-0-1. Prerequisite: consent of the School. Winter quarter.

Developments in the design and planning of traffic engineering and transportation systems, impact of current literature, and technology on the field.

### **CE 8061. Construction Seminar**

0-2-1. Corequisite: CE 6003.

Engineered construction. Whenever possible, guest speakers from the construction industry. Graduate students will present results of required special research projects and thesis research.

### **CE 8071-81-91. Seminar in Hydraulics, Fluid Mechanics, and Hydrology**

1-0-1 each. Fall, winter, and spring quarters.

Presentation and discussion of research developments, current research topics, and graduate student research in hydraulics, fluid mechanics, and hydrology.

### **CE 8101-2-3-4-5. Special Topics**

Credit hours equal last digit of course number.

### **CE 8113-4-23. Special Topics**

Credit hours equal last digit of course number.

### **CE 8500-1. Special Problems**

Credit hours to be arranged.

### **CE 8756. Master's Special Research Problem**

Credit hours to be arranged.

Six to 12 hours of master's research problem to be scheduled by master's students not writing thesis during two or more successive quarters.

### **CE 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

### **CE 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

### **CE 8999. Doctoral Thesis Preparation**

Credit hours to be arranged.

For students in preliminary stages of formulating their doctoral research program who have not obtained formal approval of thesis topic.

### **CE 9000. Doctoral Thesis**

## **ENGINEERING COMPUTER GRAPHICS**

### **EGR 1170. Introduction to Visual Communication and Engineering Design**

2-3-3.

Computer-aided engineering design fundamentals. Projection theory, sketching, creative design, and geometric modeling.

## **ENGINEERING SCIENCE AND MECHANICS**

*Note: Some ESM courses are offered on an alternate-year basis. The designation "even years" in a course description refers to even academic years, eg., 92-93. "Odd years" refers to odd academic years, e.g., 93-94.*

### **ESM 2201. Statics**

3-0-3. Prerequisite: PHYS 2121. Pre- or corequisite: MATH 2507.

Elements of statics in two and three dimensions, centroids, analysis of structures and machines, friction.

Text: at the level of McGill and King, *Statics*.

### **ESM 2211. Mechanics of Solids I**

3-0-3. Prerequisite: PHYS 2121. Pre- or corequisite: MATH 2507.

Forces and moments; equilibrium of particles and bodies in two and three dimensions; introductory structural analysis of multiforce members; friction; applications to axially loaded members; stress and strain.

### **ESM 3111. Experimental Methods in Engineering Science and Mechanics**

2-3-3. Prerequisites: EE 3400, MATH 3308, ESM 3201, 3301, ENGL 3020. Spring quarter.

Methods used to observe behavior of physical parameters in engineering problems, photo-optics, signal analysis, transducers and transducer circuits, models and analogies.

Text: at the level of Tve and Dornholdt, *Engineering Instrumentation*.

### **ESM 3201. Dynamics I**

3-0-3. Prerequisite: ESM 2201 or 2211.

Kinematics and kinetics of rigid bodies in plane motion.

Text: at the level of McGill and King, *An Introduction to Dynamics*.

### **ESM 3311. Mechanics of Solids II**

3-0-3. Prerequisite: ESM 2211. Pre- or corequisite: MATH 2508.

Concepts and definitions of stress, strain, and properties; introduction to behavior of materials; explicit equations of Hookean isotropic behavior; applications to torsion of circular shafts; thin-walled vessels; bending of symmetrical beams; superposition with applications to problems.

### **ESM 3760. Dynamics II**

3-0-3. Prerequisite: ESM 3201.

Kinematics and kinetics of three-dimensional motion of rigid bodies; introduction to vibrations. Cross listed with ME.

Text: at the level of McGill and King, *An Introduction to Dynamics*.

### **ESM 3901 through 3909. Special Problems in Engineering Science and Mechanics**

Credit to be arranged. 3 hours maximum. Prerequisite: junior standing.

Individual study and analysis of problems of current and future interest in engineering and science, approved by faculty adviser.

### **ESM 4122. Project in Engineering Science and Mechanics I**

0-3-1. Prerequisite: senior standing in engineering science and mechanics.

Through discussions with the faculty adviser and other

members of the faculty, students will determine the design-related engineering problem they wish to study. A detailed written project proposal will be submitted to and approved by the student's faculty project adviser prior to the end of the quarter.

## **ESM 4123. Project in Engineering Science and Mechanics II**

0-6-2. Prerequisite: ESM 4122.

Continuation of ESM 4122. Students will complete the solution of the engineering problem proposed in ESM 4122, and submit a written report for the approval of his/her faculty project adviser.

## **ESM 4201. Intermediate Dynamics I**

3-0-3. Prerequisite: ESM 3202 or consent of the School.

Kinematics and kinetics of particles and particle systems; applications include motion in resisting medium, redistribution of mass, central force motion, effects of earth rotation.

Text: at the level of Marris and Stoneking, *Advanced Dynamics*.

## **ESM 4202. Intermediate Dynamics II**

3-0-3. Prerequisite: ESM 4201 or consent of the School.

Two- and three-dimensional motion of a rigid body, Euler's equations, introduction to energy methods, and Lagrange's equations.

## **ESM 4211. Mechanical Vibrations II**

3-0-3. Prerequisites: ESM 4210 and ESM 3302 or equivalent. Fall quarter.

Complex representation, step and impulse loads, many degrees of freedom, influence coefficients, matrix methods, stability of solution, vibrations of strings, beams and membranes, approximate methods.

Text: at the level of Timoshenko, Young, Weaver, *Vibration Problems in Engineering*.

## **ESM 4301. Mechanics of Deformable Bodies**

3-0-3. Prerequisite: ESM 3301.

Small strain linear elasticity in two and three dimensions, applications in generalized plane stress and plane strain, torsion and bending of noncircular prisms.

## **ESM 4302. Stress Analysis**

3-3-4. Prerequisite: ESM 4301.

Continuation of ESM 4301, further treatment of torsion and bending, strain energy, introduction to thin plates and simple shells, approximation methods.

## **ESM 4752. Biomechanics**

3-0-3. Prerequisites: MATH 3308 or equivalent, ESM 3301 or equivalent. Winter quarter.

The mechanics of living tissue, e.g., arteries, skin, heart muscle, and bone. Constitutive equations for tissues and some simple mechanical models. Biomechanical instrumentation. Cross listed with ME.

## **ESM 4760. Engineering Acoustics and Noise Control I**

3-0-3. Prerequisite: senior standing.

Acoustics related to noise and its control, acoustic terminology, wave propagation, solutions to the wave equation, instrumentation, sound field in large and small rooms, noise legislation. Cross listed with AE and ME.

## **ESM 4761. Engineering Acoustics and Noise Control II**

3-0-3. Prerequisite: ESM 4760 or equivalent.

Continuation of ESM 4760 emphasizing techniques for the solution of noise problems. Vibration isolation, energy absorption, dissipative and reactive mufflers, enclosures, barriers, properties of materials, panel damping. Cross listed with AE and ME.

## **ESM 4770. Structural Integrity and Durability**

3-0-3. Prerequisite: ESM 3301 or AE 2101.

Simple stress-concentration problems involving plastic deformation, residual stresses, hysteresis, creep, and relaxation. Introduction to fatigue and fracture mechanics. Crack-growth calculations and wearout models. Cross listed with AE.

## **ESM 4791. Mechanical Behavior of Composites**

3-0-3. Prerequisites: MATE 2301 or AE 4813, MATE 3463 or ESM 3301 or AE 2102.

The stress-strain behavior of anisotropic composite structures and the elastic and plastic properties of matrix and reinforcing materials are covered for polymers, ceramics, and metals. Cross listed with AE, CHE, CE, MATE, ME, TEX.

## **ESM 4792. Fundamentals of Fiber-reinforced Composites I: Structural Mechanics**

3-0-3. Prerequisites: AE 2102 or ESM 3301.

Introduction to the mechanics of fiber-reinforced composite materials. Advantages and uses of composites. Property characterization methods. Lamina and laminate analysis. Failure mechanisms. Applications to structural components made of composites. Cross listed with AE, CHE, CE, MATE, ME, TEX.

## **ESM 4793. Composite Materials and Processes**

3-0-3. Prerequisites: CHEM 1102 PHYS 2123.

Basic principles of selecting component materials and manufacturing composites are presented. Polymeric, metallic, and ceramic systems are considered. Cross listed with AE, CHE, CE, MATE, ME, TEX.

## **ESM 4794. Laboratory in Composites Manufacture and Testing**

2-3-3. Prerequisites: ESM 4791 or 4792, and 4793.

Covers major manufacturing processes and testing techniques involved in composites. Analysis, planning, and design of practical parts will also be covered. Cross listed with AE, CHE, CE, MATE, ME, TEX.

## **ESM 4801 through 4809. Special Topics in Engineering Science and Mechanics**

1-0-1 through 9-0-9, respectively. Prerequisite: senior standing.

Special courses not included in regular course offerings.

## **ESM 4901 through 4909. Special Problems in Engineering Science and Mechanics.**

Credit to be arranged. 3 hours maximum. Prerequisite: senior standing.

Individual study and analysis of problems of current and future interest in engineering and science, approved by faculty adviser.

**ESM 6111. Theory of Experimental Stress Analysis**

2-3-3. Prerequisite: ESM 3214 or consent of the School. Spring quarter.

Study of surface stress and strain using brittle coatings and strain gauges. Electrical resistance cemented and welded strain gauges, strain gauge circuits, static and dynamic problems, transducer design and circuits. Vibrating wire strain gauges. Application of failure theories.

**ESM 6117. Experimental Photomechanics I**

2-3-3. Prerequisite: ESM 3301 or equivalent. Fall quarter, odd years.

Polarized light, mathematical description, light transformations, photoelastic models, use of transmitted light for stress analysis in two-dimensional problems, birefringent coatings.

**ESM 6118. Experimental Photomechanics II**

2-3-3. Prerequisite: ESM 6117. Winter quarter, odd years.

Three-dimensional photoelastic stress analysis using transmitted light and scattered light methods, numerical methods, Moiré fringes, holographic interferometry.

**ESM 6201. Advanced Dynamics I**

3-0-3. Prerequisites: ESM 4210 and MATH 3308, 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.

**ESM 6202. Advanced Dynamics II**

3-0-3. Prerequisite: ESM 6201. Winter quarter.

A continuation of ESM 6201. Hamilton's principle, Hamilton's canonical equations, energy and momentum integrals, Hamilton-Jacobi theory, study of selected papers from recent dynamics literature.

**ESM 6221. Vibrations I**

3-0-3. Prerequisite: MATH 4582 or consent of the School. Fall quarter.

Lagrange's equations, small oscillations of conservative and nonconservative systems, natural modes; response of multidegree-of-freedom systems; introduction to vibration of continuous systems.

**ESM 6222. Vibrations II**

3-0-3. Prerequisite: ESM 6221, 6321, or 6341. Winter quarter.

Free and forced longitudinal, torsional, and lateral vibration of bars; vibration of membranes, plates, shells, and extended elastic bodies; approximate methods.

**ESM 6223. Wave Propagation in Solids**

3-0-3. Prerequisite: ESM 6222 or consent of the School. Spring quarter.

Wave propagation in elastic solids; dilatational equivoluminal and surface waves, reflection and refraction; waves in structural elements; analysis of impact problems.

**ESM 6241. Gyroscopic Motion and Devices**

3-0-3. Prerequisite: ESM 6201 or equivalent. Spring quarter, odd years.

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.

**ESM 6261. Space Mechanics I**

3-0-3. Prerequisite: graduate standing. Fall quarter, even years.

The two-body problem, Kepler's equation, transfer orbits, Hohmann transfer, dynamics of rocket motion, rocket staging.

**ESM 6262. Space Mechanics II**

3-0-3. Prerequisite: ESM 6261 or consent of the School. Winter quarter, odd years.

Celestial sphere, aberration, parallax, Laplace's and Gauss' methods, three- and n-body problems, Lagrangian points, Lagrange brackets, perturbations of an oblate planet, and atmospheric drag.

**ESM 6281. Random Vibrations I**

3-0-3. Prerequisites: MATH 4215 or consent of the School. Fall quarter, even years.

Statistical analysis of mechanical systems, correlation function, power spectral density, response to random inputs, method of normal modes, fatigue failures, nonstationary inputs, vibration of beams.

**ESM 6282. Random Vibrations II**

3-0-3. Prerequisite: ESM 6281. Winter quarter, even years.

Continuation of ESM 6281. Advanced engineering problems in random theory, nonstationary random inputs and response, measurement of power spectra, Fokker-Planck techniques, nonlinear systems.

**ESM 6301. Advanced Strength of Materials**

3-0-3. Prerequisites: MATH 3308, CE 3214. 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.

**ESM 6321. Applied Elasticity I**

3-0-3. Prerequisite: CE 3214 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.

**ESM 6322. Applied Elasticity II**

3-0-3. Prerequisite: ESM 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.

**ESM 6341. Theory of Elasticity I**

3-0-3. Prerequisites: CE 3214 and MATH 3308, or consent of the School. Winter quarter.

Introduction to generalized tensors, analysis of deformation, equations of motion, linearly elastic materials, formulation of the first, second and mixed boundary value problems.

**ESM 6342. Theory of Elasticity II**

3-0-3. Prerequisite: ESM 6341 or consent of the School. Spring quarter.

Continuation of ESM 6341, linear elasticity, Saint-Venant's theory of torsion, bending of beams, Love's strain function, Galerkin vector, Papkovitch-Neuber representation, stress potentials, Airy's stress function.

**ESM 6343. Theory of Elasticity III**

3-0-3. Prerequisite: ESM 6342 or consent of the School. Fall quarter.

Continuation of ESM 6342; variational formulation of elasticity, energy theorems, introduction to thermoelasticity, representation of biharmonic functions by analytic functions of a complex variable.

## **ESM 6361. Theory of Elastic Stability I**

3-0-3. Prerequisites: CE 3214 and MATH 4582, or consent of the School. Winter quarter.

Various stability methods and their applicability, the elastica problem, snap and bifurcation buckling, stability of conservative systems, buckling of beams on elastic foundation, lateral buckling.

## **ESM 6362. Theory of Elastic Stability II**

3-0-3. Prerequisite: ESM 6361 or consent of the School. Spring quarter.

Stability of various systems—velocity dependent, conservative, dissipative, circulatory, and nonstationary, with examples of each, recent developments in elastic stability theory.

## **ESM 6371. Theory of Plates**

3-0-3. Prerequisites: 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.

## **ESM 6372. Theory of Shells**

3-0-3. Prerequisite: ESM 6371 or consent of the School. Summer quarter.

Stresses and deformation of shells with and without bending under various loading conditions, shells forming surfaces of revolution, hyperbolic paraboloidal and elliptic paraboloidal shells.

## **ESM 6381. Plasticity**

3-0-3. Prerequisite: ESM 6321 or 6341, or consent of the School. 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.

## **ESM 6391. Finite Elasticity**

3-0-3. Prerequisite: ESM 4351 or consent of the School. Winter quarter.

Kinematics of finite deformation, stress, deformation and strain tensors, classical theory of finite elasticity for isotropic materials, introduction to simple materials.

## **ESM 6401-2. Optimization Techniques I and II**

3-0-3 each. Prerequisite: graduate standing. Winter and spring quarters, even years.

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.

## **ESM 6411. Energy Methods in Mechanics**

3-0-3. Prerequisites: CE 3214, MATH 4582 or consent of the School. Summer quarter.

Virtual work, minimum total potential energy, minimum

complementary energy, Castigliano's theorems, applications of calculus of variations, Rayleigh-Ritz method.

## **ESM 6450. Finite Elements, Boundary Elements, and Other Computational Methods in Mechanics I**

3-0-3. Prerequisite: graduate standing in engineering. Fall quarter.

Review of weighted residual methods; linear solid and structural problems; finite element variational method—assumed displacement method; element interpolation, integration; assembly and solution of large systems of equations; convergence of finite element method; edge function method; boundary elements methods, plane and 3-D elasticity.

## **ESM 6451. Finite Elements, Boundary Elements, and Other Computational Methods in Mechanics II**

3-0-3. Prerequisite: ESM 6450 or consent of the instructor. Winter quarter.

Mixed and hybrid methods; assumed stress and multifield finite elements; combined finite elements and boundary elements; plate and shell problems; application to fracture—composites; finite deformation analysis; alternate stress and strain measures; objective stress rates-strain rates; finite element rate (incremental) methods.

## **ESM 6452. Finite Elements, Boundary Elements, and Other Computational Methods in Mechanics III**

3-0-3. Prerequisite: ESM 6451 or consent of the instructor. Spring quarter.

Rate (incremental) analysis of finite strain problems; finite elasticity-finite strain elasto-plasticity; alternative variational rate finite element methods; stability; transient dynamic response; current developments in discrete approximations in fluid flow.

## **ESM 6501-2. Fluid Mechanics I and II**

3-0-3. Prerequisite: graduate standing. Fall and winter quarters.

Mechanical principles of rational fluid mechanics. Kinematics, balance laws, examples of constitutive equations of fluids including perfect, Navier-Stokes, Rivlin-Ericksen fluids, potential flows, viscometric flows, introduction to approximate solutions and boundary-layer theory.

## **ESM 6751-2. Complex Systems Design I, II**

2-4-3 each. Prerequisite: graduate standing in any school or senior with consent of the School. Winter and spring quarters.

Interdisciplinary team design of systems of current interest to society that have large technological factors. Individual research and interaction with nonuniversity resource persons and faculty. Grades based on oral and written reports. Cross listed with ISyE and ME.

## **ESM 6760-1-2. Acoustics I, II, and III**

3-0-3 each. Prerequisite: MATH 4349 or consent of the School.

Introductory analytical methods, and stochastic process, the wave equation in a compressible fluid, radiation of wind, reflection, refraction, diffraction and scattering of sound waves, duct acoustics. Cross listed with AE and ME.

## **ESM 6763. Noise Reduction and Control (Industrial Applications)**

3-0-3. Prerequisite: ESM 6760, ESM 4760 or equivalent. Spring quarter.

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. Cross listed with AE and ME.

**ESM 6764. Ocean Acoustics**

3-0-3. Prerequisite: GEOL 4300 or consent of the School. MATH 4321, 4582, ESM 6760 recommended. Spring quarter.

Propagation of sound waves in the oceans, stress-strain relationships, asymptotic ray theory. Propagation in shallow water and deep water. Cross listed with GEOS and ME.

**ESM 6781. Biosolid Mechanics**

3-0-3. Prerequisite: consent of the instructor. Spring quarter.

Mechanics as applied to living tissues. Bioviscoelastic solids: the constitutive equations for blood vessels, muscles, cartilage, bone, and other tissues. Cross listed with ME.

**ESM 7000. Master's Thesis****ESM 7101-2-3-4-5. Master's Report**

1-0-1 through 5-0-5, respectively. Prerequisite: consent of the adviser.

A theoretical and/or experimental investigation in a major area of interest to an M.S. candidate. Written report must be approved by faculty adviser. Required of all M.S. students not doing a thesis.

**ESM 7201. Mechanics of Composite Materials**

3-0-3. Prerequisite: ESM 6371, ESM 6321 or 6341, or consent of the instructor. Summer quarter.

Basic theory of anisotropic elasticity, equations for laminated composites, properties of laminates, estimation of the composite anisotropic moduli, bending, buckling and failure criteria of laminates.

**ESM 7221. Nonlinear Vibrations I**

3-0-3. Prerequisites: ESM 6201, and MATH 4582 or their equivalents. Winter quarter, odd years.

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.

**ESM 7222. Nonlinear Vibrations II**

3-0-3. Prerequisite: ESM 7221. Spring quarter, odd years.

Nonlinear vibrations of nonautonomous one-degree-of-freedom systems, method of Duffing, perturbation method, Bogoliuboff method, Ritz-averaging method, stability criteria, subharmonics, two degree-of-freedom systems.

**ESM 7231. Wave Propagation in Continuous Media**

3-0-3. Prerequisite: ESM 6501 or consent of the School. Fall quarter, odd years.

The theory of propagation of singular surfaces in three dimensions. Hadamard's lemma, Maxwell's theorem, compatibility conditions for weak singular surfaces, general balance at a singular surface, weak waves, applications to wave propagation in various materials.

**ESM 7371. Stability of Shells**

3-0-3. Prerequisites: ESM 6361, 6372. Fall quarter.

Linear and nonlinear theories for shell buckling, stability of thin stiffened and unstiffened plates and cylindrical shells under various loads, edge effects, imperfection sensitivity studies.

**ESM 7501. Viscoelasticity**

3-0-3. Prerequisites: ESM 6391, 6501 or consent of the School. Spring quarter.

The theory of viscoelasticity, simple fluids, viscoric flows, and the determination of material functions.

**ESM 7511. Analytical Fracture Mechanics**

3-0-3. Prerequisites: ESM 6321 or 6341 and MATH 4320 or equivalent. Spring quarter.

Half-plane problems. Symmetric crack problems. Crack-extension criteria. Antisymmetric crack problems. Williams' series. Effect of nearby boundaries. Crack growth under cyclic loading. Design problems.

**ESM 7750. Biofluid Mechanics**

3-0-3. Prerequisite: AE 6000 or ESM 6501, 6502 or consent of instructor. Summer quarter.

A unified treatment on hemorheology, hemodynamics, pulsatile flows, microcirculation, joint lubrication, pulmonary physiology, etc., with emphasis on quantitative approach. Also listed as AE 7750.

**ESM 7791. Damage and Failure in Composites**

3-0-3. Prerequisite: AE/ChE/CE/ESM/ME/MATE/TFE 4791 or 4792 or AE 4120.

Methods for analysis and failure of fiber reinforced composite material systems. Treatment of mechanisms of toughening, multiple cracking mechanisms. Failure in woven fabric, braided and special geometry composites. Cross-listed with AE/ChE/CE/ME/MATE/TFE 7791.

**ESM 7792. Mechanics of Composites (ESM 7201 will become "Inactive")**

3-0-3. Prerequisites: AE/ChE/CE/ESM/ME/MATE/TFE 4792, or AE 4120, ESM 6321 or ESM 4351, or equivalent.

Anisotropic elasticity, hygrothermal behavior stress analysis of laminated composites including 3-D effects, stress concentrations, free-edge effects, thick laminates, adhesive and mechanical connections, fracture of composites. Cross-listed with AE/ChE/CE/ME/MATE/TFE 7792.

**ESM 7793. Manufacturing of Composites**

3-0-3. Prerequisite: AE/ChE/CE/ESM/ME/MATE/TFE 4793

Major manufacturing techniques for metal- and polymer-matrix composites. Modeling of processes with emphasis on fundamental mechanisms and effects. Cross-listed with AE/ChE/CE/ME/MATE/TFE 7793.

**ESM 7999. Preparation for Doctoral Qualifying Examination**

Credit to be arranged. Prerequisite: consent of the adviser.

**ESM 8001-2-3. Graduate Seminar**

1-0-1 each.

**ESM 8103-13-23-33-43-53. Special Topics**

3-0-3. Prerequisite: consent of the adviser.

Special ad hoc courses not included in regular ESM graduate course offerings.

**ESM 8104-14-24-34-44-54. Special Topics**

4-0-4 each. Prerequisite: consent of the adviser.

Special ad hoc courses not included in regular ESM graduate course offerings.



**ESM 8105-15-25-35-45-55. Special Topics**

5-0-5 each. Prerequisite: consent of the adviser.

Special ad hoc courses not included in regular ESM graduate course offerings.

**ESM 8501-2-3. Special Problems**

Credit to be arranged. Prerequisite: consent of the adviser.

Individual study and analysis of problems of current and future interest in engineering and science.

**ESM 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**ESM 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**ESM 8999. Doctoral Thesis Preparation**

Credit to be arranged.

For students in preliminary stages of formulating doctoral research program who have not obtained formal approval of thesis topic.

**ESM 9000. Doctoral Thesis**

## School of Electrical and Computer Engineering

**Established in 1896**

**Location: Van Leer Building**

**Telephone: (404) 894-2901**

*Director and Georgia Power Distinguished Professor*—Roger P. Webb; *Associate Director and Professor*—J. Alvin Connelly; *Associate Director for External Affairs and Professor*—Hans B. Püttgen; *Associate Director for Graduate Affairs and Professor*—Dale C. Ray; *Associate Director for Undergraduate Affairs and Professor*—William E. Sayle; *Computer Engineering Program Coordinator and Associate Professor*—Joseph L.A. Hughes; *Assistant to the Director for Laboratory Instruction*—Thomas E. Brewer; *Assistant to the Director for Computer Services*—David S. Webb; *Julius Brown Chair and Regents' Professor*—Thomas K. Gaylord; *John O. McCarty/Audichron Chair and Regents' Professor*—Ronald W. Schafer; *Schlumberger Professor in Microelectronics*—Phillip E. Allen; *Hightower Chair and Professor*—Edward W. Kamen; *Joseph M. Pettit Chair in Microelectronics and Professor*—James D. Meindl; *Georgia Power Distinguished Professor*—Ajeet Rohatgi; *Joseph M. Pettit Chair in Electronic Packaging and Professor*—Rao R. Tummala; *Byers Eminent Scholar Chair and Professor*—Carl M. Verber; *Regents' Professors*—Russell M. Mersereau, George P. Rodrigue, Glenn S. Smith; *Regents' Professor Emeritus*—Kendall L. Su; *Professors*—Cecil O. Alford, Thomas P. Barnwell III, Kevin F. Brennan, Mark A. Clements, John A. Copeland (director, Georgia Center for Advanced Telecommunications Technology), John F. Dorsey, Robert K. Feeney, James D. Foley, Monson H. Hayes, David R. Hertling, Richard J. Higgins (director, Microelectronics Research Center), Edward B. Joy, Richard P. Kenan, W. Marshall Leach, Jr., James H. McClellan, Athanasios P. Meliopoulos, Demetrius T. Paris (Vice President for Research and Graduate Programs), John B. Peatman, William T. Rhodes, Jay H. Schlag, Paul G. Steffes,

John P. Uyemura, George S. Vachtsevanos, Erik I. Verriest; *Professors Emeriti*—Henry C. Bourne, Jr., Aubrey M. Bush, Daniel C. Fielder, Thomas M. White; *Associate Professors*—Ian K. Akyildiz, Mark G. Allen, Paul J. Benkeser, Martin A. Brooke, April S. Brown, John A. Buck, W. Russell Callen, Jr., Elias N. Glysis, James O. Hamblen, William D. Hunt, Nan Marie Jokerst, Arthur J. Koblasz, Chin-Tau Lea, Vijay Madiseti, Petros Maragos, Mohamed F. Moad, Andrew F. Peterson, Raymond R. Scott, Jr., Mark J. T. Smith, Gordon L. Stüber, David G. Taylor, Yorai Wardi, Stephen B. Wicker, Sudhakar Yalamanchili; *Assistant Professors*—John R. Barry, Richard M. Bass, Miroslav Begovic, Daniel Blumenthal, Giorgio Casinovi, Abhijit Chatterjee, Stephen P. DeWeerth, Timothy J. Drabik, Ko-Hui Michael Fan, Albin J. Gasiewski, Thomas G. Habetler, Bonnie S. Heck, Mary Ann Ingram, Joy Laskar, Francois Malassenet, Gary S. May, Henry L. Owen, David E. Schimmel, Douglas B. Williams, D. Scott Wills, Serena M. Zabin; *Laboratory Coordinator/Instructor*—Bruce McFarland; *Lecturers*—Anthony J. Ayoub, Michael D. Furman, Frank C. Lambert, John H. Matthews, Kambiz Nayeibi, W. Whitfield Smith.

### **Adjunct Faculty**

Christopher F. Barnes\*, Devon G. Crowe\*, Jim D. Echarid\*, J. Lee Edwards\*, Robert L. Eisner, George Ewell\*, Anthony Gadiant, Allen K. Garrison\*, Midhat J. Gazale, Gary G. Gimmetstad\*, Nile F. Hartman, Bruce Harvey\*, Ernest J. Holder\*, William A. Holm\*, Morris P. Kesler, Linda S. Martinson, John H. Matthews, John G. Meadors\*, Serge Perrine, Leslie W. Pickering\*, Mario Rabinowitz, Edward K. Reedy\*, Robert W. Rice\*, Mark A. Richards, Craig Richardson, Jeffrey J. Sitterle\*, Bhushan L. Sopor, Christopher Summers\*, Madhavan Swaminathan, Johnson J. H. Wang\*, James C. Wiltse\*.

\*GTRI

### **General Information**

The cornerstones of electrical engineering, the control of information and electric power, result from the fact that electrical energy is the only form of energy that can be transmitted efficiently and under controlled conditions, even over great distances, from point of origin to point of use.

Utilization of this fact has enabled electrical engineers to pioneer such diverse and important fields as communications, computers, and electric power.

The School of Electrical and Computer Engineering provides undergraduate and graduate programs that prepare students to participate in a broad range of career opportunities. Modern facilities and laboratories support experimental and theoretical programs of instruction and research.

For additional information about the School's programs, please obtain the *EE/CmpE Student Handbook*, available upon request or by calling the School at (404) 894-2900. Every enrolled EE or CmpE student must consult this source of information concerning special rules and degree requirements.

### **Undergraduate Programs**

The School of Electrical and Computer Engineering offers two undergraduate degree programs: electrical engineering (EE) and computer engineering (CmpE). Both programs include a large number of elective hours enabling students to individually tailor their programs to provide emphasis in a particular specialization or exposure to a broad range of subjects. Elective courses are available in a wide variety of major areas such as bioengineering, computers, control, microelectronics, electronic design and applications, signal processing, electro-optics, electric power, electromagnetics, and telecommunications. Additionally, students may elect to take advanced courses in other programs such as physics or management.

Engineering analysis and design concepts are integrated throughout both the undergraduate electrical engineering and computer engineering programs. Both programs culminate in major design experiences involving a broad range of issues including economics, safety, and other societal considerations.

### **Graduate Program**

Programs leading to the master's and doctoral degrees in electrical and computer engineering are provided by the School. Technical interest areas include bioengineering, computer engineering, digital signal processing, electric power engineering, electromagnetics, electronic

design and applications, microelectronics, optics, systems and controls, and telecommunications.

The master's degree program requires 50 credit hours beyond the bachelor's degree. Courses are offered all four quarters, making it possible for part-time students to continue an uninterrupted program of study throughout the year. Full-time students can complete the master's program in one calendar year.

The doctoral degree program is research oriented and highly individualized. Typically, at least four years of study beyond the bachelor's degree are required to complete the doctoral program.

## Multidisciplinary Programs

See table on page 100.

## Bachelor of Electrical Engineering Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>CHEM 1101-2</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>CS 1501</b>			
Intro. to Computing	.....	3-3-4	.....
<b>CMPE 2500</b>			
Digital Computation I	.....	.....	3-3-4
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>Health and Performance Sciences</b> (requirements, p. 311)	3-0-3	.....	.....
<b>Humanities/Social Sciences/Modern Language Electives</b>	.....	.....	3-0-3
<b>TOTALS</b>	15-3-16	15-6-17	15-6-17

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3308</b>			
Differential Equations	.....	.....	5-0-5
<b>PHYS 2122</b>			
Electromagnetism	4-3-5	.....	.....

### PHYS 2123

Optics and Modern

Physics

### CS 1502

Intro. to Programming

### ESM 2201

Statics

### CMPE 2510

Computer Arch I

### EE 3200, 3250

Elements of Electrical

Engineering I, II

**Humanities/Social**

**Sciences/Modern**

**Languages Electives**

.....	3-0-3	6-0-6	
<b>TOTALS</b>	12-9-15	16-3-17	17-3-18

### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>EE 3212-13</b>			
Signals and Systems I, II	3-0-3	3-0-3	.....
<b>EE 3280</b>			
Electronic Circuits	4-0-4	.....	.....
<b>EE 3300, 3310</b>			
Electromagnetics I, II	3-0-3	3-0-3	.....
<b>EE 3330</b>			
Electromechanical Systems and Energy Conversion	.....	.....	3-0-3
<b>EE 3351</b>			
Fundamentals of Microelectronic Devices	3-0-3	.....	.....
<b>EE 3400</b>			
Instrumentation Lab	1-3-2	.....	.....
<b>EE 3480</b>			
Electronic Circuits Laboratory	.....	0-3-1	.....
<b>ENGL 3015</b>			
Public Speaking	.....	3-0-3	.....
<b>ENGL 3020</b>			
Technical Writing	.....	.....	3-0-3
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	3-0-3	3-0-3
<b>Electives</b>	.....	3-3-4	X-X-9
<b>TOTALS</b>	17-3-18	15-6-17	X-X-18

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	3-0-3	3-0-3
<b>Electives</b>	X-X-14	X-X-14	X-X-13
<b>TOTALS</b>	X-X-17	X-X-17	X-X-16

Total Credit Hours Required for Graduation = 203

## Electives

The electrical engineering curriculum requires 203 quarter hours including 54 hours of electives and 30 hours of specified humanities/social sciences/modern languages electives. The 54 hours of electives must include a minimum of

1.) 9 hours of technical electives subject to approval by the School of Electrical and Computer Engineering. Generally, the technical electives are junior or senior engineering (not EE or CmpE), mathematics, or natural sciences courses. The technical electives must include two approved engineering science options.

2.) 27 hours of electrical engineering or computer engineering electives, subject to School approval. These EE/CmpE electives must include the courses corresponding to a single approved Area of Specialization. Course substitutions generally will NOT be approved for an Area of Specialization.

3.) 18 hours of free electives. These free electives may be taken at any time during a student's course of study. Up to six hours of basic ROTC and a maximum of nine hours of advanced ROTC may be used for elective credit.

Furthermore, electives must be selected to include approved options in applied probability and ethics.

## Humanities/Social Sciences/Modern Languages Electives

Eighteen credit hours of humanities and 18 credit hours of social sciences are required, including ENGL 1001-2. See p. 33 for a list of acceptable elective courses.

The courses selected to fulfill the humanities and social sciences requirements must provide both breadth and depth and should not be a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one of each.

All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia: HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

## Computer Engineering

Computer engineering is a discipline that combines the study of computer systems with the

traditional aspects of electrical engineering. The increasing use of computers in all engineering disciplines has created a demand for professionals with computer hardware and software skills and with an understanding of the fundamentals of engineering.

The objective of the computer engineering (CmpE) degree program is to produce graduate engineers at the baccalaureate level who are able to design, analyze, and use computer systems. The program in computer engineering encompasses both areas of computer design and computer applications. Computer design emphasizes the structure of computers and requires expertise in computational theory, digital design, and computer architecture. Computer applications emphasize the use of computers in engineering systems and require computer interfacing techniques, both low-level and high-level programming techniques, mathematical algorithms, and a general knowledge of computer operating systems. Both areas require an in-depth understanding of computer software at the machine and systems level.

Additional information about the program may be obtained from the *EE/CmpE Student Handbook*, available upon request or by calling the School at (404) 894-2900. Every EE and CmpE student enrolled must consult this source of information concerning special rules and degree requirements.

## Bachelor of Computer Engineering Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>CHEM 1101-2</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>CS 1501</b>			
Intro. to Computing	.....	3-3-4	.....
<b>CMPE 2500</b>			
Digital Computation I	.....	.....	3-3-4
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>Health and Performance Sciences</b> (requirements, p. 311)	3-0-3	.....	.....

## Humanities/Social Sciences/Modern Languages Electives

<b>TOTALS</b>	15-3-16	15-6-17	15-6-17
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## Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
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<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3308</b>			
Differential Equations	.....	.....	5-0-5
<b>PHYS 2122</b>			
Electromagnetism	4-3-5	.....	.....
<b>PHYS 2123</b>			
Optics and Modern Physics	.....	4-3-5	.....
<b>CS 1502</b>			
Intro. to Programming	3-6-5	.....	.....
<b>CMPE 2510</b>			
Computer Architecture I	.....	3-3-4	.....
<b>CS 2430</b>			
Control and Concurrency	.....	.....	3-3-4
<b>EE 2200</b>			
Intro. to Discrete Systems	.....	3-3-4	.....
<b>EE 2250</b>			
Electric Circuit Analysis	.....	.....	5-0-5
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	.....	3-0-3
<b>TOTALS</b>	15-9-18	13-9-16	16-3-17

## Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
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<b>CMPE 3510</b>			
Computer Architecture II	3-3-4	.....	.....
<b>CMPE 3500</b>			
Digital Computation II	.....	3-3-4	.....
<b>EE 3400</b>			
Instrumentation Laboratory	1-3-2	.....	.....
<b>EE 3280</b>			
Electronic Circuits	4-0-4	.....	.....
<b>EE 3480</b>			
Electronic Circuits Lab	.....	0-3-1	.....
<b>EE 3230</b>			
Linear Systems and Transforms	.....	4-0-4	.....
<b>EE 3340</b>			
Random Signals and Noise	.....	.....	3-0-3
<b>MATH 3012</b>			
Applied Combinatorics	3-0-3	.....	.....
<b>CS 3431</b>			
Operating Systems and Data Management	.....	.....	4-0-4
<b>ENGL 3015/3020</b>			
Public Speaking/Technical Writing	.....	3-0-3	.....

## Computer Engineering

<b>Electives</b>	.....	3-0-3	X-X-4
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	3-0-3	3-0-3
<b>Free Electives</b>	.....	.....	3-0-3

<b>TOTALS</b>	14-6-16	16-6-18	X-X-17
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## Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
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<b>MATH 4305</b>			
Finite-Dimensional Vector Spaces	3-0-3	.....	.....
<b>CMPE 4500, 4510</b>			
CMPE Design I, II	.....	2-9-5	2-9-5
<b>Engineering Science Elective</b>	3-0-3	.....	.....
<b>Computer Engineering Electives</b>	3-0-3	X-X-4	X-X-4
<b>Humanities/Social Sciences/Modern Languages Electives</b>	6-0-6	3-0-3	3-0-3
<b>Free Electives</b>	3-0-3	6-0-6	3-0-3
<b>TOTALS</b>	18-0-18	X-X-18	X-X-15

**Total Credit Hours Required for Graduation = 203**

## Electives

The computer engineering curriculum contains 39 hours of electives in addition to 30 hours of specified humanities/social sciences/modern languages electives. The 39 hours of electives must include a minimum of

- 1.) An approved engineering science option of at least 3 hours.
- 2.) Three hours of written or verbal communications, which may be satisfied by ENGL 3015, ENGL 3020, or a course or courses approved by the School.
- 3.) 18 hours of computer engineering, electrical engineering, or computer science electives, subject to School approval.
- 4.) 15 hours of free electives. Free electives may be taken at any time during a student's course of study. All of these hours may be satisfied using ROTC credits for ROTC students.

Furthermore, electives must be selected to include an approved ethics option and an approved CmpE Area of Concentration. Refer to

the *EE/CmpE Student Handbook* or contact the EE/CmpE Academic Office for a current list of Area of Concentration courses.

NOTE: Area of Concentration requirements must be satisfied precisely; course substitutions (between areas or of other courses) will generally NOT be approved.

## **Humanities/Social Sciences/Modern Languages Electives**

Eighteen credit hours of humanities and 18 credit hours of social sciences are required including ENGL 1001-2. See p. 33 for a list of acceptable elective courses.

The courses selected to fulfill the humanities and social sciences requirements must provide both breadth and depth and should not be a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one of each.

All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia: HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

## **Courses of Instruction**

*Note: Detailed topical course outlines are provided in a publication available in the academic office of the School of Electrical and Computer Engineering.*

### **COMPUTER ENGINEERING**

#### **CmpE 1700. Computer and Digital Design Fundamentals** 3-0-3.

An introduction to the fundamental concepts of digital systems, including number systems, boolean logic, and an overview of computer organization. Not for EE or CmpE majors.

#### **CmpE 2500. Digital Computation I** 3-3-4. Prerequisite: CS 1501.

Basic concepts of engineering design for digital computational systems. Function definition, switch and wire design, boolean functions, combinational logic, memory, state machines, sequential logic, and digital arithmetic.

#### **CmpE 2510. Computer Architecture I** 3-3-4. Prerequisites: CmpE 2500 and CS 1502.

Computational model concepts. Basic datapath, controller, and memory system in overall machine architecture. Design projects on behavioral descriptions of components and their integration and implementation.

#### **CmpE 2811-2-3-4-5. Special Topics**

Last digit in each course number designates corresponding number of credit hours. Normally taken by sophomores.

New developments in computer engineering are presented as demand or interest warrants.

#### **CmpE 3500. Digital Computation II** 3-3-4. Prerequisites: CmpE 2510 and EE 3280.

Advanced digital design techniques building on circuits, electronics, architecture, and basic digital design. Design and implementation of complex digital systems.

#### **CmpE 3510. Computer Architecture II** 3-3-4. Prerequisite: CmpE 2510.

Instruction set architecture design, effect of ISA on microarchitecture and compiler, and introduction to pipelining. Memory hierarchy, caches, interleaved memory, virtual memory, and memory management.

#### **CmpE 3811-2-3-4-5. Special Topics**

Last digit in each course number designates corresponding number of credit hours. Normally taken by juniors.

New developments in computer engineering are presented as demand or interest warrants.

#### **CmpE 4180. VLSI Design and Testing I** 3-3-4. Prerequisites: CmpE 3500 and EE 3280.

Formalisms and methodologies of structured VLSI design. Design and testing at the architectural, register-transfer, logic, circuit, and physical levels. Design project using high-level computer-aided design tools.

#### **CmpE 4181. VLSI Design and Testing II** 3-3-4. Prerequisite: CmpE 4180.

Custom design and layout methods. Emphasis on low-level design issues and optimizations. Design project involving a complete custom chip.

#### **CmpE 4190. Introduction to Simulation Methods** 3-0-3. Prerequisites: CmpE 2510, CS 2430, and either EE 3230 or EE 3213.

Techniques for logic and circuit simulation. Algorithms for discrete-time, continuous-time, deterministic and statistical simulation of lumped- or distributed-parameter systems.

#### **CmpE 4500. Computer Engineering Design I** 2-9-5. Prerequisites: CmpE 3500, CmpE 3510, CS 3431, and senior standing.

Capstone design experience for computer engineering majors. Design of a processor and associated instruction set. Testing via simulation models. First course of a two-quarter sequence.

#### **CmpE 4510. Computer Engineering Design II** 2-9-5. Prerequisite: CmpE 4500.

Continuation of capstone design experience. Design project will lead to detailed hardware design and skeletal operating system.

#### **CmpE 4760. Advanced Computer Architecture** 3-0-3. Prerequisites: CS 3760 or CmpE 3510; CS 3431 recommended.

An advanced study of computer architecture, emphasizing high-performance single processor computers. Control unit and execution unit pipelining, instruction level parallelism, high performance memory systems, RISC architectures, vector computers.

## **CmPE 4811-2-3-4-5. Special Topics**

Last digit in each course number designates corresponding number of credit hours. Normally taken by seniors.

New developments in computer engineering are presented as demand or interest warrants.

## **ELECTRICAL ENGINEERING**

### **EE 2200. Introduction to Discrete Systems**

3-3-4. Prerequisite: MATH 1509 and CS 1501.

Analysis of discrete-time systems and signals. Block diagram representation of systems. Computer-aided analysis and simulation of basic applications in electrical and computer engineering.

### **EE 2250. Electric Circuit Analysis**

5-0-5. Prerequisites: EE 2200, MATH 2507, and PHYS 2122.

Analytical tools for passive networks. Kirchhoff's laws, mesh and node analysis, network theorems, DC and AC circuits. Solution via Laplace transform methods. Numerical simulation of circuits via SPICE.

## **EE 2811-2-3-4-5. Special Topics**

Last digit in each course number designates corresponding number of credit hours. Normally taken by sophomores.

New developments in electrical engineering are presented as demand or interest warrants.

### **EE 2900-1-2-3. Special Problems**

Credit to be arranged. Normally taken by sophomores.

Special engineering problems are assigned according to each student's needs, interests, and capabilities.

### **EE 3130. Electromagnetics with Computer Applications**

4-0-4. Prerequisites: EE 2250 and MATH 2508.

Study of electromagnetic fields for computer applications. Transmission lines, wave propagation, and waveguiding structures. Application to electromagnetic interference and circuit design.

### **EE 3180. Digital Integrated Circuits**

4-0-4. Prerequisite: EE 3280.

Analysis of digital integrated circuit families of importance to modern computer systems. Internal circuit operation, DC and transient characteristics, noise margins, fabrication, and applications.

### **EE 3200. Elements of Electrical Engineering I**

3-0-3. Prerequisites: PHYS 2122 and either MATH 2507 or MATH 2501.

Introduction to basic concepts of circuit elements, circuit models, and techniques for circuit analysis.

### **EE 3212. Signals and Systems I**

3-0-3. Prerequisites: EE 3250 and MATH 3308.

Theory of signals and linear time-invariant systems. Fourier analysis and applications to modulation and filtering.

### **EE 3213. Signals and Systems II**

3-0-3. Prerequisite: EE 3212.

Theory of Laplace and Z-transforms for solving circuits and representing systems. Feedback systems and applications. Sampling. Discrete-time signals and systems.

### **EE 3214. Systems and Controls**

3-0-3. Prerequisite: EE 3213.

Frequency-domain control techniques for linear systems, computer-aided design projects.

### **EE 3230. Linear Systems and Transforms**

4-0-4. Prerequisite: EE 2250.

Theory of signals and linear time-invariant systems. Convolution, Fourier analysis, and linear transforms. Relation of computer-aided simulation tools to the mathematical methods.

### **EE 3250. Elements of Electrical Engineering II**

3-0-3. Prerequisite: EE 3200. Corequisite: MATH 3308.

Time-domain analysis, ac circuits, and two-port networks.

### **EE 3270. Nonlinear Devices and Circuits**

3-0-3. Prerequisite: EE 3280.

Presentation of concepts important in the analysis and design of systems utilizing linear and nonlinear devices and circuits.

### **EE 3280. Electronic Circuits**

4-0-4. Prerequisite: EE 2250 or EE 3250.

Characteristics of diodes and transistors, and their application in amplifiers and switching circuits. Small-signal and large-signal circuit models. Various levels of integrated circuits are introduced.

### **EE 3300. Electromagnetics I**

3-0-3. Prerequisites: PHYS 2122 and ESM 2201. Corequisite: MATH 3308.

A study of Maxwell's equations. Electromagnetic theory of simple media. Electrostatics, magnetostatics, and electromagnetostatics.

### **EE 3310. Electromagnetics II**

3-0-3. Prerequisites: EE 3300 and either EE 2250 or 3250.

An introduction to the theory and applications of plane waves and transmission lines.

### **EE 3330. Electromechanical Systems and Energy Conversion**

3-0-3. Prerequisite: EE 3310.

Fundamentals of electromechanical energy conversion, electromechanical devices and systems. Energy state function, force energy relationships, basic transducers, introduction to A.C. and D.C. machines.

### **EE 3340. Random Signals and Noise**

3-0-3. Prerequisites: EE 3213 or EE 3230.

Study of probability, random variables, and random processes for applications in electrical engineering.

### **EE 3351. Fundamentals of Microelectronic Devices**

3-0-3. Prerequisites: PHYS 2123 and CHEM 1102. Corequisite: MATH 3308.

Physics and fabrication of semiconductor devices and integrated circuits. Device terminal relations from consideration of charge carriers and band structure of materials. IC fabrication.

**EE 3400. Instrumentation Laboratory**

1-3-2. Prerequisite: EE 2250 or EE 3250.

Introduction to instrumentation equipment and techniques. Basic laboratory techniques and practice. Operation of oscilloscopes and meters. Measurement of parameters of electrical engineering components and devices.

**EE 3431. Junior Electrical Engineering Laboratory III**

0-3-1. Prerequisites: EE 3270 and EE 3480.

Presentation of topics for experimentation in circuits and electronics which illustrate the operation and application of integrated circuits.

**EE 3480. Electronic Circuits Laboratory**

0-3-1. Prerequisite: EE 3280.

Experiments on the properties of diodes, transistors, operational amplifiers, and digital switching networks. Comprehensive coverage of the analysis, design, and testing of electronic circuits.

**EE 3703. Electric Power Conversion**

2-0-2. Prerequisite: EE 2250, EE 3710, or EE 3250.

Not for electrical engineering students. A study of energy conversion principles and devices such as motors, generators, transformers, and rectifiers.

**EE 3710. Introduction to Electronic Systems**

3-0-3. Prerequisite: PHYS 2122.

Not for electrical or computer engineering students. An introduction to electric circuit elements and electronic devices and a study of circuits containing such devices. Both analog and digital systems are considered.

**EE 3741. Electronic Systems Laboratory**

0-3-1. Prerequisite: EE 3710.

Not for electrical or computer engineering students. A survey of modern electronic circuits used in analog and digital systems.

**EE 3811-2-3-4-5. Special Topics**

Last digit in each course number designates corresponding number of credit hours. Normally taken by juniors.

New developments in electrical engineering are presented as demand or interest warrants.

**EE 3900-1-2-3. Special Problems**

Credit to be arranged. Normally taken by juniors.

Special engineering problems are assigned according to each student's needs, interests, and capabilities.

**EE 3951-2-3. Undergraduate Research**

Credit to be arranged. Prerequisite: normally taken by juniors.

These courses enable students to receive credit for participating in organized research programs (such as UROP) under the supervision of a faculty member.

**EE 4010. Electric Machines**

3-0-3. Prerequisite: EE 3330.

Constructional features, operational characteristics, and equivalent circuits of transformers and rotating induction, synchronous, and DC machines.

**EE 4011. Analog Filter Design**

3-0-3. Prerequisite: EE 3213 or EE 3230.

An introduction to the theory, design techniques, and applications of analog passive and active filters.

**EE 4012. Electric Energy Conversion**

3-3-4. Prerequisite: EE 3330.

Principles of rotating A.C. and D.C. machines. Analysis techniques and application studies of individual and interconnected devices. Coordinated laboratory exercises.

**EE 4014. Introduction to Automation and Robotics**

3-0-3. Prerequisite: EE 3213 or EE 3230.

Basic concepts of automation and the role of robotics in assembly and manufacturing. Robotic systems are studied, focusing on design, control, and applications.

**EE 4015. Principles of Feedback Control**

3-3-4. Prerequisites: EE 3213 and EE 3230.

A study of automatic control systems. Basic control principles, system modeling, and analysis techniques. Coordinated laboratory exercises.

**EE 4016. Feedback Control System Design and Implementation**

3-3-4. Prerequisite: EE 4015.

A major design experience in control systems. Specification, design, and construction of signal transducers, and construction and testing of the overall system. An introduction to modern control theory.

**EE 4019. Power System Analysis**

3-0-3. Prerequisite: EE 3330.

A study of power systems, power system components, and techniques of analysis.

**EE 4023. Integrated Circuits and Systems**

3-0-3. Prerequisite: EE 3270.

Introduces the principles of analog design using integrated circuit technologies and prepares the student for work in the analog IC design industry or provides a background for further course work.

**EE 4024. Speech Analysis, Synthesis, and Compression**

3-0-3. Prerequisite: EE 3213 or EE 3230.

Modern speech analysis and synthesis techniques as applied to the communication problem of speech synthesis. Classical phonology, vocoders, vocal tract analogs, spectral analysis of speech.

**EE 4026. Audio Engineering**

3-0-3. Prerequisites: EE 3270 and EE 3310.

An introduction to the application of the tools of electrical engineering to the detection, measurement, processing, recording, and reproduction of audio frequency signals. Basic principles of sound. Microphones. Loudspeakers. Power amplifiers. Disk phonograph systems. Magnetic tape systems. Broadcast audio. Audio signal processing. Acoustical instrumentation.

**EE 4031. Microwave Devices and Circuits**

3-0-3. Prerequisite: EE 4130.

To acquaint the student with specific properties of



microwave transmission lines and waveguides, with the design of passive microwave components, and with the characteristics of various microwave sources.

## **EE 4037. Antennas**

3-3-4. Prerequisite: EE 4130.

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.

## **EE 4038. Introduction to Radar**

3-0-3. Prerequisites: EE 4130 and satisfaction of the probability requirement.

An introduction to radar system, including the operation of pulsed, CW, CWF, and MTI radars. Surveys the application of antennas, probability, and signal processing to radar.

## **EE 4045. Power System Protection**

3-0-3. Prerequisite: EE 4019.

An introduction to fundamental concepts in the protection of electric power system apparatus.

## **EE 4046. Power System Engineering**

3-0-3. Prerequisite: EE 4019.

Modeling of power system elements and components, elements of steady-state operation and power system protection.

## **EE 4047. Power Electronics**

3-0-3. Prerequisites: EE 3213, EE 3280, and EE 3330.

An introduction to power semiconductor devices and to the electronic circuits incorporating these devices that can be used in the amplification, generation, and control of electrical energy.

## **EE 4050. Optical Engineering**

3-0-3. Prerequisite: EE 3310.

Introduction to optics and optical systems as applied to modern engineering problems. Image formation, holography, optical data processing, optical memories, specification of optical systems, fiber optics.

## **EE 4051. Fiber Optics**

3-0-3. Prerequisite: EE 4130.

An introduction to optical fibers as applied to communication systems. Topics include field theory of step index fibers, dispersion, coupling, sources, detectors, and elementary system design.

## **EE 4052. Fiber Optics Laboratory**

2-4-4. Prerequisite: EE 4130.

Basic optical laboratory equipment and techniques. Characterization of basic components of optical communication systems. State-of-the-art fiber test equipment.

## **EE 4055. Semiconductor Device Electronics**

3-0-3. Prerequisite: EE 3300 and EE 3351.

An introduction to the basic physical principles involved in the analysis of semiconductor devices important to microelectronics and instrumentation.

## **EE 4056. Integrated Circuit Fabrication**

3-0-3. Prerequisite: EE 4055 or EE 4023.

A basic study of the fabrication processes required to create silicon-integrated circuits. Emphasis is placed on wafer processing techniques and device realization.

## **EE 4057. Integrated Circuit Device Electronics**

3-0-3. Prerequisite: EE 4055.

A detailed examination of the active devices important in high-density integrated circuits. Emphasis is placed on advanced device physics and design aspects.

## **EE 4058. Electronic Systems Packaging**

3-0-3. Prerequisites: EE 3280 and EE 3351.

Survey of mainstream and newly emerging technologies for packaging from the die level to the system level. Treatment of design issues surrounding high-performance systems.

## **EE 4061. Communication Systems**

3-0-3. Prerequisites: EE 3340 and either EE 3213 or EE 3230.

Modern binary and M-ary digital signaling techniques. Noise processes and their effect on binary signaling. Matched filter receivers.

## **EE 4062. Communication Systems Laboratory**

0-3-1. Prerequisite: EE 3400. Corequisite: EE 4061.

Experiments in signal processing and communication systems.

## **EE 4063. Communication Systems II**

3-0-3. Prerequisite: EE 4061.

Performance analysis of analog and M-ary digital communications in noise. Satellite communications link analysis. AM, FM TV stereo systems. Spread-spectrum techniques.

## **EE 4064. Introduction to RF Design**

3-0-3. Prerequisites: EE 3213, EE 3270, and EE 3310.

Basic radio frequency design techniques using lumped element circuits in the frequency range from 1 to 1000 MHz.

## **EE 4065. RF Amplifier Design**

3-0-3. Prerequisite: EE 4064.

The concepts introduced in EE 4064 are expanded into systematic procedures for the analysis and design of radio frequency amplifiers. Emphasis is on wide band width, S-parameter-based design at VHF and higher frequencies.

## **EE 4066. Advanced RF Amplifiers and Oscillator Design**

3-0-3. Prerequisite: EE 4065.

Advanced techniques applicable to the design of radio frequency amplifiers and oscillators. Emphasis on microstrip implementation of UHF and microwave circuits.

## **EE 4067. Radio Receiver and Transmitter Design**

3-0-3. Prerequisite: EE 4065.

Advanced techniques for modern radio receiver and transmitter design. Linear and nonlinear communication circuitry is examined in detail.

## **EE 4072. Automatic Measurements**

2-3-3. Prerequisite: EE or CmpE senior standing.

An introduction to measurements carried out by instruments and a programmable controller via the IEEE-488 general purpose interface bus.

**EE 4074. Local Computer Networks**

3-0-3. Prerequisite: satisfaction of the probability requirement.

An introduction to the design and performance analysis of local computer communication networks, emphasizing analysis of representative multi-access procedures. Polling networks, random access networks, and ring networks are considered in detail.

**EE 4075. Microcomputer-based Design**

3-3-4. Prerequisite: CmpE 2510.

Development of the ability to define and design "smart" devices and instruments using a microcontroller (i.e., a single-chip microcomputer) is emphasized.

**EE 4077. Interfacing Small Computers**

3-3-4. Prerequisites: CmpE 2510 and familiarity with C language programming.

Design, implementation, and debugging of computer interfacing circuits. PC architecture, bus, interrupts, direct memory access, and I/O capabilities. Design project in a laboratory environment.

**EE 4078. Digital Signal Processing**

3-0-3. Prerequisite: EE 3213 or EE 3230.

An introduction to the theory and application of processing discrete data. Special attention will be paid to the design and implementation of both FIR and IIR digital filters.

**EE 4081. Introduction to Bioelectronics**

3-0-3. Prerequisite: EE 3310.

An introduction to the quantitative study of the electrophysiology in the human body. Membrane biophysics, action potentials, extracellular fields, electrophysiology of the heart and skeletal muscle, and functional neuromuscular stimulation.

**EE 4082. Linear System Theory**

3-0-3. Prerequisite: EE 3213 or EE 3230.

Linear system theory with emphasis on transform and state-variable methods. Applications to both continuous and discrete systems.

**EE 4083. Computer Simulation of Systems**

3-3-4. Prerequisite: EE 3213 or EE 3230.

Numerical modeling of systems. Predictive tools including neural networks, optimization techniques, and modeling of differential equations.

**EE 4084. Transistor Circuit Analysis**

3-0-3. Prerequisites: EE 3270 and EE 3431. Mandatory corequisite: EE 4085.

Analysis and design of linear electronic circuits. Single-stage amplifiers, multistage amplifiers, tuned amplifiers with emphasis on design techniques.

**EE 4085. Electronic Design Laboratory**

0-3-4. Mandatory corequisite: EE 4084.

Practical design problems that emphasize creativity and imagination are posed, and their solutions are individually implemented in the laboratory.

**EE 4086. Operational Amplifier Design**

3-3-4. Prerequisites: EE 3270 and EE 3431.

Theory and applications of operational amplifiers as they are currently utilized in today's electronic systems to produce both linear and nonlinear functional operations.

**EE 4087. Biomedical Instrumentation**

3-3-4. Prerequisites: EE 3280 and EE 3480 or EE 3710 and EE 3741.

An introduction to the principles, applications, and design of the medical instruments most commonly used in hospitals. Laboratory design projects.

**EE 4089. Bioengineering Design**

2-6-4. Prerequisites: EE 4081 and EE 4087

Students work in teams on bioengineering projects. Lectures address topics concerning the art of the design process and the practical design issues facing the bioengineer.

**EE 4090. EE Senior Seminar**

1-0-1. Prerequisite: EE or CmpE junior standing.

Bridge between an undergraduate electrical engineering education and a postgraduate career. Weekly lecture followed by a question-and-answer period.

**EE 4095. Electrical Transients in Power Systems**

3-0-3. Prerequisite: EE 4019.

Analysis of transient conditions in power systems. System parameters. Types of transients. Protective devices and techniques.

**EE 4110. Electrical Engineering Design**

0-9-3. Prerequisite: EE or CmpE senior standing.

Individualized electrical and electronic design projects, selected in consultation with the student's faculty adviser.

**EE 4120. Microelectronics Design Experience**

1-6-3. Prerequisites: EE 4055, EE 4056, and EE 4752.

A major design experience in microelectronics specialty area. Students propose and design a microelectronic device such as an operational amplifier, MEMS, or photodetector array.

**EE 4121. Device Fabrication and Evaluation**

1-9-4. Prerequisite: EE 4120.

Students place a previously designed fabrication process into practice to fabricate and evaluate a microelectronic device.

**EE 4130. Electromagnetics Applications**

3-0-3. Prerequisite: EE 3310.

Concepts in waveguiding and radiation, with applications to microwave engineering and optics.

**EE 4140. Power Systems Design**

2-6-4. Prerequisite: EE 4046

Protective relaying operation. A major design project concerning integrated power system design and operations.

**EE 4141. Introduction to Building Electrical Systems**

3-0-3. Prerequisites: EE 2250, EE 3250, or EE 3710.

Electric power distribution systems for buildings and plants. Study of National Electric Code. Lighting design considering sources, luminaries, and reflectances.

**EE 4142. Introduction to Illumination Engineering**

3-0-3. Prerequisites: PHYS 2123, EE 3310, and EE 4141.

Discussion of light and human vision. Presentation of various light sources, luminaries, and photometrics. Introduction to system designs.

## **EE 4143. Advanced Building Electrical Systems**

2-6-4. Prerequisite: EE 4142.

Power system harmonic analysis techniques. Computer techniques for system load studies. An integrated design project dealing with electrical building systems.

## **EE 4160. Communication System Design**

3-3-4. Prerequisite: EE 4061.

Computer-aided design and performance evaluation of communication systems.

## **EE 4170. Digital Signal Processing Laboratory**

1-3-2. Prerequisite: EE 4078.

Computer-based laboratory experiments for digital signal processing. Computer tools for filtering and frequency response. Introduction to FFT, spectrum analysis and filter design software.

## **EE 4171. Applications of Digital Signal Processing**

3-0-3. Prerequisite: EE 4078.

Applications of digital signal processing to speech processing, image processing, radar, and adaptive filters. The emphasis is on computer implementation of processing systems for the various applications.

## **EE 4172. Real-time Digital Signal Processing Implementation**

2-6-4. Prerequisites: EE 4078 and CS 1502.

Real-time implementation of signal processing algorithms using a DSP microprocessor and computer host processor. Software development and testing for host and real-time I/O.

## **EE 4173. Design Synthesis of Application-specific Signal Processors**

3-3-4. Prerequisites: EE 4078 and CmpE 2510.

Specification, VLSI implementation and verification of application-specific signal processing circuits using a hardware description language. Design tools. Optimization of designs.

## **EE 4411. Senior Electrical Engineering Laboratory I**

0-3-1. Prerequisites: EE 3400 and EE 4130.

The use, operation, and limitations of standard electromagnetic field measurement and signal generating equipment.

## **EE 4421. Senior Electrical Engineering Laboratory II**

0-3-1. Prerequisites: EE 3330 and EE 3400 or EE 3703 and EE 3741.

Experimental studies of electromagnetic and electromechanical systems.

## **EE 4751. Laser Theory and Applications**

3-0-3. Prerequisite: PHYS 2123.

Principles of laser operations. Types of lasers. Survey lectures on the applications of lasers to various fields. Also taught as PHYS 3751.

## **EE 4752. Silicon Integrated Circuit Processing Laboratory**

1-4-3. Prerequisite: EE 3351

Introduction to several critical process steps used in the fabrication of integrated circuits. Each student fabricates and electrically characterizes a silicon wafer of p-MOS transistors. Also taught as ChE 4752.

## **EE 4780. Energy Conversion Engineering**

3-0-3. Prerequisite: thermodynamics.

Principles of advanced energy conversion for electric power. Operation and engineering considerations. Also taught as ME 4780 and NE 4780.

## **EE 4811-2-3-4-5. Special Topics**

Last digit in each course number designates corresponding number of credit hours. Normally taken by seniors.

New developments in electrical engineering are presented as demand or interest warrants.

## **EE 4900-1-2-3. Special Problems**

Credit to be arranged. Normally taken by seniors.

Special engineering problems are assigned according to each student's needs, interests, and capabilities.

## **EE 4951-2-3. Undergraduate Research**

Credit to be arranged. Prerequisite: normally taken by seniors.

These courses enable students to receive credit for participating in organized research programs (such as UROP) under the supervision of a faculty member.

## **EE 6050. Random Processes I**

3-0-3. Prerequisite: graduate standing.

An introduction to the concepts of probability theory and random variables with applications to electrical engineering problems.

## **EE 6051. Random Processes II**

3-0-3. Prerequisite: EE 6050 or equivalent.

An introduction to the theory of stochastic processes. Filtering and harmonic analysis. Energy properties. Wiener, Poisson, Gaussian, Markov processes. Engineering applications are emphasized.

## **EE 6057. Telecommunications I**

3-0-3. Prerequisite: EE 6050.

Basic binary and M-ary digital signaling techniques with emphasis on the effects of noise. Performance analysis and comparisons of alternative systems.

## **EE 6058. Telecommunications II**

3-0-3. Prerequisite: EE 6057.

Design and performance evaluation of digital communication systems operating over time-dispersive band-limited channels.

## **EE 6063. Methods in Pattern Recognition**

3-0-3. Prerequisite: EE 6050.

Approaches to pattern classification, feature extraction, and training are considered, including the use of linear discriminant functions, clustering, gradient methods, and syntactic pattern recognition. Several examples of pattern recognition systems are also included.

## **EE 6070. Fourier Techniques and Signal Analysis**

3-0-3. Prerequisite: graduate standing.

Fourier transform applications to the analysis of signals in communications, controls, electromagnetics, optics, and signal processing.

## **EE 6072. Fourier Optics and Holography**

3-0-3. Prerequisite: EE 6070.

Principles of diffraction, lenses, coherent and incoherent imaging, optical information processing, and holography presented in a linear systems framework.

**EE 6073. Optical Signal Processing**

3-0-3. Prerequisite: EE 6072.

An introduction to the principal concepts, methods, and technology of coherent, incoherent, acousto-optic, numerical, and logic-based optical signal processing.

**EE 6081. Information Theory**

3-0-3. Prerequisite: graduate standing.

The concepts of information, information rate, and channel capacity are developed and applied to communication theory problems.

**EE 6082. Coding**

3-0-3. Prerequisite: graduate standing.

Coding techniques for efficient, reliable communication are introduced. Techniques studied include parity-check, maximal-length, Hamming, BCH and convolutional codes, Viterbi decoding and coding for burst-noise channels.

**EE 6083. Coding Theory II**

3-0-3. Prerequisite: EE 6082.

Finite field theory and its use in the design and analysis of error control schemes for digital communication systems.

**EE 6086. Cryptography and Data Security**

3-0-3. Prerequisite: graduate standing.

Use of information theory, complexity theory, and number theory for design and evaluation of cryptosystems. Techniques for defeating cryptosystems and implementation issues.

**EE 6090. Satellite Communications Systems**

3-0-3. Prerequisite: graduate standing.

Satellite communications system design including microwave transmission, satellite transponders, earth station hardware (antennas, microwave components, analog and digital modulation schemes), and satellite networks.

**EE 6092. Computer Communication Systems**

3-0-3. Prerequisite: graduate standing.

A study of quantitative design techniques for computer communication networks. Capacity assignment, concentrator and buffer design, and choice of network geometry are among topics covered.

**EE 6093. Communications Networks**

3-0-3. Prerequisite: EE 6050; EE 6051 is strongly recommended.

An introductory presentation of queueing theory and its application to the performance evaluation of local area networks.

**EE 6094. Broadband Switching Systems**

3-0-3. Prerequisite: EE 6050.

Broadband switching systems designed to support multirate, multicast, and multimedia sources. Multirate circuit switching, ATM cell-based packet switching architecture, and B-ISDN standards.

**EE 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.

**EE 6101. Time Varying and Nonlinear Systems**

3-0-3. Prerequisite: EE 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 Liapunov and Popov's theories.

**EE 6102. Nonlinear Control Systems**

3-0-3. Prerequisite: EE 6100.

Controllability and observability of nonlinear systems. Differential geometric approach for analysis and feedback design of nonlinear dynamic systems. Applications.

**EE 6111. Feedback Control Systems I**

3-0-3. Prerequisite: EE 6100.

Optimal control approach to control system design. Formulation of optimal control problems using state-space programming, calculus of variations and maximum principles.

**EE 6112. Feedback Control Systems II**

3-0-3. Prerequisites: EE 6050 and either EE 6111 or EE 6131.

Design techniques for stochastic dynamical systems. Analysis of stochastic systems, state estimation, stochastic control, and adaptive control.

**EE 6113. Feedback Control Systems III**

3-0-3. Prerequisite: EE 6100.

Application of discrete time control to continuous systems. Time and frequency domain analysis of sampled data systems.

**EE 6114. Adaptive Systems**

3-0-3. Prerequisite: EE 6100.

Parameter adaptation for the identification and control of dynamic systems. Adaptive techniques applied to systems with state feedback and generalized to systems with only output feedback. Convergence, robustness, and extensions to nonlinear systems.

**EE 6131. Optimum Linear Filters**

3-0-3. Prerequisites: EE 6050 and EE 6100.

Estimation theory, both classical and modern approaches. Applications in communication and control. System identification techniques.

**EE 6132. Nonlinear Filtering**

3-0-3. Prerequisite: EE 6051 and EE 6131.

The modern theory of random processes, including the Ito-stochastic calculus, the use of martingale methods, and some of the recent developments in nonlinear filtering theory.

**EE 6152. Computer Simulation**

3-0-3. Prerequisites: graduate standing.

A study of computational methods for use in the digital simulation of deterministic systems. Several simulation projects are a part of the course.

**EE 6154. Computer Hardware and Software for Manufacturing**

3-0-3. Prerequisites: graduate standing.

This course provides an overview of the basic information processing services required to support manufacturing systems and processors. It is designed for the Computer Integrated Manufacturing Systems Program. Not for EE majors.

**EE 6155. Computers in Manufacturing Laboratory**

0-3-1. Prerequisite: graduate standing.

Introductory laboratory covering robot simulation, digital and analog I/O, and asynchronous communication. Not for EE majors.

**EE 6180. VLSI Design I**

3-0-3. Prerequisite: CmpE 4180.

An introduction to very large scale integrated circuit design and performance analysis. Individual subcircuit cell design is emphasized.

**EE 6181. VLSI Design II**

3-0-3. Prerequisite: EE 6180.

A study of very large scale integrated circuit design tools and automated placement and routing. Testing and design for testability are emphasized.

**EE 6191. Digital Systems Testing**

3-0-3. Prerequisite: CmpE 3500; CmpE 4180 is recommended. Test methodologies and design techniques for improving testability of combinational and sequential digital systems. Applications in computer architecture and integrated circuit design. Includes design project.

**EE 6201. Automata Theory I**

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.

**EE 6202. Automata Theory II**

3-0-3. Prerequisite: EE 6201.

A continuation of digital system study, including fault detection and decomposition of systems. Reliability, memory span, and quadded logic are also examined.

**EE 6203. Automata Theory III**

3-0-3. Prerequisite: graduate standing.

An introduction to finite automata through study of sequential circuits. Concepts in modern algebra are developed for direct application to sequential circuits.

**EE 6250. Microwave Design Laboratory**

0-3-1. Prerequisite: EE 4031 or EE 6252.

Design and test of passive microwave components using automated measurement techniques.

**EE 6251. Applied Electromagnetics**

3-0-3. Prerequisite: graduate standing.

Advanced electromagnetic theory. Particular and complementary solutions of the wave equation for both discrete and continuous cases. Analysis, synthesis, and boundary value problems.

**EE 6252. Microwaves**

3-0-3. Prerequisite: EE 6251.

Field analysis of guided waves. Equivalent-circuit theory of microwave systems. Broadband impedance matching. Passive microwave devices. Microwave cavities. Periodic structures and filters.

**EE 6253. Antennas**

3-0-3. Prerequisite: EE 6251; EE 4037 is recommended.

Classical antenna theory. Antenna array analysis and synthesis. Electromagnetic characterization and design of several antenna types, such as wire, aperture, broadband, parasitic, helical, spiral, microstrip, and loop antennas. Introduction to antenna measurements.

**EE 6254. Antenna Measurements**

3-0-3. Prerequisite: EE 4037 or EE 6253.

Electromagnetic parameters of antennas. Far field, near field, and compact range antenna measurements. Laboratory demonstrations are included.

**EE 6261. Numerical Methods for Electromagnetics**

3-0-3. Prerequisite: graduate standing.

Introduction to numerical methods such as the finite-difference time-domain and the finite element methods applied to electromagnetics.

**EE 6301. Electro-optics**

3-0-3. Prerequisite: graduate standing.

Introduction to electro-optics with emphasis on lasers and modern optics. Topics include Gaussian beams, laser theory and laser types, mode-locking, Q-switching, harmonic generation, parametric oscillation, and light modulation. Applications discussed include high-power laser systems and optical communications.

**EE 6310. Analog Integrated Circuits Design I**

3-0-3. Prerequisites: EE 4023 and graduate standing.

Builds upon and further develops design and analysis techniques for the fabrication, modeling, and simulation of monolithic analog integrated circuits.

**EE 6311. Analog Integrated Circuits Design II**

3-0-3. Prerequisites: EE 4023 and graduate standing.

Develops advanced circuit design and research capabilities by building on the introduction to analog circuits provided in EE 4023.

**EE 6320. Analog Systems Design I**

3-0-3. Prerequisites: EE 4086 and graduate standing.

Introduces analog system design principles using integrated circuit technologies. System definition, design, simulation, and testing considerations of analog circuits such as A/D and D/A converters, switched capacitor circuits, and waveform generators.

**EE 6321. Analog Systems Design II**

3-0-3. Prerequisite: EE 6320.

Continuation of the study of the analysis, design, and interrelationships of complex analog integrated circuits and systems. Continuous time filters, switched capacitor filters, and an example of an existing complex analog integrated system.

**EE 6340. Integrated Optics**

3-0-3. Prerequisite: graduate standing.

Theory and design of guided wave optical devices and integrated guided wave optical systems including fiber optics.

**EE 6341. Fiber Optics**

3-0-3. Prerequisite: graduate standing.

Field theory of optical fibers with emphasis on fiber-based devices. Topics include pulse propagation, measurement techniques, sensors, and nonlinear effects.

**EE 6342. Nonlinear Optics**

3-0-3. Prerequisite: EE 6301. Quantum mechanics at the level of EE 6451 is recommended.

An introduction to the field of nonlinear optics, exploring the physical mechanisms, analysis methods, experimental techniques, and applications.

**EE 6345. Optical Modulation**

3-0-3. Prerequisite: graduate standing.

Birefringence; grating diffraction, electro-optic, photorefractive, and acousto-optic temporal and spatial modulation.

**EE 6360. Simulation and Modeling of Analog Circuits**

3-0-3. Prerequisite: graduate standing.

Introduction to the principles and methodology of analysis and design of both discrete and integrated analog circuits.

**EE 6369. Digital MOS ICs I**

3-0-3. Prerequisite: graduate standing; EE 6311 is a recommended corequisite.

Electronics foundation of VLSI systems design. Emphasis is on quantitative characterization of digital MOS circuits using analysis and computer techniques.

**EE 6370. Digital MOS ICs II**

3-0-3. Prerequisite: EE 6369.

Advanced digital MOS logic circuit techniques. Timing problems, soft node characteristics, system analysis styles, and structured logic approaches are covered.

**EE 6380. Frequency Synthesizers**

3-0-3. Prerequisites: EE 4086 and graduate standing.

The study of generating any arbitrary frequency from a given frequency standard. Digital and analog phase locked loops, frequency mixers, spurious signals, and phase noise are considered.

**EE 6381. Low-noise Electronic Design**

3-3-4. Prerequisites: EE 4023 and graduate standing.

Sources of noise in electronic instrumentation design and employment of design techniques to reduce the effects of noise.

**EE 6391. Medical Imaging Systems**

3-0-3. Prerequisites: EE 3213 or EE 3230 and graduate standing.

Principles of medical imaging systems. Tomographic imaging systems employing X-ray, ultrasound, nuclear medicine, and nuclear magnetic resonance.

**EE 6410. Adaptive Filtering**

3-0-3. Prerequisites: EE 4078 and EE 3340.

An introduction to the design and implementation of digital adaptive filters. Performance of a variety of different filtering algorithms and structures.

**EE 6413. Digital Filters**

3-0-3. Prerequisite: EE 4078.

Comprehensive treatment of the design, implementation, and application of digital signal processing algorithms. Sampling and A/D conversion, properties of discrete linear systems, digital filter design, implementation of digital filters, and fast algorithms for discrete Fourier analysis.

**EE 6414. Advanced Digital Signal Processing**

3-0-3. Prerequisites: EE 4078 and either EE 6050 or EE 3340.

A selection of advanced topics in digital signal processing. Topics include signal modeling, Wiener filtering, and power spectrum estimation.

**EE 6415. Digital Processing of Speech Signals**

3-0-3. Prerequisite: EE 4078 or EE 6413.

A detailed treatment of the theory and application of digital speech processing. Provides fundamental knowledge about speech signals and speech processing methods and about how digital techniques are applied in speech transmission, speech synthesis, speech recognition, and speaker verification.

**EE 6416. Multidimensional Digital Signal Processing**

3-0-3. Prerequisite: EE 4078.

An introduction to the analysis and manipulation of signals of more than one independent variable, such as images and arrays of sensors. Topics covered include multidimensional digital filtering and multidimensional spectrum analysis.

**EE 6417. Multiprocessor Architectures for Digital Signal Processing**

3-0-3. Prerequisite: EE 6413.

An introduction to the use of graph-theoretic, matrix, and statistical techniques to the implementation of digital signal processing algorithms by multiprocessor computers. Topics covered include matrix representations for flow graphs, finite word length effects, and synchronous and asynchronous implementations.

**EE 6418. Digital Image Processing**

3-0-3. Prerequisite: EE 4078 or EE 6413; EE 6050 is recommended.

An introduction to image processing fundamentals. Major topics include image compression, picture enhancement, image restoration, and segmentation.

**EE 6419. Spatial Array Processing**

3-0-3. Prerequisites: EE 4078 or EE 6413; EE 6050 and MATH 4305 strongly recommended.

An introduction to application areas where signals are sampled over space as well as time. Application of time-based techniques to spatial processing and the development of algorithms unique to spatial processing.

**EE 6421. Advanced Network Theory**

3-0-3. Prerequisite: graduate standing.

An introduction to applied combinatorics including combinations, permutations, recursion, partition, generating functions, inclusion and exclusion, rook polynomials, and Polya's theorem.

**EE 6431. Electroacoustics**

3-0-3. Prerequisite: graduate standing.

An introduction to the physical details needed to understand ultrasonic transducers, acoustic wave propagation and scattering, and the application of these details to systems for biomedical ultrasound, non-destructive evaluation, and acoustic microscopy.

**EE 6451. Electrical Properties of Materials**

3-0-3. Prerequisite: graduate standing.

Basis of quantum mechanical formalism and modeling to serve as an introduction to the modern study of electrical properties of materials.

## **EE 6452. Magnetic and Dielectric Properties of Materials**

3-0-3. Prerequisite: EE 6451.

Dielectrics, piezo- and ferroelectrics and their application to electromechanical devices. Quantum basis of magnetism. Magnetic interactions, domains, resonance, and devices.

## **EE 6453. Solid-state Electronic Devices**

3-0-3. Prerequisite: graduate standing.

Study of charge and energy transport in semiconductors with applications in pn junction, interface and thin film, optoelectronic and bulk-effect devices.

## **EE 6454. Microstructure Fabrication Techniques**

3-0-3. Prerequisite: EE 6310.

An examination of the physics, chemistry, and integrated circuit engineering techniques required to fabricate device structures with dimensions in the micron region.

## **EE 6455. Physical Properties of Semiconductors**

3-0-3. Prerequisite: EE 6451 strongly recommended.

An advanced presentation of solid-state physics, equilibrium and nonequilibrium statistical mechanics essential to the understanding of semiconductors and semiconductor devices.

## **EE 6456. Solar Cells**

3-0-3. Prerequisite: EE 4055 or EE 3351 or equivalent.

A practical understanding of semiconductor materials and technology as it relates to the development of efficient solar cells. Emphasis will be placed on opto-electronic properties of materials, basic operating principles of solar cells, modeling, design, and fabrication of high-efficiency solar cells.

## **EE 6461. Modern Magnetic Materials and Devices**

3-0-3. Prerequisite: EE 6452.

Basic operation and design of magnetic memories and microwave devices. Crystal structure, chemical composition. Properties of ferrites, garnets, and orthoferrites.

## **EE 6500. Introduction to Management and Control of Energy Systems**

3-0-3. Prerequisite: EE 6100.

Presents fundamental concepts of static and dynamic system theory as applied to typical energy engineering problems.

## **EE 6501. Planning of Power Systems**

3-0-3. Prerequisite: EE 6502; EE 6503 strongly recommended.

An introduction to planning procedures for large-scale technical operations. Technical and economic constraints on planning. Techniques for formulation of rational planning problems.

## **EE 6502. Control and Operation of Interconnected Power Systems**

3-0-3. Prerequisites: EE 4019 and EE 6100.

Power flow analysis techniques. Modern control of power systems with emphasis on security, economic, and environmental issues.

## **EE 6503. Evaluation of Power System Reliability**

3-0-3. Prerequisite: EE 4019.

Techniques for the study of power system reliability. Probabilistic models for power system performance. Techniques for subsystem and composite system reliability analysis.

## **EE 6511. Transmission Lines**

3-3-4. Prerequisite: graduate standing.

A study of electric power transmission line parameters, models and techniques for analysis of steady-state and transient conditions. AC, DC, HV, and underground transmission.

## **EE 6520. Real-time Control of Power Systems**

3-0-3. Prerequisites: EE 4019 and EE 6100.

Real-time control functions in power systems. Energy control centers. Hierarchical, automatic generation, reactive power, and emergency controls. Security constraint economic operation.

## **EE 6521. Power System Stability**

3-0-3. Prerequisites: EE 4019 and EE 6100.

Methods of stability analysis of interconnected power systems. System modeling, analysis techniques for determination of static and dynamic stability.

## **EE 6525. Adjustable Speed Drives**

3-3-4. Prerequisites: EE 4012 and either EE 4047 or EE 6531.

Study of the control schemes and the associated solid-state controllers required to achieve adjustable speed/torque characteristics of AC and DC motors.

## **EE 6526. High Voltage Techniques**

3-3-4. Prerequisites: EE 3330 and EE 4130.

Study of various high voltage phenomena, such as lightning and switching transients, and of the related simulation and measurement techniques. Practical high voltage laboratory experiments are included.

## **EE 6530. Power Semiconductor Devices**

3-0-3. Prerequisite: graduate standing.

The physical considerations involved in the use of heavy-current semiconductor devices.

## **EE 6531. Solid-state Power Conversion**

3-0-3. Prerequisite: graduate standing.

The physical and electrical considerations involved in the analysis and design of solid-state inverters and converters.

## **EE 6550. Multivariable System Theory**

3-0-3. Prerequisite: EE 6100.

Structural properties, controllability, observability, canonical forms. Applications to pole-shifting, decoupling, system realization and identification. Introduction to multidimensional systems.

## **EE 6757. Industrial Robotics**

3-0-3. Prerequisite: EE 4015 or ME 4445.

The hardware and software components of industrial robotic systems are studied. Robot configurations, motion description and analysis, programming, sensors, controls, end-effectors, actuation, and applications are included.

## **EE 6758. Sensors and Transducers in Manufacturing Systems**

3-0-3. Prerequisite: graduate standing.

Theory, design, and implementation of sensors for manufacturing processes. Applications of systems and controls and signal processing techniques.

**EE 6759. Engineering Intelligent Systems**

3-0-3. Prerequisite: graduate standing.

Concepts of machine intelligence, automata theory, and neural networks. The course focuses primarily on artificial intelligence methods for planning and control of large-scale engineered processes.

**EE 6760. Parallel Computer Architecture I**

3-0-3. Prerequisites: CS 3760 or CmpE 3510; CS/CmpE 4760 recommended.

Parallel computer architecture, focusing primarily on MIMD organization. Data dependence relationships, synchronization, multiprocessor scheduling, switching networks, shared memory architectures, multiprocessor cache coherence, message-based multicomputers, dataflow computers.

**EE 6761. Parallel Computer Architecture II**

3-0-3. Prerequisite: CS/EE 6760.

Parallel computer architecture, focusing primarily on SIMD and special purpose machine organization. Word-parallel and bit-serial SIMD machine architecture, skewed memory systems, reconfigurable architectures, VLSI computation, VLIW machines.

**EE 6790. Computer Integrated Manufacturing Systems I**

3-0-3. Prerequisite: graduate standing.

A broad overview of the functions, processes, and disciplines of computer integrated manufacturing.

**EE 6791. Computer Integrated Manufacturing Systems II**

3-0-3. Prerequisite: EE 6790.

An in-depth study of current issues, emerging technologies, and future developments in computer integrated manufacturing.

**EE 6792. Computer Integrated Manufacturing Systems Seminar**

1-0-1. Prerequisite: graduate standing.

Guest speakers on a broad range of CIMS related topics; research, applications, and technology.

**EE 6793. Robot Dynamics and Control**

3-0-3. Prerequisite: EE 6100.

The course provides an introduction to the control of robot manipulators and includes the following topics: robot arm kinematics and inverse kinematics, robot dynamics, classical and modern control schemes for robot arm control typified by optimal, adaptive, and nonlinear control.

**EE 6965. Power System Relaying**

3-3-4. Prerequisite: EE 4019.

Principles and techniques of electric power system protection. Application of relaying techniques for system stabilization, protection of high-voltage transmission system and substations. Coordinated field trips and demonstrations.

**EE 7000. Master's Thesis****EE 7051-2-3. Advanced Communication Theory**

3-0-3. Prerequisite: consent of the instructor.

Latest developments in communications are treated in

lecture and seminar. Emphasis on current literature and open research areas.

**EE 7101. Advanced Feedback Control Theory**

3-0-3. Prerequisite: EE 6100.

Advanced techniques for analysis and design of automatic control systems.

**EE 7251-2-3. Advanced Electromagnetic Theory**

3-3-4 each. Prerequisite: consent of the instructor.

Topics of fundamental importance in electromagnetics. Advanced developments in the fields of antennas, propagation, and microwave theory and practice.

**EE 7254. Antennas and Wave Propagation in Matter**

3-0-3. Prerequisite: EE 6251.

The analysis of antennas embedded in or near material bodies such as the earth or the ocean. Field equations and constitutive parameters in material regions; theoretical analyses of wire antennas; antennas as probes; wave propagation near a material interface; theory and construction of experimental scale models.

**EE 7255. Electromagnetic Scattering, Absorption, and Propagation**

3-0-3. Prerequisite: EE 6251 and undergraduate-level quantum mechanics.

Scattering, absorption, and emission processes underlying electromagnetic remote sensing. Applications in active and passive systems.

**EE 7261. Computational Methods for Electromagnetic Scattering**

3-0-3. Prerequisite: EE 6251.

Integral and differential equation formulations for electromagnetic scattering. Method of moments and finite element discretization processes.

**EE 8001-2-3. Seminar**

1-0-1. Prerequisite: graduate standing.

Speakers with diverse backgrounds and representing many different industries and institutions describe their experiences, entrepreneurial ventures, and research challenges.

**EE 8140 through 8149. Special Topics**

1-0-1 each.

Special topics of unusual current interest; introductory treatments of new developments in electrical and computer engineering.

**EE 8240 through 8249. Special Topics**

2-0-2 each.

**EE 8340 through 8349. Special Topics**

3-0-3 each.

**EE 8430 through 8439. Special Topics**

4-0-4 each.

**EE 8440 through 8449. Special Topics**

5-0-5 each.



**EE 8500-1-2-3. Special Problems**

Credit to be arranged. (Maximum of three credits per quarter.)

Problems meeting the special interests of the student.

Approval to schedule must be obtained in advance of registration.

**EE 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**EE 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**EE 9000. Doctoral Thesis**

## School of Industrial and Systems Engineering

**School established in 1945, Department in 1924**

**Location: Groseclose Building**

**Telephone: 404 894-2300**

*Director and Professor*—John J. Jarvis, Robert N. Lehrer (emeritus); *Associate Director for Undergraduate Programs and Professor*—R. Gary Parker, Nelson K. Rogers (emeritus); *Associate Director for Graduate Programs and Professor*—William W. Hines; *Associate Director for Academic Support*—Donna C. Llewellyn; *A. Russell Chandler III Chair and Professor*—George L. Nemhauser; *Coca-Cola Chair and Professor*—Ellis L. Johnson; *Gwaltney Chair and Regents' Professor*—John A. White, Jr.; *UPS and Regents' Professor*—H. Donald Ratliff; *Regents' Professor Emeritus*—Harold E. Smalley; *Professors*—Jerry Banks, Earl R. Barnes, John J. Bartholdi III, John P. Crecine, Augustine O. Esogbue, Jack R. Lohmann, Leon F. McGinnis, Jr., Alan L. Porter, William B. Rouse (adjunct), Richard L. Serfozo, Alexander Shapiro, Michael E. Thomas, Gerald J. Thuesen, Craig A. Tovey, Gideon Weiss; *Professors Emeriti*—Leslie G. Callahan, David E. Fyffe, Cecil G. Johnson, Lynwood A. Johnson, Harrison M. Wadsworth, C.M. Shetty, Rocker T. Staton; *Associate Professors*—Christos Alexopoulos, Faiz Al-Khayyal, Jane C. Ammons, Willard R. Fey, Robert D. Foley, Marc Goetschalckx, David Goldsman, T.

Govindaraj, Paul M. Griffin, Steven T. Hackman, Anthony J. Hayter, Russell G. Heikes, Christine M. Mitchell, Justin A. Myrick, Loren K. Platzman (adjunct), Frank E. Roper, Martin Savelsbergh, Gunter P. Sharp, Kwok Tsui, John H. VandeVate, Donovan B. Young; *Assistant Professors*—Cynthia Barnhart, James Calvin, Lloyd Clarke, Victoria Chen, Jim Dai, Alexander C. Kirlik, Renato Monteiro, Shane Pederson, Chen Zhou; *Principal Research Engineer*—Ira W. Pence; *Co-director, Logistics Institute*—Edward H. Frazelle.

**General Information**

Industrial and systems engineering provides both a basic engineering foundation and a grounding in the interactions between technology and management. Students in the program are usually interested in obtaining a fundamental engineering background as the basis for professional specialization in activities associated with the field—operations research, management science, systems engineering, methods, organization, planning—or as preparation and foundation for other endeavors such as management, law, medicine, health systems, or other pursuits. The study of industrial and systems engineering places emphasis upon developing the student's abilities to analyze and design systems that integrate technical, economic, and social behavioral factors in industrial, service, social, and government organizations. The degree program offered is the Bachelor of Industrial Engineering (B.I.E.).

**Bachelor of Industrial Engineering**

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

## Options for Exceptional Students

An optional program is available to encourage students with superior abilities to participate in a range of unusual educational opportunities. Participation in these programs requires demonstrated scholastic excellence and prior arrangement with the student's adviser. The program includes the following options, individually or in combination.

### Graduate-level courses in lieu of senior-year electives

Students with a cumulative grade point average of 3.3 or above may schedule up to nine credit hours of approved graduate-level courses. These credits, when approved by the student's adviser, may apply subsequently toward a graduate degree.

### Accelerated study

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

### Individual project and research work

Students with a 3.0 average or above during the preceding three quarters (including at least 45 credits) may schedule up to 12 credits of project work, research work, or both. The student will perform this work, which may substitute for senior-year electives, in collaboration with the faculty or advanced graduate students. Students with less than a 3.0 average are limited to six credits of such project or research work.

### Visiting scholar/practitioner offerings

Occasionally, the School brings to campus selected individuals of unique accomplishment for course offerings built around their special areas of activity, thus making available a broader range of course materials than regularly provided. The

typical schedule is Friday afternoon and evening instruction four times during the quarter.

## Health Systems

Health systems is the field of study and practice aimed toward improving the delivery of health care services through the application of systems science and management engineering. Programs emphasize systematic planning, engineering design, and scientific management in respect to health care facilities, manpower, and methods.

The program in health systems is an academic aspect of the School of Industrial and Systems Engineering. The program has education, research, and service components, and it engages in interdisciplinary and interinstitutional research, continuing education, and community outreach activities through the Health Systems Research Center.

Undergraduate elective courses prepare students for professional careers as health systems analysts and hospital management engineers.

## Graduate Programs

The School of Industrial and Systems Engineering offers five master's degrees: the Master of Science in Industrial Engineering, the Master of Science in Operations Research, the Master of Science in Statistics, the Master of Science in Health Systems, and the undesignated Master of Science. It also offers the Doctor of Philosophy.

The M.S.I.E. program is available to students with an industrial engineering background and to other engineers who satisfy requirements covering the principal subject matter of the current Bachelor of Industrial Engineering curriculum. The M.S.O.R., M.S.S., and M.S.H.S. programs are available for students holding the B.S. in engineering, mathematics, or science. Requisites include work in probability, statistics, engineering economy, linear algebra, advanced calculus, and optimization, as well as selected application area work. The student may satisfy these requirements after enrollment; however, such course work may not apply toward fulfilling the degree requirements. The undesignated M.S. program is for those students who wish to work in the areas of systems analysis, human-machine

systems engineering, or manufacturing systems. An undesignated M.S. program (thesis option) is also available for students who wish to pursue specific objectives not covered by the programs above.

The programs in industrial engineering, operations research, statistics, and health systems and the undesignated master's programs in systems analysis and manufacturing systems offer the option of either taking 33 credit hours of course work plus 15 credit hours of research culminating in a thesis, or taking 48 credit hours of course work. Under the undesignated master's degree, the program in human-machine systems permits only the thesis option.

The doctoral program is intended for highly qualified individuals for whom past accomplishments and evaluation 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. Students may begin graduate programs in any quarter.

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

### **Video-based Master's Program**

The School of Industrial and Systems Engineering offers working professionals throughout the continental United States the opportunity to enroll in many of its graduate courses through video technologies. Qualified individuals can complete the requirements for the master's degree utilizing the video-based delivery system. See page 16, video-based instruction.

### **Program in Algorithms, Combinatorics, and Optimization**

The program in algorithms, combinatorics, and optimization (ACO) is a multidisciplinary graduate program sponsored jointly by the School of Industrial and Systems Engineering, the College of Computing, and the School of Mathematics. The

program is arranged to bring together the study of discrete structures and the design and analysis of algorithms in areas such as graph theory, integer programming, combinatorial optimization, and polyhedral theory. It is intended for students possessing a strong background in one or more of the fields represented by the sponsoring units.

Each student in the program will have a single home department chosen from among the participating units, all of which contribute courses for the program. Students may apply to the ACO program at Georgia Tech through any one of these three units.

### **Multidisciplinary Programs**

See table on page 100.

### **Program in Statistics**

The School of Industrial and Systems Engineering in the College of Engineering, the School of Mathematics in the College of Sciences, and the School of Management in the Ivan Allen College offer graduate work leading to the Master of Science in Statistics. The nature of this cooperative program emphasizes statistics as a science necessary in a technological environment such as that at Georgia Tech. Within this program, students can concentrate their studies on a specific area of application such as engineering, quality control, or management. Although this program can lead to further work toward a doctorate in statistics, it will primarily provide the background requisite for a professional career in statistics.

Career fields for graduates of this program may be found in virtually all areas of research, industry, and government. The program is designed to provide the graduate with competence to organize the collection, analysis, and interpretation of data reinforced by a sound understanding of statistical principles. Students will work with faculty actively engaged in research and prepared to teach the latest developments in statistics. By following either a thesis or nonthesis program, the student may complete the degree program in 15 months. Students holding or anticipating an undergraduate degree from an accredited college or university in engineering, mathematics, science, or some other field that indicates a likelihood of successful completion of the program are encouraged to apply.

## Bachelor of Industrial Engineering Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ENGL 1001-2 (1)</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>CHEM 1101-2</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>CS 1501</b>			
Introduction to Computing and	.....	3-3-4	.....
<b>CS 1502</b>			
Introduction to Programming	.....	.....	3-6-5
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>Health and Performance Sciences</b> (requirements, p. 311)	X-X-3	.....	.....
<b>Humanities Elective (2)</b>	.....	.....	3-0-3
<b>TOTALS</b>	X-X-16	15-6-17	15-9-18

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>PHYS 2122</b>			
Electromagnetism	4-3-5	.....	.....
<b>PHYS 2123</b>			
Optics and Modern Physics	.....	4-3-5	.....
<b>ECON 2000-1</b>			
Principles of Economics I, II	3-0-3	3-0-3	.....
<b>ESM 2201</b>			
Statics	.....	.....	3-0-3
<b>ISYE 3027</b>			
Applications and Probability	.....	.....	3-0-3
<b>MGT 2000</b>			
Accounting I	.....	3-0-3	.....
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3308</b>			
Ord. Differential Equations with Linear Algebra	.....	.....	5-0-5
<b>PSY 3303</b>			
General Psychology I	.....	.....	3-0-3
<b>Social Sciences Electives</b>	3-0-3	3-0-3	3-0-3
<b>TOTALS</b>	15-3-16	16-3-17	17-0-17

### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MGT 2001</b>			
Accounting II	3-0-3	.....	.....
<b>ISYE 3025</b>			
Engineering Economy	.....	3-0-3	.....
<b>EE 3710</b>			
Intro. to Electronics Systems	3-0-3	.....	.....
<b>EE 3741</b>			
Electronic Systems Lab.	.....	0-3-1	.....
<b>ESM 3201</b>			
Dynamics	.....	.....	3-0-3
<b>ISYE 3028-9</b>			
Engineering Statistics I, II	3-0-3	3-0-3	.....
<b>ISYE 3105</b>			
Organizational Structures	.....	.....	.....
or			
<b>MGT 4100</b>			
Organizational Analysis	.....	3-0-3	.....
<b>ISYE 3010</b>			
Human-Machine Systems	.....	.....	3-0-3
<b>ISYE 3231</b>			
Deterministic Operations Research	3-0-3	.....	.....
<b>ISYE 3232</b>			
Probabilistic Operations Research	.....	3-0-3	.....
<b>ISYE 3305</b>			
Total Quality Management	3-0-3	.....	.....
<b>ISYE 4039</b>			
Quality Control	.....	.....	3-0-3
<b>ISYE 4044</b>			
Simulation	.....	.....	2-3-3
<b>Humanities Electives (2)</b>	3-0-3	3-0-3	3-0-3
<b>TOTALS</b>	18-0-18	15-3-16	14-3-15

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ISYE 3100</b>			
The Professional Practice of Industrial Engineering	0-3-1	.....	.....
<b>ISYE 4101</b>			
Operational Planning and Scheduling	3-3-4	.....	.....
<b>ISYE 4102</b>			
Operations and Facilities Design	3-3-4	.....	.....
<b>ISYE 4104-5</b>			

ISyE Design I, II	.....	0-9-3	0-9-3
<b>ISYE 4750</b>			
Data Base and Information			
System Development	.....	3-0-3	.....
<b>ENGL 3015</b>			
Public Speaking	3-0-3	.....	.....
<b>ENGL 3020</b>			
Technical Writing	.....	3-0-3	.....
<b>ME 3322</b>			
Thermodynamics I			
or			
<b>CE 3053</b>			
Fluid Mechanics	3-0-3	.....	.....
<b>Approved Technical</b>			
<b>Electives (4)</b>	.....	6-0-6	6-0-6
<b>Free Electives</b>	.....	.....	6-0-6
<b>TOTALS</b>	12-9-15	12-9-15	12-9-15

**Total Credit Hours Required for Graduation = 195**

## Electives

### (1) ENGL 1001-2

Freshmen who waive English 1001 or 1002 as a result of School of Literature, Communication, and Culture Placement Tests may substitute 2000-level or higher English courses that qualify as humanities.

### (2) Humanities Electives

See "Information for Undergraduate Students," p. 33, for humanities electives that satisfy the College of Engineering requirements. One such elective must be a 3000-level or higher English literature course.

### (3) Social Sciences Electives

Social sciences electives must include three hours of U.S. history, three hours of U.S. government, and three credit hours of social sciences. All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

### (4) Approved Technical Electives

A list of approved technical electives is available to all seniors in ISyE. Engineering design and engineering science requirements are specified.

## Health Systems Concentration

Industrial engineering undergraduates who wish to prepare themselves for practicing their profession in the rapidly expanding health industry may do so by taking various courses in health systems as a part of the approved technical electives under the B.I.E. curriculum. Georgia Tech has the only program of its type in the nation which offers undergraduates these course offerings within a B.I.E. curriculum. The health services industry is large, expensive, and in need of continuing improvement. Industrial engineers are making an important contribution to improving the quality of care and reducing the cost. These health systems courses are listed in the catalog under the "HS" designation along with the ISyE courses. They are typically offered with the same frequency as are other (non-health system) elective courses.

For students who wish to specialize further, a Master of Science in Health Systems (M.S.H.S.) is offered by the school as noted under Graduate Programs in this section.

## Electives

### Approved Elective

This elective will satisfy three of the six hours of free electives in the B.I.E. curriculum and is to be selected from a list of health systems and other courses approved by the faculty.

## Courses of Instruction

### INDUSTRIAL AND SYSTEMS ENGINEERING

#### ISYE 3010. Human-Machine Systems

3-0-3. Prerequisites: ISYE 3028, PSY 3303.

Human factors engineering and mathematical modeling of human-machine interaction in complex systems such as computers, aircraft, power generation, and process control. Emphasis on human perceptual and cognitive abilities related to interfaces.

#### ISYE 3014. Systems and Productivity

3-0-3. Prerequisite: ISYE 3105.

Human contributions to productivity and interaction of technical advances with human performance. Examination of impact of individual needs, leadership styles, and organizational design of productivity.

#### ISYE 3025. Engineering Economy

3-0-3. Prerequisite: MGT 2000 or equivalent. Limited to ISyE and HS students.

Methods of economic analysis in engineering, including decision problems, value measurement, interest relationships, criteria for decisions under certainty, risk, and uncertainty.

**ISYE 3027. Applications of Probability**

3-0-3. Prerequisite: MATH 1509.

Introduction to probability, emphasizing applications in science and engineering. Topics include probability concepts, random variables, discrete and continuous distributions.

**ISYE 3028. Engineering Statistics I**

3-0-3. Prerequisite: ISYE 3027 for ISyE students, CS 1410 or equivalent.

Introduction to statistical methodology, emphasizing applications in science and engineering. Topics include estimation, hypothesis testing, and process control.

**ISYE 3029. Engineering Statistics II**

3-0-3. Prerequisite: ISYE 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.

**ISYE 3100. The Professional Practice of Industrial and Systems Engineering**

0-3-1. Prerequisite: junior standing. Limited to ISyE students.

A laboratory seminar wherein students meet industrial and systems engineering practitioners to discuss their current work problems and career progression.

**ISYE 3105. Organizational Structures**

3-0-3.

The organizational elements, activities, and structures within which an industrial engineer functions.

**ISYE 3113. Physiological and Biomechanical Analysis of Work**

3-0-3.

Techniques of data collection and analysis for effective human-oriented tool and work place design.

**ISYE 3215. Design and Measurement of Work Methods**

3-0-3. Prerequisite: ISYE 3028.

Introduction to principles and techniques for analysis, design, and measurement of work methods.

**ISYE 3231. Deterministic Operations Research**

3-0-3. Prerequisites: Math 2508 and CS 1410.

Deterministic models and methods of operations research in solving engineering and management problems. Topics include linear models, linear programming, duality, post optimality analysis, and network analysis.

**ISYE 3232. Probabilistic Operations Research**

3-0-3. Prerequisite: ISYE 3027, 3231, or equivalent.

Stochastic models and methods in operations research to solve engineering and management problems. Includes queueing theory, queueing decision models, inventory models, Markov decision processes, and decision analysis under risk.

**ISYE 3233. Advanced Operations Research**

3-0-3. Prerequisite: ISYE 3232.

Further topics in modeling and methods for optimization. Includes advanced algorithms for linear programming, integer programming methods and applications, nonlinear programming, and dynamic programming.

**ISYE 3254. Creativity and Innovation in Engineering**

3-0-3. Prerequisite: junior standing.

Methods including examination of technological options, morphological analysis, brainstorming, metaphors and analogies, problem exposition, and concept generators. Principles of innovation and invention with examples. Numerous in-class exercises. Student project.

**ISYE 3260. Introduction to Systems Engineering**

3-0-3. Prerequisite: MATH 3308 or equivalent.

Introduction to classical/modern system analysis and feedback dynamics as applied to industrial engineering problems. Transfer functions, state models, transient and steady-state behavior, stability, and compensation.

**ISYE 3305. Total Quality Management**

3-0-3.

Introduction to the philosophy and application of Total Quality Management. Topics develop a continuous improvement approach based on systems thinking, understanding of variation, knowledge of psychology, and theory of knowledge.

**ISYE 4005. Nonlinear Programming**

3-0-3. Prerequisite: ISYE 3232 or equivalent.

Solution procedures for nonlinear programs. Unconstrained optimization, gradient and gradient-free methods, constrained optimization, Lagrange multipliers, penalty functions, and linear approximation methods.

**ISYE 4006. Integer and Dynamic Programming**

3-0-3. Prerequisite: ISYE 3232 or equivalent.

Optimization by dynamic and integer programming. Decision trees, optimality principle, and recursive relationships. Optimization in integer by cutting planes, branch and bound and implicit enumeration.

**ISYE 4024. Fundamentals of Materials Handling**

2-3-3. Prerequisites: ISYE 3025, 4102.

Development of procedures and techniques for analysis and solution of materials handling problems. Plant trips and laboratories utilized to illustrate modern materials handling methods.

**ISYE 4035. Project Management Systems Design**

2-3-3. Prerequisites: ISYE 3231 and senior standing.

Project planning and control using activity network analysis. Emphasizes network logic, scheduling computations, resource scheduling, time-cost trade-off algorithms and multiproject resource allocation.

**ISYE 4039. Quality Control**

3-0-3. Prerequisite: ISYE 3028 or equivalent.

Design of quality control systems. Quantitative techniques for establishing product specifications, process controls, acceptance inspection, and other techniques of quality assurance.

**ISYE 4044. Simulation**

2-3-3. Prerequisites: ISYE 3028, 3232.

Discrete simulation methodology emphasizing statistical basis for simulation modeling and modeling and experimentation. Overview of computer languages and continuous flow models. Laboratory exercises illustrating model architecture, inference, and optimization.

**ISYE 4073. Storage and Distribution Systems Design**

3-0-3. Prerequisite: ISYE 4102.

Fundamentals of designing efficient materials and product distribution systems emphasizing warehouse planning, materials and information flow, equipment selection, building design and location, automated warehousing and transportation.

**ISYE 4090. Legal and Ethical Phases of Engineering**

3-0-3. Prerequisite: senior standing.

Introduces the engineer to the ethical, legal, and professional attitudes to be encountered in the future working environment. Includes business, patent, and copyright law considerations.

**ISYE 4101. Operations Planning and Scheduling**

3-3-4. Prerequisites: ISYE 3231, 3232. Limited to ISyE and MSCI students.

Analytical methods for production and inventory control, emphasizing forecasting techniques, inventory models, application of mathematical programming and network models, sequencing and scheduling techniques, and line balancing.

**ISYE 4102. Operations and Facilities Design**

3-3-4. Prerequisites: ISYE 3232. Limited to ISyE and MSCI students.

Principles and practices in the design of operations and facilities for a productive system.

**ISYE 4104. ISyE Design I**

0-9-3. Prerequisites: ISYE 4101, 4044, 4102. Must be followed by ISYE 4105 in consecutive quarters. Limited to ISyE students.

Senior ISyE group design project requiring problem definition and analysis, synthesis, specification, and installation of a designed solution in off-campus enterprise environments.

**ISYE 4105. ISyE Design II**

0-9-3. Prerequisites: ISYE 4750, 4104. Limited to ISyE students.

Senior continuation of ISyE group design project sequence (ISYE 4104) requiring problem definition and analysis, and synthesis, specification, and installation of a designed solution.

**ISYE 4145. Simulation Applications**

2-3-3. Prerequisite: ISYE 4044.

Continuation and extension of ISYE 4044. Discrete-event simulation methodology with emphasis on analysis of systems and models. Input data analysis, validation, output analysis, inference, comparison of systems, optimization of systems. Advanced modeling techniques in a computer simulation language such as GPSS.

**ISYE 4256. Industrial Robotic Applications**

3-0-3.

This course focuses on the design, selection, control, and application of industrial robots in the CIM environment. Other topics include robotic cell design, collision-free path planning, repeatability studies, and economic justification.

**ISYE 4258. Systems Dynamics**

3-0-3.

System dynamics philosophy and methodology for modeling, simulating, analyzing, and improving dynamic behavior in human systems. Emphasis on large, nonlinear, feedback control systems. Student project.

**ISYE 4725. Engineering Economy**

3-0-3. Prerequisite: sophomore standing. Not available to ISyE students.

Fundamental principles and basic techniques of economic analysis of engineering projects, including economic measures of effectiveness, time value of money, cost estimation, break-even and replacement analysis.

**ISYE 4750. Data Base Information System Development**

3-0-3. Prerequisite: junior standing.

Development of data bases and information systems. The course covers system development life cycle, structured analysis/design tools, the relational data model, and information query processing.

**ISYE 4756. Technological Forecasting**

3-0-3. Prerequisite: senior standing.

Increasingly rapid technological change impacts industrial processes. Qualitative and quantitative methods are combined to predict the direction and magnitude of such changes.

**ISYE 4757. Technology Assessment**

3-0-3. Prerequisite: senior standing.

Systematic efforts to anticipate impacts on society that may occur when a technology is introduced, extended, or modified. Considers concepts, organization, and uses of various specific assessment methods.

**ISYE 4897-8-9. Special Topics**

3-0-3 each. Prerequisite: senior standing.

Courses in special topics of timely interest to the profession, conducted by resident or visiting faculty.

**ISYE 4991-2-3. Special Problems**

Credit to be arranged. Prerequisites: senior standing in ISyE and prior faculty topic approval.

A one- to three-hour credit opportunity to develop initiative and apply fundamental principles by performing senioriginal laboratory or research work in industrial and systems engineering.

**ISYE 4994-5-6. Research and Projects I, II, III**

Credit to be arranged. Prerequisites: senior standing in ISyE 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.

**ISYE 6101. Modern Organizations**  
3-0-3.

An overview of the essentials of organizational behavior with emphasis on analyzing, evaluating, and integrating organizational activities.

**ISYE 6205. Cognitive Engineering**

3-0-3. Prerequisites: participation in the Georgia Tech Cognitive Science program, the ISyE graduate program in human-machine systems, or permission of the instructor.

The application of existing cognitive science concepts to system design, and the development of concepts appropriate for understanding and aiding cognition in naturally or technologically complex environments.

**ISYE 6214. Models of Interactive Computer Interfaces**

3-0-3. Prerequisites: ISYE 3010, 6401, CS 2100.

Models that predict and describe human behavior on interactive computer interfaces are covered. A common theme among course topics is modeling users with mechanisms. These mechanisms include optimum seeking, formal grammars, internal device models, task analyses, and human information processing.

**ISYE 6215. Models of Human-Machine Interaction**

3-0-3. Prerequisite: ISYE 3010 or equivalent.

The development and use of mathematical models of human behavior are considered. Approaches to modeling that are discussed include estimation theory, control theory, queueing theory, fuzzy set theory, rule-based models, pattern recognition, and Markov processes. Applications considered include flight management, air traffic control, process monitoring and control, failure detection and diagnosis, and human-computer interaction.

**ISYE 6218. Work Systems Design**

3-0-3. Prerequisite: consent of the School.

Advanced study of the design of work systems, with emphasis on the human operator and that role in the work system.

**ISYE 6219. Human Factors Engineering**

3-0-3.

Application of cognitive engineering principles and knowledge of human capabilities and limitations in the design of human-machine interfaces.

**ISYE 6221. Human-Machine Control Systems**

3-0-3. Prerequisite: consent of the School.

An introduction to the application of systems engineering and qualitative modeling methodologies to the analysis and design of human-machine control systems.

**ISYE 6223. Understanding and Aiding Human Decision Making**

3-0-3. Prerequisite: ISYE 3010 or equivalent.

Prescriptive and descriptive theories of human decision making are discussed and contrasted. Approaches to aiding human decision making are considered in the context of these theoretical frameworks. Applications-oriented issues are emphasized.

**ISYE 6224. Advances in Human-Machine Systems Research**

3-0-3. Prerequisite: ISYE 3010 or 6215.

The course explores and examines state-of-the-art research directions such as supervisory control models of human command control tasks; human-computer interface in the scheduling and supervision of flexible manufacturing systems.

**ISYE 6225. Advanced Engineering Economy**

3-0-3. Prerequisites: ISYE 3025, 3231.

Advanced engineering economy topics, including measuring economic worth, economic optimization under constraints, analysis of economic risk and uncertainty, foundations of utility theory.

**ISYE 6226. Replacement Analysis**

3-0-3. Prerequisites: graduate standing, ISYE 3025, 6734, or equivalent.

Emphasis on analytical methods utilized to evaluate the economic desirability of replacement and retirement options in capital investment. Current tax law and analytical methods for estimating asset service lives are utilized to more accurately model replacement decisions.

**ISYE 6301. Quality Control Systems**

3-0-3. Prerequisite: ISYE 4039.

The design of quality control systems for production and service enterprises. Topics include costs of quality, quality control systems design, and evaluation of system performance.

**ISYE 6302. Quality Control in Manufacturing Systems**

3-0-3. Prerequisite: graduate standing.

Quality assurance in manufacturing systems and the standard statistical methods useful in designing and manufacturing high quality products. Not available for credit to students pursuing MSIE or those with credit for ISYE 4039.

**ISYE 6303. Manufacturing Planning and Control**

3-0-3. Prerequisite: graduate standing.

Systems and methods for planning, scheduling, and control of production in the manufacturing environment. Not available for credit towards the MSIE degree.

**ISYE 6305. Forecasting Systems**

3-0-3. Prerequisite: ISYE 3029 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.

**ISYE 6306. Inventory Systems**

3-0-3. Prerequisite: ISYE 3027, 3231, or equivalent.

An introductory course in inventory theory. Deterministic lot size models, probabilistic models of continuous and periodic review policies, dynamic models, and multi-echelon systems.

**ISYE 6307. Scheduling Theory**

3-0-3. Prerequisite: ISYE 6650.

Analysis of sequencing and scheduling activities. Static scheduling problems, dynamic scheduling systems, simulation studies of priority dispatching rules, priority queueing models.

**ISYE 6308. Analysis of Production Operations**

3-0-3. Prerequisites: ISYE 6306, 6669.

Mathematical models for production planning. Applications of mathematical programming, dynamic programming, network theory and heuristic methods to problems of planning production, inventories, and capacity.



**ISYE 6400. Design of Experiments I**

3-0-3. Prerequisite: ISYE 6739 or equivalent.

Analysis and application of standard experimental designs, including factorials, randomized block, latin squares, confounding and fractional replication multiple comparisons, and an introduction to response surfaces.

Text: at the level of Box, Hunter, Hunter, *Statistics for Experimenters*.

**ISYE 6401. Applied Regression Analysis I**

3-0-3. Prerequisite: ISYE 3028 or 6739 or equivalent.

Analysis of data from unplanned experiments. Emphasis on the application of statistical principles to empirical model building.

**ISYE 6402. Time Series Analysis**

3-0-3. Prerequisite: ISYE 3029 or equivalent.

Building empirical-stochastic models of the autoregressive moving-average form for stationary and nonstationary phenomena. Topics include identification procedures, parameter estimation, diagnostics checking, and model forecasting.

Text: at the level of Box and Jenkins, *Time Series Analysis, Forecasting and Control*.

**ISYE 6404. Nonparametric Statistics**

3-0-3. Prerequisite: ISYE 6739 or equivalent.

Basic concepts and applications of nonparametric statistics. Order statistics, runs, goodness-of-fit tests, one-sample, two-sample, and k-sample tests for location and scale.

**ISYE 6405. Response Surfaces I**

3-0-3. Prerequisite: ISYE 6400.

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, orthogonal blocking.

Text: at the level of Myers, *Response Surface Methodology*.

**ISYE 6406. Response Surfaces II**

3-0-3. Prerequisite: ISYE 6405.

A continuation of ISYE 6405. Topics include optimal designs for fitting polynomials, experiments with mixtures, multiple response problems, mechanistic model building, and sequential designs.

**ISYE 6407. Sampling Techniques**

3-0-3. Prerequisite: ISYE 3029 or equivalent.

Survey sampling techniques. Topics include simple random and stratified random sampling, ration estimation, regression techniques, systematic, cluster and multistage, sampling, and sources of error.

Text: at the level of Cochran, *Sampling Techniques*, 3rd Edition.

**ISYE 6427. Applied Statistical Decision Theory**

3-0-3. Prerequisite: MATH 4260 or equivalent.

An intermediate-level course in statistical decision theory and its application to economic analysis and statistical decision problems. The techniques of Bayesian inference are developed and applied.

**ISYE 6450. Design of Experiments — Messy Multifactor Designs**

3-0-3. Prerequisite: ISYE 6400.

A continuation of experimental design methods, stressing the design and analysis of multifactor experiments including nonfactorial designs. Topics include unbalanced designs, split plot/repeated measures designs and random effects models.

**ISYE 6515. Analysis of Distribution Systems**

3-0-3. Prerequisite: ISYE 6661 or 6669, or equivalent.

Study of the various types of transportation systems available to enterprises for distributive services. Analysis of distribution alternatives stressed, emphasizing design of economic and control systems encountered.

**ISYE 6520. Computer Control in Manufacturing**

2-3-3. Prerequisites: graduate standing in ISyE, ME, EE, Textiles, and other related programs. Fundamental knowledge of computers and structured programming.

Introduction to fundamentals of computer control of manufacturing equipment including numerically controlled machines, robots, conveyers, and programmable controllers with the course emphasis on integration, interfaces, and networking.

**ISYE 6524. Material Flow Systems**

3-0-3. Prerequisites: ISYE 6661 or 6669, or equivalent.

Methodology useful in analyzing and designing material flow systems, with specific emphasis on warehousing systems. Emphasizes quantitative modeling.

**ISYE 6530. Intelligent Manufacturing**

3-0-3. Prerequisite: CIMS-I.

Introduction to applications of artificial intelligence in product design, process planning, equipment selection, machine layout, handling and storage, scheduling, and real-time control. The students will learn several emerging AI techniques for integrating the functional areas of manufacturing.

**ISYE 6540. Electronic Assembly Systems**

3-0-3.

Manufacturing systems, design, and analysis of the production of electronic products from the printed circuit level to the system assembly level.

**ISYE 6650. Probabilistic Models in Operations Research**

3-0-3. Prerequisite: ISYE 3027 or equivalent.

Introduction to stochastic models and their applications. Discrete and continuous-time Markov processes. Poisson and renewal-reward processes. Elementary queueing and reliability models. Statistical estimation of model parameters.

Text: at the level of Ross, *Introduction to Probability Models*, 2nd Edition.

**ISYE 6656. Queueing Theory**

3-0-3. Prerequisite: ISYE 6650.

Service systems with queueing. Markov process formulations of systems to study queue lengths, waiting time, and average costs. Applications to manufacturing, system maintainability, computers, and telecommunications.

**ISYE 6661. Optimization I: Linear Programming**

4-0-4. Prerequisite: linear algebra.

Theory, algorithms, and applications of linear programming. Formulation of the linear programming problem. The simplex method and resolution of degeneracy. Duality and sensitivity analysis. Efficiency of the simplex method. The revised simplex method, basis factorization, and bounded variables. The dual simplex method. Large-scale problems: column generation and decomposition. Geometry of polyhedra. This course is for students seriously considering a Ph.D.

**ISYE 6662. Optimization II: Network Flows and Discrete Optimization**

4-0-4. Prerequisite: ISYE 6661 or ISYE 6669.

Network flow models and applications. Algorithms for the maximum flow, shortest path, and minimum cost flow problems. Integer programming models and strong formulations. Computational complexity of integer programming problems. Branch-and-bound, cutting plane, Lagrangian dual and hybrid algorithms. This course is for students seriously considering a Ph.D.

**ISYE 6663. Optimization III: Nonlinear Programming**

4-0-4. Prerequisite: ISYE 6661. Corequisite: MATH 4317 or equivalent.

Fundamental concepts in nonlinear programming. Algorithms and convergence. Gradient and second order methods. Reduced gradient and projection approaches. Polynomial algorithms and interior point methods. Dual methods. This course is for students seriously considering a Ph.D.

**ISYE 6669. Linear Deterministic Models in Operations Research**

4-0-4. Prerequisite: ISYE 3231 or equivalent.

The optimization of linear models, including the revised, dual, and primal dual simplex methods, duality theorems, decomposition, cutting plane algorithms, and some network algorithms.

**ISYE 6670. Nonlinear Deterministic Models in Operations Research**

4-0-4. Prerequisite: ISYE 6669 or equivalent.

Algorithms for solving nonlinear unconstrained and constrained problems, including penalty function methods, quadratic programming and linearization methods.

**ISYE 6671. Discrete Deterministic Models in Operations Research**

3-0-3. Prerequisite: ISYE 6669 or equivalent.

The optimization of discrete deterministic models, including general enumerative methods and special algorithms for well-known discrete problems on graphs and networks.

**ISYE 6679. Computational Methods in Optimization**

3-0-3. Prerequisites: ISYE 6669 and a thorough knowledge of PASCAL, MODULA, or C at the level of CS 2100.

Strategies and techniques for translating optimization theory into effective computational software. Emphasis on applications in linear, nonlinear, and integer programming, networks and graphs.

**ISYE 6680. Location Theory**

3-0-3. Prerequisite: ISYE 6669 or consent of the School.

Applications of optimization theory to the location of

facilities. Area and point location problems in discrete and continuous space are examined. Private and public sector applications are considered.

**ISYE 6734. Methods of Operations Research**

5-0-5. Prerequisite: MATH 2508. Corequisite: statistics.

An introduction to the methods for analytical formulation and solution of decision problems. Mathematical methods of optimization and classical operations research models are introduced. Not available for degree credit to ISyE students except for those in the Master of Science in Statistics program.

**ISYE 6739. Experimental Statistics**

4-0-4. Prerequisite: MATH 2508.

An introduction to the application of statistics. Topics include probability concepts, sampling distributions, point and interval estimation, hypothesis testing, multiple linear regression, analysis of variance. Not available for degree credit to ISyE students.

Text: at the level of Hines and Montgomery, *Probability and Statistics*.

**ISYE 6751-2. Complex Systems Design I, II**

2-4-3 each. Prerequisite: graduate standing.

This two-quarter sequence permits students from all schools to meet, form an interdisciplinary team, and carry out preliminary design of a significant complex system.

**ISYE 6761. Stochastic Processes I**

3-0-3. Prerequisites: ISYE 3027 or MATH 4215 or equivalent.

Introduction to Markov chains, Poisson processes and renewal processes. Transient and limiting behavior. Average cost and utility measures of systems. Modeling of inventories, cash management, system availability, storage facilities, and flows in manufacturing and computer networks.

**ISYE 6762. Stochastic Processes II**

3-0-3. Prerequisites: ISYE 6761 or MATH 4221 and consent of the instructor.

Introduction to continuous-time Markov jump processes, Brownian motion and discrete-time martingale optional sampling and convergence. Modeling of queues, storage, finance, and production.

**ISYE 6763. Stochastic Optimization**

3-0-3. Prerequisites: ISYE 6661 and ISYE 6762.

Optimization of stochastic systems over time, introduction to stochastic dynamic programming (Markov decision processes) and optimal stopping models.

**ISYE 6770. Management of Technology (MOT) Project Initiation**

0-3-1. Prerequisite/Corequisite: Enrolled in the MOT Certificate Program.

Under faculty supervision, students will work in a multidisciplinary team to develop a viable proposal for the MOT project (ISYE 6774).

**ISYE 6771. Management of Technology I**

3-0-3. Prerequisites: Graduate standing; B.S. in engineering, computer, or physical sciences.

This course examines factors in the firm's external environment essential to managing technology. Topics include industrial competitiveness and technological innovation; the roles of government; and developing information about the environment.

**ISYE 6772. Management of Technology II**

3-0-3. Prerequisites: graduate standing; B.S. in engineering, computer or physical sciences.

This course will focus on the resources management for a technology-based firm. Emphasis will be given to planning under conditions of rapid technological innovation, international competition, and quickly changing market needs.

**ISYE 6773. Management of Technology III**

3-0-3. Prerequisites: graduate standing; B.S. in engineering, computer or physical sciences.

This course will explore the technology-strategic management interface from an internal as well as an external perspective which focuses on the strategic implications of competing in technologically sophisticated industries.

**ISYE 6774. Management of Technology Project**

0-9-3. Prerequisites: graduate standing; B.S. in engineering, computer or physical sciences.

Under the joint supervision of a faculty member and a representative of a technology-based host firm, students will work in a multidisciplinary team on a task devoted to solving a real problem of the firm.

**ISYE 6775. Management of Technology Seminar**

1-0-1. Prerequisites: graduate standing; B.S. in engineering, computer or physical sciences.

This seminar will be offered each quarter in conjunction with the MOT I, II, and III core courses. It will introduce students to the frontiers of some key technologies and allow them to hear about current MOT practices and problems of industry. (Course offered on S/U basis only.)

**ISYE 6776. MOT Seminar II**

1-0-1. Prerequisite/ Corequisite: MOT Seminar.

This seminar will be offered quarterly. It will introduce students to the frontiers of some key technologies and allow them to hear about current MOT practices and problems of industry.

**ISYE 6777. Analysis of Emerging Technologies**

4-0-4. Prerequisite: graduate standing or permission of instructor.

Provides training in technology forecasting and assessment methods; addresses current and future prospects for three key emerging technologies: biotechnology, advanced materials, and information and telecommunications.

**ISYE 6781. Reliability Theory**

3-0-3. Prerequisite: MATH 4215 or equivalent.

Structural properties and reliability of coherent systems. Parameter families of distributions in reliability theory. Monotone failure rates. Multivariate distributions and inequalities in reliability theory.

Text: at the level of Barlow and Proschan, *Statistical Theory of Reliability and Life Testing*.

**ISYE 6790. Computer Integrated Manufacturing Systems I**

3-0-3. Priority to CIMS students.

A broad overview of the functions, processes, and disciplines of computer integrated manufacturing.

**ISYE 6791. Computer Integrated Manufacturing Systems II**

3-0-3. Prerequisite: CIMS I.

An in-depth study of current issues, emerging technologies, and future developments in computer integrated manufacturing.

**ISYE 6792. Computer Integrated Manufacturing Systems Seminar**

1-0-1.

Guest speakers on a broad range of CIMS related topics: research, applications, and technology.

**ISYE 6799. Quasi-experimental Design**

3-0-3. Prerequisite: ISYE 6800.

Design, application, statistical analysis, and critical evaluation of quasi-experiments (i.e., extension of experimental design concepts into field settings that preclude ideal, randomized experiments).

**ISYE 6800. Systems Research and Applications I**

3-0-3. Prerequisite: ISYE 4000 or consent of the School.

Individual work and study of cases reflecting the application of the systems engineering process to the modeling, analysis, design, and implementation of various classes of human-machine, socioeconomic, and ecological systems.

**ISYE 6801. Systems Research and Applications II**

3-0-3. Prerequisite: ISYE 6800.

An interdisciplinary class project requiring small team organization and directed at the application of the systems engineering process to a single problem area.

**ISYE 6805. Reliability Engineering**

3-0-3. Prerequisites: MATH 4215, 4221, or equivalent.

Reliability prediction for nonmaintained systems, availability prediction for maintained systems, life demonstration test design, the concept of system effectiveness.

**ISYE 6816. System Dynamics Principles**

3-0-3.

System dynamics philosophy and methodology for modeling, simulating, analyzing, and improving dynamic behavior in human systems. Emphasis on large, nonlinear, feedback control systems. Student project.

**ISYE 6817. System Dynamics Analysis**

3-0-3. Prerequisite: ISYE 6816.

More advanced study of system dynamics principles. Noise, forecasting, delays, special feedback structures in human systems. Aggregation and parameter estimation methods. World model dynamics. Student project.

**ISYE 6818. System Dynamics Research**

3-0-3. Prerequisite: ISYE 6817.

System dynamics principles employed in a major project. Advanced model formulation. Validation, dominant-loop and transition analyses. Contributions of IEMS/OR to system dynamics studies. Real system implementation.

**ISYE 6831. Advanced Simulation**

3-0-3. Prerequisite: graduate standing.

Extension of discrete-event, digital simulation methods presented in ISYE 4044. Emphasis on model building and the design and analysis of simulation experiments for complex systems.

**ISYE 6835. Simulation of Manufacturing Systems**

3-0-3. Prerequisite: graduate standing or permission of the instructor.

Analysis of manufacturing processes using general purpose simulation languages and simulators; a variety of manufacturing problems and their solution using simulation; presentations by practitioners; student projects.

**ISYE 6841. Decision Support Systems**

2-3-3. Prerequisites: ISYE 6734 or equivalent, ISYE 6739 or equivalent.

Interactive computer support of design, analysis, and decision making. Hands-on project in decision-aiding system development. APL programming language syntax and practice.

**ISYE 6845. Effective Use of Interactive Computer Graphics**

3-0-3. Prerequisites: CS 2100 and graduate standing.

Proper use of color, shapes, and text to develop good graphical interfaces are taught. Human performance considerations, including appropriate perceptual and cognitive aspects, are considered.

**ISYE 7000. Master's Thesis**

Required of degree candidates in the master's thesis option.

**ISYE 7210. Simulation of Interactive, Real-time Dynamic Systems**

3-6-5. Prerequisites: ISYE graduate standing, ISYE 6215 and ISYE 6831 or permission of the instructor.

Principles and laboratory experience in design and implementation of interactive simulations of complex dynamic systems. Topics include event management, user input processing, interface design, data logging, and analysis.

**ISYE 7400. Design of Experiments II**

3-0-3. Prerequisite: ISYE 6400.

A continuation of experimental design stressing fractional factorials, analysis of unbalanced data, and covariance models. Topics include confounding and fractional designs, incomplete blocks, general methods for the analysis of unbalanced data, and covariance analysis.

**ISYE 7401. Applied Regression Analysis II**

3-0-3. Prerequisite: ISYE 6401.

A continuation of the concepts of multiple regression analysis begun in ISYE 6401. Topics include multilinearity diagnostics, biased estimation, detection of high-leverage observations, robust fitting, and an introduction to nonlinear regression.

**ISYE 7441. Linear Statistical Models I**

3-0-3. Prerequisites: MATH 4260 and ISYE 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*.

**ISYE 7442. Linear Statistical Models II**

3-0-3. Prerequisite: ISYE 7441.

A continuation of ISYE 7441 emphasizing linear statistical models of less than full rank. Balanced designs, including fixed, mixed, and random models, are stressed.

Text: at the level of Graybill, *Linear Statistical Models*.

**ISYE 7524. Analysis of Material Handling Systems**

3-0-3. Prerequisites: ISYE 6524, ISYE 6669 or equivalent, ISYE 6671 or equivalent.

Study of the most recent research in analysis of material handling systems. Special emphasis will be placed on models and techniques which allow good design of material handling systems. The course will consist of lectures, class discussions, and student projects.

**ISYE 7656. Advanced Queueing Theory**

3-0-3. Prerequisite: ISYE 6656.

Markov process models of networks of service stations with queueing. Jackson, reversible, and partially balanced networks. Computational procedures for performance measures. Analysis of manufacturing and computer systems.

**ISYE 7673. Nonlinear Programming**

3-0-3. Prerequisite: ISYE 6670.

Advanced nonlinear programming topics, including general convergence theory and convergence rate. Issues connected with direction finding and step sizes, optimization of nonsmooth functions, cutting plane methods and their convergence.

**ISYE 7674. Dynamic Programming**

3-0-3. Prerequisite: ISYE 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.

**ISYE 7675. Network Flows**

3-0-3. Prerequisite: ISYE 6662 or 6671 or consent of the instructor.

Current literature in networks, including characterization theorems and algorithms for flow problems, flow with gains, multicommodity flows, disconnecting sets, and matching theory.

**ISYE 7676. Combinatorial Optimization**

3-0-3. Prerequisite: ISYE 6662 or 6671 or consent of the instructor.

Principal topics include independent sets and cliques in graphs, graph coloring, trees and circuits, planarity and matching. Some complexity issues are covered as well as worst-case performance for efficient heuristics.

**ISYE 7677. Integer Programming**

3-0-3. Prerequisite: ISYE 6662 or 6671 or consent of the instructor.

The methods and applications of integer programming, including cutting plane methods, implicit enumeration, heuristic techniques, relaxations, facets, and other developments.

**ISYE 7678. Decomposition Methods for Large Systems**

3-0-3. Prerequisite: ISYE 6669.

The course deals with solution strategies, illustrated with examples, for handling complex systems with large number of variables and/or restrictions, linear and nonlinear.

## **ISYE 7680. Advanced Location Theory**

3-0-3. Prerequisite: ISYE 6670, 6680, or consent of the School.

Theoretical aspects of location problems are emphasized, drawing upon results from linear and nonlinear programming, graph theory, and network analysis. Recent research literature is covered.

## **ISYE 7761. Convex Analysis and Polyhedra**

3-0-3. Prerequisites: ISYE 6661 and MATH 6021 or consent of the instructor.

Separation results, including the Hahn-Banach theorem and Farkas' Lemma. Polarity and duality relations. Normal and tangent cones. Polyhedra. Convex functions. Applications to optimization.

## **ISYE 8011-2-3. Seminar**

1-0-1 each. Audit basis only

## **ISYE 8100-1-2. Special Topics**

3-0-3 each. Prerequisite: consent of the School.

Special topic offerings not included in regular courses.

## **ISYE 8561-2-3. Seminar in Operations Research**

Credit to be arranged. Prerequisite: consent of the School.

Topics within the area of operations research that are of a special interest to the faculty and graduate students but are not included in regularly offered courses.

## **ISYE 8601-2. Projects in Operations Research**

Credit to be arranged. Prerequisite: consent of the School.

This course provides, through project work, experience in the application of operations research methods to real-world systems.

## **ISYE 8704-5-6. Special Problems in Industrial Engineering**

Credit to be arranged. Prerequisite: consent of the School.

## **ISYE 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

## **ISYE 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

## **ISYE 9000. Doctoral Thesis**

## **HEALTH SYSTEMS**

### **HS 3001. Introduction to Health Systems**

3-0-3. Prerequisite: junior standing.

Historical background; nature, problems, and costs of health care institutions; health resource planning, finance, health care policy, role of government; methods improvement and management engineering.

### **HS 3011. Hospital Functions**

3-0-3. Prerequisite: junior standing.

Internal structure, functions, and management problems of hospitals, including departmental interactions, hospital and medical terminology, process flows of materials, supplies, personnel, patients, paperwork, and information.

### **HS 3221. Health Information Systems**

3-0-3. Prerequisites: HS 3001 or 3011, CS 1410, MGT 2000.

Hospital and medical information systems, data collection, storage, processing and reporting, file design, record structure, processing requirements, controls, report formats, medical records, and statistical audits.

### **HS 3331. Hospital Cost Analysis**

3-0-3. Prerequisites: HS 3001 or 3011, MGT 2001.

Microeconomic analysis of health care delivery, hospital cost finding and cost analysis, evaluating financial alternatives, budget development, pricing policy, rate setting, reimbursement formulas, and cost containment.

### **HS 3341. Health Systems Planning**

3-0-3. Prerequisite: HS 3001 or 3011.

The systems approach to health planning, policy and program decisions, functional systems specifications, recycling for compromise, systems integration, facility and manpower requirements.

### **HS 4115. Health Field Applications I**

3-0-3. Prerequisites: HS 3001 or 3011.

Establishing and operating a hospital management engineering program; applications of methods engineering, work measurement, sampling, job evaluation, and incentives to hospital management systems problems.

### **HS 4116. Health Field Applications II**

3-0-3. Prerequisites: HS 3001 or 3011, ISYE 3025, 3028, 3231.

Applications of industrial engineering, operations research, and other quantitative methods to hospital management systems problems. Techniques include statistics, forecasting, managerial control, queueing, simulation, economic analysis, and optimization.

### **HS 6001. Introduction to Health Systems**

3-0-3.

Description of the health care system and its interactive resource components, with emphasis upon accessibility, availability, distribution, and cost. Health systems inputs, processes, and outputs.

### **HS 6115. Health Systems Applications I**

3-0-3. Prerequisites: HS 6001.

Applications of industrial engineering techniques to hospital management problems. Improving work methods, measuring performance, staffing and scheduling, job analysis, employee compensation, and dealing with variability.

### **HS 6116. Health Systems Applications II**

3-0-3. Prerequisites: HS 6001, ISYE 3028, 3231.

Applications of operations research and other quantitative methods to hospital management problems. Forecasting, managerial control, waiting lines, facility planning, resource allocation, and information systems.

**HS 6117. Health Systems Applications III**

3-0-3. Prerequisites: HS 6001, ISYE 3025, MGT 6000.

Applications of economics, engineering economy, and cost accounting to hospital management problems. Case-mix methodologies, budgeting, revenue enhancement, cost containment, and governmental regulation.

**HS 6231. Project Management**

3-0-3. Prerequisite: HS 6001.

Principles and techniques of managing a health systems service program; project planning, direction, and control; dealing with environmental subtleties; management reporting and project implementation.

**HS 6341. Health Systems Planning**

3-0-3. Prerequisites: HS 6001, ISYE 3028.

Community health planning, facility master planning, health care requirements analysis, systems integration, financial planning, and life-cycle costs.

**HS 6342. Community Health Systems**

3-0-3. Prerequisites: HS 6001, ISYE 3028.

Planning for health care needs of a community as a system. Analysis of community structure, decision making, planner-community interactions, and accessibility barriers to services.

**HS 6351. Research and Evaluation Methods**

3-0-3. Prerequisite: graduate standing.

Principles and techniques of planning, proposing, conducting, evaluating, and reporting research projects. Elements of the scientific method. Critical review of theses, research reports, and publications.

**HS 6571-2-3-4-5-6. Graduate Field Training**

0-3-1 through 0-18-6. Prerequisite: HS 6351. Open to HS students only.

Field training for individual graduate students in relation to health care institutions, health service organizations, or health planning agencies. Graduate project, formal written report, and oral presentation. Normally part time over two or three quarters.

**HS 6665. Graduate Case Studies**

3-0-3. Prerequisites: HS 6001, 6115, 6116.

Applications of hospital management engineering and health systems planning techniques using examples drawn from professional practice and research reported in the literature.

**HS 7000. Master's Thesis**

Prerequisite: prior arrangement with the School.

**HS 7665. Graduate Projects**

1-6-3. Prerequisite: prior arrangement with the School.

Research projects addressed at real-life problems confronting operational health care institutions and employing modern principles and approaches of health systems analysis. Project report.

**HS 8092-3. Graduate Seminars**

1-0-1 each.

Guest speakers, discussions of health issues, problems and solutions, field training experiences, and employment opportunities.

**HS 8161-2-3-4. Topics in Health Systems**

3-0-3 each. Prerequisite: prior arrangement with the School.

Provides formal course work on special topics not included in regular health systems graduate courses.

**HS 8261-2-3-4. Special Topics**

1-0-1 through 4-0-4. Prerequisite: prior arrangement with the School.

Special or experimental offerings of topical coverage not included in regular health systems graduate courses.

**HS 8971-2-3-4. Special Problems**

Credit to be arranged. Prerequisite: prior arrangement with the School.

Individual student projects that apply systems techniques to health care management and planning problems with emphasis upon student initiative, methodology, problem solution, and written report.

**HS 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**HS 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

## **School of Materials Science and Engineering**

**Established in 1985, School of Ceramic  
Engineering established in 1924.**

**Location: Bunger-Henry Building**

**Telephone: 404-894-2816**

*Director and Professor*—Ashok Saxena;  
*Associate Director and Professor*—Joe K.  
Cochran; *Principal Research Engineer and  
Associate Director for Research*—Kathryn Logan;  
*Regents' Professor*—Thomas Sanders; *Professor  
and Composites Education and Research Center  
Director*—Steven W. Johnson; *Professors*—  
James F. Benzel, Arun M. Gokhale, Miroslav  
Marek, Rao Tummala, Laura J. Turbini;  
*Professors Emeritus*—Robert F. Hochman, Ervin  
E. Underwood; *Associate Professors*—Rosario  
Gerhardt, D. Norman Hill, William S. Rees, Robert  
F. Speyer, Stuart R. Stock, Naresh N. Thadhani,  
Z.L. Wang; *Assistant Professors*—W. Brent  
Carter, Janet M. Hampikian, Meilin Liu, Byungwoo  
Park; *Principal Research Scientist and Adjunct  
Professor*—Thomas L. Starr; *Adjunct*

*Professors*—Agaram S. Abhiraman, Prashant Desai, C. J. Summers, R. A. Young; *Mechanical Properties Research Laboratory Director*—David L. McDowell.

## General Information

Recent surveys predicting the demand for engineering graduates in the 1990s suggest that the field of materials science engineering can expect the most potential for growth and advancement. Many more graduates will be needed. To meet this anticipated demand, the School of Materials Engineering was established on March 1, 1985. The name of the School was changed to the School of Materials Science and Engineering (MSE), July 1992, to reflect the broad range of the discipline. The School presently offers a bachelor's degree in materials engineering as well as ceramic engineering. Graduate degrees (M.S. and Ph.D.) are offered in metallurgy, ceramic engineering, and polymers. The various degree programs are described in the following sections.

## Undergraduate Programs Materials Science and Engineering

In the past five to ten years, there has been a growing awareness that many technological advances are being limited by the availability of materials. In many cases, materials cannot be usefully categorized into the traditional classes of metals, ceramics, or polymers. Examples include composites that are being introduced in airframes, automobile components and sporting equipment; devices that are being fabricated from once exotic compounds for the electronics and computer industry; and ordered alloys used in the envisioned National Aerospace Plane and High Speed Civil Transport. In response to rapidly evolving technology, traditional disciplines such as metallurgy and ceramics are developing into more broadly based materials programs in which students are provided with an education emphasizing the fundamentals and the principles of structure-property-processing relationships independent of the class of material. There is a growing recognition that the needed discipline is

"materials," and most of the leading institutions in the United States have adopted this approach. All engineers need education in materials, and a significant number of specialists in materials will be required to meet the needs of industry.

The objective of this program is to graduate engineers at the baccalaureate level who are educated in the fundamentals of the structure-property-processing relationship of materials and who can design, test, select, manufacture, and optimize components of all types of materials. Students follow a rigorous curriculum in basic science as well as the fundamental engineering disciplines. The goal of the materials science and engineering program is to produce graduates who are prepared to meet new technological challenges in which problems are solved by considering the relative merits of all classes of materials and who are prepared for graduate work at leading universities.

## Bachelor of Materials Engineering Curriculum (Suggested Schedule)

<b>Freshman Year</b>			
<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 1101-1112</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>MATH 1507-8-9</b>			
Calculus I,II,III	5-0-5	5-0-5	5-0-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I,II	3-0-3	3-0-3	.....
<b>ENGL Elective</b> (ENGL 2110, 2201, 2310, or 2401)	.....	.....	3-0-3
<b>Health and Performance Sciences</b> (requirements, p. 311)	.....	.....	3-0-3
<b>CS 1700</b>			
Digital Computer Organization and Programming	.....	.....	3-0-3
(Because of limited offerings of CS 1700, TEXT 1040 may be substituted in Winter and Spring quarters,.)			
<b>Engineering Elective</b>	.....	3-0-3	.....
<b>Humanities/Social Sciences/Modern Languages Elective</b>	3-0-3	.....	.....
<b>TOTALS</b>	15-3-16	15-3-16	18-3-19

**Sophomore Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>PHYS 2122-3</b>			
Physics	4-3-5	4-3-5	.....
<b>CHEM 3412</b>			
Physical Chemistry	.....	.....	3-0-3
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3308</b>			
Differential Equations	.....	.....	5-0-5
<b>ESM 2201</b>			
Statics	3-0-3	.....	.....
<b>ESM 3301</b>			
Mechanics of Deformable Bodies	.....	5-0-5	.....
(ESM 3301 is no longer offered, use CE 2213 as a substitute.)			
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	3-0-3	3-0-3
<b>CS 2250</b>			
Technical Information Resources	1-0-1	.....	.....
<b>MATE 2101</b>			
Principles and Applications of Engineering Materials	.....	.....	4-0-4
<b>MATE 3101</b>			
Engineering Materials Lab.	.....	.....	0-3-1
<b>TOTALS</b>	16-3-17	15-3-16	15-3-16

**Junior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATE 3004</b>			
Thermodynamics and Phase Equilibria of Materials	.....	4-0-4	.....
<b>MATE 3446</b>			
Crystallography and X-ray Diffraction	3-3-4	.....	.....
<b>MATE 3312-3</b>			
Physical and Electronic Properties of Materials I,II	.....	2-0-2	2-0-2
<b>MATE 3463</b>			
Mechanical Behavior of Materials	3-3-4	.....	.....
<b>MATE 3006</b>			
Physical Metallurgy and Ceramics	.....	.....	3-0-3
<b>MATE 4793</b>			
Composite Materials and Processing	.....	.....	3-0-3
<b>ISYE 3028</b>			
Engineering Statistics I	.....	.....	3-0-3
<b>CHE 3311</b>			
Heat Transfer or	.....	.....	3-0-3
<b>ME 3345</b>			
Conduction and Radiation Heat Transfer			

**CHE 4750-1**

Polymer Science I, II	3-0-3	3-0-3	.....
<b>CHEM 3311</b>			
Organic Chemistry I	3-0-3	.....	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	3-0-3	3-0-3
<b>ENGL 3020</b>			
Technical Writing	.....	3-0-3	.....
<b>TOTALS</b>	15-6-17	15-0-15	17-0-17

**Senior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATE 4003</b>			
Materials Processing	.....	3-3-4	.....
<b>MATE 4413</b>			
Microscopy of Materials	.....	.....	3-3-4
<b>MATE 4491</b>			
Corrosion	.....	.....	3-0-3
<b>MATE 4311-2</b>			
Engineering Materials	.....	3-0-3	3-0-3
<b>*MATE XXXX-X-X</b>			
Cross listed with ME, CE, ChE, ESM, AE, TFE.			
Specialization Series	3-0-3	3-0-3	3-0-3
<b>ISYE 4725</b>			
Engineering Economy or	.....	.....	3-0-3
<b>CHE 4431</b>			
Chemical Engineering Economics			
<b>EE 3710</b>			
Intro. to Electronic Systems	3-0-3	.....	.....
<b>EE 3741</b>			
Electronic Systems Lab.	.....	0-3-1	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	3-0-3	.....
<b>Free Electives</b>	9-0-9	3-0-3	3-0-3
<b>TOTALS</b>	18-0-18	15-6-17	18-3-19

**Total Credit Hours Required for Graduation = 203**

**\*Specialization Courses**

Students in the materials engineering program will be required to follow one of the Specialization Series (nine hours) listed below:

<b>Option</b>	<b>Suggested Course</b>
Electronic Materials	EE 4055, 4056, 4057, and MATE 4055
Composites Engineering	MATE 4791, 4792, 4794, TEX 4600, and AE 4813
Mechanics of Materials	ESM 3201, 3302, 3311, 3760, 4111, 4301, and 4302
Ceramic Engineering	MATE 3007, 3008, 4102, 4104, and 4210
Metallurgical Engineering	MATE 4421, 4422, 4464, and ME 4110
Polymer Engineering	CHE 4760, 4803 (Polymer Rheology and Processing), and TEX 4200, 4504



appropriate courses may be substituted upon approval of undergraduate adviser.

Each option in the series consists of nine units. Students may use free electives to follow a second and third option.

## Ceramic Engineering

The School of Materials Science and Engineering offers a four-year curriculum leading to the Bachelor of Ceramic Engineering. Graduates are well prepared for positions in the ceramic industry or for graduate work at leading universities. Additional courses are also available that will introduce nonmajors to ceramic materials, processes, and applications.

In the United States, the ceramic industry annually produces more than \$40 billion worth of products ranging from brick, tile, glass, and dinnerware to high-temperature refractories for furnace linings, abrasives, many sophisticated electronic components, and high tech ceramic products. While traditional products create a continuing demand for trained personnel, the development of new products constantly opens fresh career opportunities. Some examples of new products include auto and jet engine parts, electronic circuitry for computers, and ceramic composite materials for various aerospace applications. Current research areas at Georgia Tech include thin wall hollow ceramic spheres (aerospheres), high-temperature superconductors, directionally solidified entectic composites, and electro-optical materials.

## Bachelor of Ceramic Engineering Curriculum (Suggested Schedule)

### Freshman Year

Course	1st Q.	2nd Q.	3rd Q.
<b>CHEM 1101-1112</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>ENGL Elective</b> (ENGL 2110, 2201, 2310, or 2401)	.....	.....	3-0-3
<b>Health and Performance Sciences</b>			
(requirements, p. 311)	.....	.....	3-0-3

### CS 1700

Digital Computer Organization and Programming	.....	.....	3-0-3
(Because of limited offerings of CS 1700, TEXT 1040 may be substituted in Winter and Spring quarters.)			
<b>Engineering Elective</b>	.....	3-0-3	.....
<b>Humanities/Social Sciences/Modern Languages Elective</b>	3-0-3	.....	.....
<b>TOTALS</b>	15-3-16	15-3-16	18-3-19

### Sophomore Year

Course	1st Q.	2nd Q.	3rd Q.
<b>PHYS 2122-3</b>			
Physics	4-3-5	4-3-5	.....
<b>CHEM 3412</b>			
Physical Chemistry	.....	.....	3-0-3
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3308</b>			
Differential Equations	.....	.....	5-0-5
<b>ESM 2201</b>			
Statics	3-0-3	.....	.....
<b>ESM 3301</b>			
Mechanics of Deformable Bodies	.....	5-0-5	.....
(ESM 3301 is no longer offered, use CE 2213 as a substitute.)			
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	3-0-3	3-0-3
<b>CS 2250</b>			
Technical Information Resources	1-0-1	.....	.....
<b>MATE 2101</b>			
Principles and Applications of Engineering Materials	.....	.....	4-0-4
<b>MATE 3101</b>			
Engineering Materials Lab.	.....	.....	0-3-1
<b>TOTALS</b>	16-3-17	15-3-16	15-3-16

### Junior Year

Course	1st Q.	2nd Q.	3rd Q.
<b>MATE 3446</b>			
Crystallography and X-ray Diffraction	3-3-4	.....	.....
<b>MATE 3004</b>			
Thermodynamics and Phase Equilibria of Materials	.....	4-0-4	.....
<b>MATE 3312-3</b>			
Physical and Electronic Properties of Materials I,II	.....	2-0-2	2-0-2
<b>MATE 3463</b>			
Mechanical Behavior of Materials	3-3-4	.....	.....

<b>MATE 3006</b>			
Physical Metallurgy and Ceramics	.....	.....	3-0-3
<b>MATE 3008</b>			
Glass Technology	.....	3-3-4	.....
<b>MATE 3007</b>			
Pyrometry and Thermal Analysis	.....	2-3-3	.....
<b>CHEM 2110</b>			
Chemical Structures and Properties	.....	3-0-3	.....
<b>CHEM 3413</b>			
Physical Chemistry	.....	.....	3-0-3
<b>ISYE 3028</b>			
Engineering Statistics I	3-0-3	.....	.....
<b>CHE 3311</b>			
Heat Transfer or	3-0-3	.....	.....
<b>ME 3345</b>			
Conduction and Radiation			
Heat Transfer	3-0-3	.....	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	.....	9-0-9
<b>TOTALS</b>	15-6-17	14-6-16	17-0-17

**Senior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATE 4104</b>			
Ceramic Processing	3-3-4	.....	.....
<b>MATE 4003</b>			
Materials Processing	.....	3-3-4	.....
<b>MATE 4102</b>			
Refractories	2-3-3	.....	.....
<b>MATE 4413</b>			
Microscopy of Materials	.....	.....	3-3-4
<b>MATE 4210</b>			
Energy Conservation and Control	.....	.....	3-0-3
<b>MATE 4311</b>			
Engineering Materials I	.....	3-0-3	.....
<b>MATE 4793</b>			
Composite Materials and Processing	.....	.....	3-0-3
<b>CHE 4751</b>			
Polymer Science and Engineering II	.....	3-0-3	.....
<b>CHEM 3311</b>			
Organic Chemistry I	.....	3-0-3	.....
<b>ISYE 4725</b>			
Engineering Economy or	.....	3-0-3	.....
<b>CHE 4431</b>			
Chemical Engineering Economics			
<b>EE 3710</b>			
Introduction to Electronic Systems	3-0-3	.....	.....

<b>EE 3741</b>			
Electronic Systems Lab	.....	0-3-1	.....
<b>Humanities/Social Sciences/Modern Languages Elective</b>	3-0-3	.....	.....
<b>Free Electives</b>	6-0-6	3-0-3	6-0-6
<b>TOTALS</b>	17-6-19	18-6-20	15-3-16

**Total Credit Hours Required for Graduation = 205**

**Multidisciplinary Programs**

See table on page 100.

**Electives**
**Freshman Engineering Electives**

Any of the following courses are acceptable as credit for freshman engineering electives: EGR 1170, CHE 1110, CE 1503, EE 1300, ESM 1101, NE 1010, NE 1100, NS 1002, NS 1003, or TEX 1100.

**Free Electives**

Fifteen hours of free electives may be taken at any time during a student's course of study. ROTC students may satisfy all of these hours with ROTC credits.

**Humanities/Social Sciences/Modern Languages Electives**

See Information for Undergraduate Students, "Humanities and Social Sciences Requirements," p. 33. The courses selected to fulfill the humanities and social sciences requirements must provide both breadth and depth and not be limited to a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one of each. Students should see their academic adviser for course sequences that satisfy the depth requirement. All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

**Graduate Programs**

The field of materials is a vital component of the industrial economy because of its central contribution to the selection and use of materials in all engineering and scientific fields. Master's and doctoral degrees in metallurgy, polymers, and ceramic engineering are offered. An excellent

selection of undergraduate courses is also offered in preparation and support of graduate studies. Course offerings and research activities cover a range of subject areas in the broad field of materials. Subjects include physical metallurgy, mechanical properties, fracture mechanics, corrosion science and engineering, processing, phase equilibria, nondestructive testing, X-rays, phase transformations, glass science, electronic/technical ceramics, thin film semiconductors, dispersions and rheology, refractories, surface analysis, fiber science, polymerization reaction engineering, polymer process simulation, mechanical properties of polymers, and process-structure-property characterization of polymers. For a listing of approved polymer courses, also see the listings in the Schools of Chemical Engineering and Textile and Fiber Engineering. Research facilities are among the program's strong features.

Graduates find employment with manufacturing firms in light and heavy industry, in research laboratories of private firms and federal agencies, and in academic institutions. Several recent graduates have filled positions of high responsibility in these areas and have been instrumental in advancing the level of materials engineering practice in the United States.

The materials engineering faculty participates in numerous multidisciplinary programs including manufacturing engineering, surface science technology, microelectronics, electronic packaging, polymers, and composites.

### **Mechanical Properties Research Laboratory**

The Mechanical Properties Research Laboratory (MPRL) was established to encourage interdisciplinary research and educational opportunities in the field of the mechanical behavior of materials. Faculty members representing various academic disciplines at Georgia Tech, as well as staff members of the Georgia Tech Research Institute (GTRI), are involved in its activities. The research programs, which focus on the fracture and fatigue behavior of engineering materials, are interdisciplinary and based on a combined fracture mechanics-materials science point of view. Projects involving the behavior of metals, ceramics, polymers, and composites all fall within the scope of the laboratory.

Graduate students participating in MPRL research usually enroll for the master's or doctoral degree in the traditional discipline of their choice. However, they pursue course work related to a broader understanding of materials and benefit from the association with other students and faculty in the interdisciplinary setting. Students with backgrounds in materials science, mechanical engineering, metallurgy, ceramics, chemistry, physics, or any other branch of engineering, are encouraged to apply. A graduate-level certificate program involving courses offered by materials, aerospace, and mechanical engineering is also available.

### **Composites Education and Research Center**

The Composites Education and Research Center (CERE) is another interdisciplinary center similar to MPRL, providing students with the opportunity to participate in interdisciplinary course work and research projects in the area of composites. A graduate level certificate program is available to students of materials science and engineering in composites and several graduate courses are available.

### **The Master's Degree**

The programs in MSE offer graduate work leading to the degrees of Master of Science in Metallurgy, Ceramic Engineering, and Polymers, and Master of Science with a major in materials engineering. The student admitted for graduate work will normally have completed an undergraduate program in ceramics, metallurgy, polymers, or materials. However, students with undergraduate degrees or backgrounds in other fields (e.g., physics, chemistry, geology, and chemical, mechanical, nuclear, or geological engineering) may qualify by taking certain minimum prerequisites during the early part of their graduate studies. To assure a smooth transition into the graduate program, the student should select appropriate electives during his or her undergraduate studies.

The student must prepare an individualized program of study for this degree in consultation with his or her graduate adviser. The proposed program must receive the approval of the graduate coordinator and the School director and must include a thesis.

Opportunities for course work and thesis

research are also available in interdisciplinary areas such as composite and electronic materials, within the framework of metallurgy, polymers, materials engineering, and ceramic engineering degree options. The specific degree conferred will depend on the undergraduate background, choice of course work, and thesis research.

## **Metallurgical Engineering**

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

## **Ceramic Engineering**

This option emphasizes courses and research in ceramic materials, which includes areas such as powder processing, fabrication of high-density materials, high-temperature thermal conduction, strength of low-density materials, high-temperature superconductivity, electronic ceramics, refractories, and ceramic matrix composites.

## **Polymers**

The Master of Science degree in Polymers is offered through the Schools of Materials, Chemical, and Textile Engineering. The core course requirements for polymer degrees are the same in each school. This core is designed to provide a balanced treatment of the chemistry, physics, and engineering of polymeric materials. At the same time, the wide range of elective courses and research projects permits the students to develop an in-depth knowledge of a particular area of polymer science or engineering. This combination of breadth and depth of study is vital to the successful performance of polymer scientists and engineering graduates.

## **The Doctoral Degree**

The Doctor of Philosophy degree is directed toward the goal of attaining proficiency in the pursuit of independent scholarly work. The degree comprises course work in the principles of materials generally, with emphasis on metallurgy,

polymers, ceramics, or electronic materials. Additional requirements include specialized courses both in the area of the doctoral thesis and in one or two other areas, passing comprehensive examinations, and an independent research investigation.

Candidates for the doctoral degree are required to complete at least 18 credit hours of graduate-level course work beyond the M.S. degree, with a minimum GPA of 3.0. Each student must also earn 15 credit hours in a coherent minor field, chosen in consultation with the adviser. Students should commence participation in the School's research programs early in their graduate careers.

## **Financial Aid**

A number of fellowships and research assistantships from outside sources and industry are available to provide financial assistance for qualified graduate students. In addition, a limited number of Presidential Fellowships, as well as teaching and research assistantships, are available from the Institute. Waiver of out-of-state tuition is possible for qualified students. Further information can be obtained by writing the director of the School of Materials Science and Engineering.

## **Courses of Instruction**

### **MATE 1101. Introduction to Materials Engineering**

1-0-1. Elective for freshmen.

An orientation in materials is provided for both major and nonmajor engineering students. The course introduces the major classes of materials and how the materials engineering curriculum meets present industrial needs.

### **MATE 1801-2-3-4. Special Topics**

1 through 4 credit hours, respectively.

### **MATE 2101. Principles and Applications of Engineering Materials**

4-0-4. Prerequisites: CHEM 1102 or 1112; PHYS 2123.

The principles of engineering materials directed toward their application in engineering design. Equilibrium and nonequilibrium structures and properties; corrosion; engineering application and failure analysis.

Text: at the level of W. D. Callister, Jr., *Materials Science and Engineering: An Introduction*.

### **MATE 3004. Thermodynamics and Phase Equilibria of Materials**

4-0-4. Prerequisite: CHEM 3412.

Review basic laws and relationships between thermodynamic quantities. Use thermodynamic data to predict chemical reactions and equilibria.

**MATE 3006. Physical Metallurgy and Ceramics**

3-0-3. Prerequisites: MATE 2101 or equivalent and MATE 3004.

The course is intended to provide the student with a firm grasp of the fundamentals of defect structures and phase transformations in metal and ceramic systems.

**MATE 3007. Pyrometry and Thermal Analysis**

2-3-3. Prerequisite: PHYS 2122.

Temperature measurement using thermocouple, optical pyrometers, and radiation pyrometers is emphasized. Differential thermal analysis, thermogravimetric analysis, and dilatometry is presented for characterization of ceramic materials.

Text: at the level of Speyer, *Thermal Analysis of Materials*.

**MATE 3008. Glass Technology**

3-3-4. Prerequisite: MATE 2101 or equivalent.

Fundamentals of glass structures, composition, properties, manufacturing, and applications are described. The factors controlling crystallization, adherence, color, opacification, and stresses in glassy protective coatings are presented.

Text: at the level of Doremus, *Glass Science*.

**MATE 3101. Engineering Materials Laboratory**

0-3-1. Prerequisites: can be taken either concurrently with or after 2101; or 3702, 3, 4, or 5.

The principles of engineering materials are demonstrated in the laboratory. Instruction is given on basic laboratory skills.

**MATE 3312. Physical and Electronic Properties of Materials I**

2-0-2. Prerequisite: MATE 3446.

This course introduces the concepts necessary to understand the electronic, magnetic, and optical properties of the various classes of materials: metals, semiconductors, ceramics, and polymers.

**MATE 3313. Physical Properties of Materials II**

2-0-2. Prerequisite: MATE 3312.

This second course of the sequence centers around the understanding of the important physical processes in solids.

**MATE 3325. General Metallurgy**

3-0-3. Prerequisites: CHEM 1102, PHYS 2121. Not open to students in the School of Chemical Engineering.

Introductory physical metallurgy and characteristics and engineering applications of cast irons and steels. Static and dynamic properties of metals and alloys.

Text: at the level of Keyser, *Materials Science of Engineering*.

**MATE 3446. Crystallography and Diffraction Analysis of Materials**

3-3-4. Prerequisites: PHYS 2123, MATH 3308, MATE 2101 or equivalent.

This course is an introduction to the theory and practice of diffraction analysis of crystalline materials. Particular emphasis is placed on X-ray methods.

Text: at the level of Cullity, *Elements of X-ray Diffraction*.

**MATE 3463. Mechanical Behavior of Materials**

3-3-4. Prerequisites: ESM 3301, MATE 2101 or equivalent.

The goal of this course is to introduce the student to the mechanical behavior of the major classes of materials such as

ceramics, metals, polymers, and composites. The atomic structure and morphological arrangements of these materials are reviewed and related to the mechanical behavior.

**MATE 3702. Materials Engineering for Structural and Thermal Systems**

3-0-3. Prerequisites: CHEM 1102 or 1112, and PHYS 2123.

Basic concepts in materials engineering and the application of these principles directed toward materials used in structural and thermal systems.

Text: at the level of W. D. Callister, Jr., *Materials Science and Engineering: An Introduction*.

**MATE 3703. Materials Engineering for Electronic, Magnetic, and Electro-optic Systems.**

3-0-3. Prerequisites: CHEM 1102 or 1112, and PHYS 2123.

Basic concepts in materials engineering and the application of these principles directed toward materials used in electronic, magnetic, and electro-optic systems.

Text: at the level of W. D. Callister, Jr., *Materials Science and Engineering: An Introduction*.

**MATE 3704. Materials Engineering for Chemical Systems**

3-0-3. Prerequisites: CHEM 1102 or 1112, and PHYS 2123.

Basic concepts in materials engineering and the application of these principles directed toward materials used in chemical systems.

Text: at the level of W. D. Callister, Jr., *Materials Science and Engineering: An Introduction*.

**MATE 3705. Materials Engineering for Nuclear Systems**

3-0-3. Prerequisites: CHEM 1102 or 1112, and PHYS 2123.

Basic concepts in materials engineering and the application of these principles directed toward materials used in nuclear systems.

Text: at the level of W. D. Callister, Jr., *Materials Science and Engineering: An Introduction*.

**MATE 4003. Materials Processing**

3-3-4. Prerequisite: MATE 3006.

Theoretical concepts of fabrication of shapes by solidification, mechanical forming, and powder processing technologies with application to industrial product manufacture. Process mechanisms and their influence on microstructure/property control and end-use are emphasized. Current advances in processing technologies are also presented.

Text: at the level of Reed, *Introduction to the Principles of Ceramic Processing*, and Dieter, *Mechanical Metallurgy*.

**MATE 4042-3. Seminar**

1-0-1. Prerequisite: junior standing.

Discussion of current ceramic and scientific literature and reports of investigations.

**MATE 4051. Cements**

2-3-3. Prerequisite: MATE 3004.

Includes the required properties of raw materials, processing, and the hydraulic properties of cements. Portland, magnesia, high alumina, dental, and gypsiferous cements are included.

Text: at the level of Bogue, *The Chemistry of Portland Cement*; or Lea, *The Chemistry of Cement and Concrete*.

**MATE 4054. Process and Temperature Control Instrumentation**

3-3-4. Prerequisite: senior standing or consent of the School.

The mathematical and physical basis for the PID control algorithm is covered. Analog and digital temperature instrumentation is explained.

**MATE 4055. Introduction to Electroceramics**

2-3-3. Prerequisites: MATE 3004, PHYS 2122.

Fabrication requirements, property control and structure-property-processing relationships in electroceramics. Materials and applications of ceramic conductors (ionic, semiconducting, and superconducting), dielectrics, ferroelectrics, piezoelectrics, electro-optic and magnetic ceramics will be covered.

Text: at the level of A.J. Moulson and J.M. Herbert, *Electroceramics: Materials-Properties-Applications*.

**MATE 4102. Refractories**

2-3-3. Prerequisites: MATE 3006, CHEM 3412.

Fundamentals of refractory materials selection and application are stressed. The raw materials and manufacturing methods used to produce refractories are covered.

Text: at the level of S.C. Carniglia and G.L. Barna, *Handbook of Industrial Refractories Technology (Principles, Types, Properties and Applications)*.

**MATE 4104. Ceramic Processing**

3-3-4. Prerequisite: MATE 3006.

Fundamentals of ceramic processing are emphasized, including synthesis, characterization, and beneficiation of ceramic raw materials, rheological behavior of slurries and pastes, drying and firing processes. Plastic-forming and casting processes are covered in detail.

Text: at the level of Reed, *Introduction to the Principles of Ceramic Processing*.

**MATE 4210. Energy Conversion and Control**

3-0-3.

Principles involved in converting various energy sources to thermal energy needed to heat kilns and furnaces are studied. Energy conversion equipment is reviewed. Methods of energy control are detailed.

**MATE 4311. Engineering Materials I-Ceramics**

3-0-3. Prerequisite: senior standing.

The object of this course is to present the major ceramic systems and their properties and relate them to industrial production and applications. This course serves as the capstone design experience for the student in the area of ceramic materials.

**MATE 4312. Engineering Materials II-Metals**

3-0-3. Prerequisite: senior standing.

Industrially important metals and alloys, their properties, and processing are reviewed. Selection and application of metallic materials in industrial design, causes and prevention of failure are emphasized. This course serves as the capstone design experience for the student in the area of metallic materials.

**MATE 4413. Microscopy of Materials**

3-3-4. Prerequisites: PHYS 2123, MATE 3446.

The object of this course is to provide both the theory and an operating knowledge of stereology, transmission electron

microscopy, and scanning electron microscopy. The course provides the student with the basis for selecting the best means of observing and analyzing the morphology and internal structure of materials.

Text: at the level of Goldstein, *Scanning Electron Microscopy and X-ray Microanalysis*.

**MATE 4421. Nonferrous Metallography**

2-3-3. Prerequisite: MATE 3006 or equivalent.

The influence of processing variables on the structure and properties of nonferrous alloys. Pyrometric instrumentation applied to heat treating and thermal analysis.

Text: at the level of Gordon and Phillips, *Structure and Properties of Alloys*.

**MATE 4422. Ferrous Metallurgy**

3-3-4. Prerequisite: MATE 3006 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.

Text: at the level of Brick, Gordon, and Phillips, *Structure and Properties of Alloys*.

**MATE 4423. Metallurgical Fabrication**

3-0-3. Prerequisite: MATE 3463 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.

**MATE 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.

Text: *Nondestructive Testing Handbook*.

**MATE 4491. Corrosion and Protective Measures**

3-0-3. Prerequisite: CHEM 3412.

Students learn the theory of oxidation and electrochemical corrosion. Major forms of corrosion and methods of corrosion protection are explained. Importance of corrosion in industrial design and economic implications are emphasized.

**MATE 4601. Electronic Packaging and Design**

3-0-3.

A multidisciplinary approach to electronic packaging design, covering the materials characterization required in present and future electronic packages, mechanical considerations, and interconnect and processing issues. Text: *Electronic Materials Handbook, Volume 1, Packaging*.

**MATE 4791. Mechanical Behavior of Composites**

3-0-3. Prerequisites: MATE 2101 or equivalent, or AE 4813; and MATE 3463 or ESM 3301 or AE 2201.

The stress-strain behavior of anisotropic composites structures and the elastic and plastic properties of matrix and reinforcing materials are covered for polymers, ceramics, and metals. Cross-listed with ME 4791.

**MATE 4792. Fundamentals of Fiber-reinforced Composites I**

3-0-3. Prerequisites: AE 2102 or ESM 3301.

Introduction to the mechanics of fiber-reinforced composite

materials. Advantages and uses of composites. Property characterization methods. Lamina and laminate analysis. Failure mechanisms. Applications to structural components made of composites. Cross listed with ME, CE, ChE, ESM, AE, TFE.

## **MATE 4793. Composite Materials and Processes**

3-0-3. Prerequisites: CHEM 1102 or 1112, PHYS 2123.

Basic principles of selecting component materials and manufacturing composites are presented. Polymeric, metallic, and ceramic systems are considered. Cross listed with ME, CE, ChE, ESM, AE, TFE. 4793.

## **MATE 4794. Laboratory in Composites Manufacturing Testing**

2-3-3. Prerequisites: AE, CHE, MATE, ME, or TEXT 4791 or 4792, and 4793.

Covers major manufacturing and testing techniques involved in composites. Analysis, planning, and design of practical parts will also be covered. Cross listed with ME, CE, ChE, ESM, AE, TFE.

## **MATE 4801-2-3-4-5. Special Topics**

1 through 5 credit hours, respectively. Prerequisite: consent of the School.

## **MATE 4951. Independent Research I**

0-3-1. Prerequisite: consent of the undergraduate coordinator.

The student selects an adviser and defines an area of research. The majority of the course focuses on literature survey and the development of the statement of the problem. MATE 4952 and 4953 must be completed for this course to be used for specialization series or free elective credit.

## **MATE 4952. Independent Research II**

0-9-3. Prerequisites: consent of the undergraduate coordinator and MATE 4951.

The student formulates and initiates an experimental plan coordinating the research with his or her adviser. The majority of the laboratory research will be conducted during this quarter. MATE 4953 must be completed for this course to be used for specialization series or free elective credit.

## **MATE 4953. Independent Research III**

0-6-2. Prerequisites: consent of the undergraduate coordinator and MATE 4952.

The student completes the experimental portion of his or her research at the beginning of the quarter and completes the writing of the research document during the remainder of the quarter.

## **MATE 6005. Dental-Medical Materials**

2-0-2. Prerequisites: MATE 2101 or equivalent, 4491.

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.

## **MATE 6011. Colloidal Properties of Hydrous Alumino Silicates**

3-0-3. Prerequisite: consent of the School.

The physicochemical properties of the plastic and nonplastic hydrous alumino silicates are studied, including viscosity, dispersion, flocculation, and permeability.

Text: at the level of Van Olphen, *An Introduction to Clay Colloid Chemistry*.

## **MATE 6012. Colloidal Properties of Hydrous Alumino Silicates**

3-3-4. Prerequisite: consent of the School.

Plastic properties of clay-water systems and industrial applications. Interactions of clay and organic compounds.

Text: at the level of Lawrence, *Clay-Water Systems*.

## **MATE 6013. Colloidal Properties of Hydrous Alumino Silicates**

3-0-3. Prerequisite: consent of the School.

Basic surface properties are studied for application to gas absorption surface area measurements and mineral flotation processes.

## **MATE 6014-5. Ceramic Applications to the Phase Rule**

3-0-3. Prerequisite: MATE 3004 or consent of the School.

Phase equilibria in one-, two-, and three-component systems are reviewed. Melting and solidification behavior in complex three-component systems are examined. Effect of oxygen pressure on phase relations in multicomponent systems is surveyed. Applications of thermodynamics to phase diagrams are studied.

## **MATE 6017-8. Glass Technology I, II**

3-0-3 each. Prerequisite: MATE 3008 or consent of the School.

Constitution of glass is studied using dynamic considerations. The reasons for the failure of oxide melts to crystallize on cooling are emphasized. Mutual polarization of ions is utilized in analyzing the various glass structures. The different experimental techniques available to study glasses are reviewed.

Text: at the level of Doremus, *Glass Science*.

## **MATE 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.

## **MATE 6024. Solidification Processing**

3-0-3. Prerequisites: MATE 3004 or equivalent and MATE 3006 or equivalent.

Application of thermodynamics, and heat and mass transport to solidification. Topics include single and multiphase solidification, solute segregation and homogenization, morphological instability, and rapid solidification.

## **MATE 6025. Powder Metallurgy**

1-3-2. Prerequisite: MATE 4423.

Physical and chemical production of metallic powders. Pressing, slipcasting, sintering, and the theoretical aspects of these processes; hot pressing and coining; industrial applications and materials.

Text: at the level of ASM *Powder Metallurgy*, selected literature by Steinburg, Kuczynski, and Schwarzkopf.

## **MATE 6052. Quantitative Optical and X-ray Crystallography**

3-3-4.

Interaction of light and X-rays with periodic crystal lattices is developed in relation to structure identification and quantitative analysis in polycrystalline ceramics.

**MATE 6053. Electronic and Technical Ceramics**

3-3-4.

Processing, properties, and structure of dielectrics, piezoelectrics, ferroelectrics, ferrites, garnets, and other technical ceramics.

**MATE 6054. Digital Temperature Instrumentation and Control Systems**

2-3-3.

Process control theory is reviewed; analog and digital instrumentations are compared; digital control algorithms for simple loops, cascaded loops, and distributed control are discussed.

**MATE 6055. Refractory Failure Analysis**

2-3-3.

Methods of determining the reason for premature failure of refractories in service are presented. Detailed case studies will be discussed and evaluated in the laboratory.

**MATE 6056. Practical Electron Microscopy**

2-3-3.

The various types of electron microscopes and how they function will be discussed. The usage of SEM techniques to investigate solid materials will be emphasized.

Text: at the level of Goldstein, *Scanning Electron Microscopy and X-ray Microanalysis*.

**MATE 6057. Surface Analysis I**

3-0-3.

Introduction to vacuum science and technology; structure of solid surfaces; low energy electron diffraction, Auger electron spectroscopy, X-ray photoelectron spectroscopy, and ultraviolet photoelectron spectroscopy.

**MATE 6091. Advanced Theory of Metallic Corrosion**

3-3-4. Prerequisite: MATE 4491.

The subject matter covers the latest theories and concepts of metallic corrosion.

**MATE 6110. Kiln and Furnace Design**

2-3-3.

Principles, methods, and devices used to provide heat for operating kilns and furnaces are reviewed. Principles of automatic control are covered. Student designs a kiln equipped with an automatic control system.

**MATE 6135. Research and Control Methods**

2-3-3. Prerequisite: consent of the School.

Emphasis on the experimental and instrumental techniques for research and control measurements. Review of optical, physical, electrical, mechanical measurement of techniques, instrumentation, laboratory demonstration.

Text: at the level of Wilson, *Introduction to Scientific Research*, and Ackoff, *Scientific Method*.

**MATE 6421. Quantitative Characterization of Microstructures**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

General, statistically exact methods for describing geometrical attributes of microstructures from random selections. Applications to actual materials or biological specimens. Manual and automatic image analysis techniques.

Text: Underwood, *Quantitative Stereology*.

**MATE 6734. Diffraction Studies**

3-6-5. Prerequisite: MATE 3446 or consent of the School.

Fundamentals, methods, and instruments used in X-ray diffraction studies of materials.

Text: at the level of Azaroff, *Elements of X-ray Crystallography*.

**MATE 7000. Master's Thesis**

Credit to be arranged.

**MATE 7011. Fundamentals of Materials Engineering**

3-0-3. Prerequisite: graduate standing.

Emphasizes the fundamental physical, analytical, and mathematical techniques commonly encountered in materials engineering including stress and strain, crystallographic and orientation transformations, X-ray, TEM, and solid-state concepts.

**MATE 7041. Phase Transformations**

3-0-3. Prerequisites: MATE 7081 and MATE 7085.

The application of thermodynamics and kinetics of phase transformations in metal and ceramic systems.

Text: Current literature on phase transformations.

**MATE 7045. Advanced Electron Microscopy I**

3-0-3. Prerequisite: MATE 3446.

This course will emphasize the dynamical theory of image contrast in thin crystalline foils and its application to the interpretation of lattice defects.

Text: at the level of L. Reimer, *Transmission Electron Microscopy*.

**MATE 7046. Advanced Electron Microscopy II**

3-0-3. Prerequisite: MATE 7045.

This course will emphasize the application of theories of electron diffraction and image contrast in thin foils to the types of problems commonly encountered in materials.

Text: at the level of L. Reimer, *Transmission Electron Microscopy*.

**MATE 7052. Advanced Dislocations and Strengthening Mechanisms I**

3-0-3. Prerequisite: MATE 3463 or equivalent.

The emphasis in this course is on the geometry of dislocations, the effects of stress on the motion of dislocations, and dislocation/dislocation interactions.

Text: Hull, *Introduction to Dislocations*.

**MATE 7053. Advanced Dislocations and Strengthening Mechanisms II**

3-0-3. Prerequisite: MATE 7052.

The emphasis in this course will be the interaction of dislocations with other defects and the correlation of these interactions with the mechanical properties of materials.

Text: selected current literature.

**MATE 7081. Metallurgical Thermodynamics**

3-0-3. Prerequisites: MATE 3004 or equivalent, CHEM 3412.

Chemical thermodynamics of metals, alloys, and metallurgical processes; chemical equilibrium; solution thermodynamics; phase equilibria.

Text: C. H. P. Lupis, *Chemical Thermodynamics of Materials*.



## **MATE 7085. Metallurgical Kinetics**

3-0-3. Prerequisites: MATE 7081.

Heat and mass transport, physical kinetics, phase transformations, diffusion mechanisms, nucleation, growth, solidification, recrystallization, precipitation, spinodal decomposition, decomposition of austenite, radiation damage.

## **MATE 7753. Fundamentals of Fracture Mechanics**

3-0-3. Prerequisites: ESM 3301, MATE 3463 or equivalent.

Advanced study of failure of structural materials under load, mechanics of fracture, microscopic and macroscopic aspects, fracture of engineering materials. Cross listed with ME.

## **MATE 7754. Advanced Fracture Mechanics**

3-0-3. Prerequisites: MATE 7753 or ME 7753; ESM 6621 or 6341 or consent of the instructor.

Nonlinear fracture mechanics including fracture under elastic-plastic conditions, concepts of time-dependent fracture mechanics, advanced test methods, J-integral theory, creep crack growth, fatigue crack growth under gross plasticity. Cross listed with ME 7754.

## **MATE 7791. Damage and Failure in Composites**

3-0-3.

Methods for analysis and failure of fiber reinforced composite material systems. Treatment of mechanisms of toughening, multiple cracking mechanisms. Failure in woven fabric, braided, and special geometry composites.

Cross listed with ME, CE, ChE, ESM, AE, TFE 7791.

## **MATE 7792. Mechanics of Composites**

3-0-3.

Anisotropic elasticity, hygrothermal behavior stress analysis of laminated composites including 3D effects, stress concentrations, free-edge effects thick laminates, adhesive and mechanical connections, fracture of composites.

Cross-listed with ME, CE, ChE, ESM, AE, TFE 7792.

## **MATE 7793. Manufacturing of Composites**

3-0-3.

Major manufacturing techniques for metal-, ceramic- and polymer-matrix composites. Modeling of processes with emphasis on fundamental mechanisms and effects.

Cross listed with ME, CE, ChE, ESM, AE, TFE 7793.

## **MATE 8001. Seminar**

2-0-1. Prerequisite: graduate standing.

The latest advances in research and development will be presented by the enrolled students from articles in recent issues of recognized periodicals.

## **MATE 8102-3-4-5. Special Topics**

1,2,3,4,5 credit hours, respectively. Prerequisite: consent of the School.

Special topic offerings of current interest not included in regular courses.

## **MATE 8501-2-3. Special Problems.**

Credit to be arranged.

Lectures, laboratory, and library work on special topics of current interest in materials suitable for a master's degree candidate.

## **MATE 9000. Doctoral Thesis**

Credit to be arranged.

# School of Mechanical Engineering

**Established in 1885**

**Location: Coon Building**

**Telephone: 404-894-3201/3202**

*Director and Regents' Professor*—Ward O. Winer; *Associate Director for Administration and Undergraduate Programs and Professor*—Alan V. Larson; *Associate Director for Graduate Studies and Professor*—William J. Wepfer; *Southern Nuclear Distinguished Professor and Professor*—Said Abdel-Khalik; *Morris M. Bryan, Jr., Chair for Advanced Manufacturing Systems and Professor*—Steven Danyluk; *George W. Woodruff Chair in Mechanical Systems and Professor*—Jerry H. Ginsberg; *Parker H. Petit Distinguished Chair for Engineering in Medicine and Professor*—Robert M. Nerem; *Rae and Frank H. Neely Distinguished Professor and Professor*—Peter H. Rogers; *Fuller E. Callaway and Regents' Professor*—Weston M. Stacey, Jr.; *Eugene C. Gwaltney, Jr., Chair in Manufacturing Systems and Regents' Professor*—John A. White; *David S. Lewis, Jr., Chair and Regents' Professor*—Ben T. Zinn; *Georgia Power Distinguished Professor and Regents' Professor*—William Z. Black; *Regents' Professor*—Amy S. Teja; *Regents' Professor Emeritus*—Mario J. Goglia; *Professors*—Wayne J. Book, Gene T. Colwell, Prateen V. Desai, Stephen L. Dickerson, Pandeli Durbetaki, Robert E. Fulton, James G. Hartley, Jacek Jarzynski, Bernd Kahn, Ratib A. Karam, David L. McDowell, Farrokh Mistree, G. Paul Neitzel, George M. Rentzepis, Richard F. Salant, Raymond P. Vito, Ajit P. Yoganathan; *Associate Professors*—Yves H. Berthelot, Ye-Hwa Chen, Jonathan S. Colton, J. Narl Davidson, Aldo A. Ferri, S. Mostafa Ghiaasiaan, Ari Glezer, Itzhak Green, Nolan E. Hertel, Sheldon M. Jeter, Prasanna V. Kadaba, David N. Ku, Thomas R. Kurfess, Kok-Meng Lee, Steven Y. Liang, Harvey Lipkin, Carolyn W. Meyers, John G. Papastavridis, Jianmin Qu, Farzad Rahnama, Nader Sadegh, Samuel V. Shelton, Marc K. Smith, Charles Ume, Timothy M. Wick; *Assistant Professors*—Daniel Baldwin, Bert Bras, Jacqueline D. Bridge, Kenneth A. Cunefare, Show-Hwa Fong, Ying-Kuo Lee, Shreyes N. Melkote, Richard W. Neu, David W. Rosen, Suresh K.

Sitaraman, Jeffrey L. Streator, C. Chris Wang, Minami Yoda, Cheng Zhu; *Adjunct Professor*—Rodney D. Ice; *Adjunct Associate Professors*—Patrick Stafford, Cyrus K. Aidun; *Part-time Instructors*—James Brazell, Sue Clark, Kenneth Crase, Michael Ryan, Jon Trueblood, F. Ward Whicker; *Principal Research Engineer*—Scott S. Bair; *Principal Research Scientist*—Ji-Xun Zhou; *Senior Research Scientist*—Janet Allen; *Research Engineers II*—John R. Bogle, Michael F. Dowling, James S. Martin, George S. McCall; *Research Engineers I*—Van B. Biesel, Steven R. Hahn, Joey Lloyd; *Research Scientist I*—Robert Abraham; *Research Scientists II*—Lula L. Hilenski, Xue-Zhen Zhang.

## General Information

Mechanical engineering (ME) was the first academic program established at Georgia Tech. On September 20, 1985, the School of Mechanical Engineering celebrated its centennial by assuming the name of one of its most distinguished alumni, Atlanta businessman and philanthropist George W. Woodruff (Class of 1917). Today, the Woodruff School offers studies not only in **mechanical engineering** but also in the related fields of **nuclear engineering** and **health physics**.

**Mechanical engineering** traditionally deals with a large diversity of engineering problems. Because of this general nature, mechanical engineering encourages a number of multidisciplinary activities to be conveniently organized within it. Mechanical engineering embraces the generation, conversion, transmission, and utilization of thermal and mechanical energy; the design and production of tools and machines and their products; the consideration of fundamental characteristics of materials as applied to design; and the synthesis and analysis of mechanical, thermal, and fluid systems, including the automation of such systems. Design, production, operation, administration, economics, and research are functional aspects of mechanical engineering.

**Nuclear engineering** is the branch of engineering directly concerned with the release, control, utilization, and environmental impact of energy from nuclear fission and fusion sources. Today, the diversity of nuclear energy allows a wide variety of applications, from the exploration

of outer space and the powering of human heart pacemakers to the generation of electricity. With the limited supply of fossil fuels and the growing concern about their environmental effect, the need for nuclear power to produce the large amount of energy demanded by our society becomes more pressing. Programs in nuclear engineering are playing an important role in educating the technical manpower required to meet this need.

**Health physics** is an applied science concerned with the protection of people and the environment from the hazards of radiation and chemical pollutants. Health physicists develop a sound philosophy of radiation protection, apply these principles on the job in an industrial or medical setting or with a regulatory agency, and devise new methods and instrumentation for the protection of both individual workers and the general public.

## Undergraduate Programs

The undergraduate curriculum in **mechanical engineering** covers the fundamental aspects of the field, emphasizes basic principles, and educates the student in the use of these principles to reach optimal design solutions for engineering problems. Specific design subject matter and materials are also drawn from engineering activities such as lunar vehicles and biomechanical systems, as well as from the more traditional areas. Emphasis in the freshman and sophomore years is on mathematics, chemistry, physics, and introductory mechanics. Students must pass all required mathematics courses with a grade of C or better. The junior and senior years are devoted to the strength of materials and metallurgy, applied mechanics, heat transfer, fluid mechanics, systems and controls, design, manufacturing, and the application of fundamentals to the diverse problems of mechanical engineering. The curriculum stresses laboratory work and design projects. Computer skills, as demonstrated by the successful completion of ME 2016, are a prerequisite for all junior- and senior-level courses. Satisfactory completion of the curriculum leads to the degree of Bachelor of Mechanical Engineering.

The undergraduate curriculum in **nuclear engineering** is structured to meet the needs of

both the student who contemplates employment immediately after graduation and the student planning to pursue graduate study. It provides maximum flexibility in the form of options for each student to develop his or her unique interests and capabilities. The core curriculum covers the basic principles of nuclear engineering, nuclear reactor core design, reactor systems engineering, nuclear power economics, reactor operations, and health physics. In addition to the Institute's academic requirements for graduation with a bachelor's degree, the average aggregate grade point ratio in nuclear engineering and health physics courses taken toward the B.N.E. degree must be 2.0 or higher. Further, the average aggregate grade point average for courses taken in engineering thermodynamics and transport phenomena must be 2.0 or higher. Students must pass all required mathematics courses with a grade of C or higher. Only the highest grade received in any repeated course will be used in calculating quality points for these supplemental criteria.

## Graduate Programs

The graduate program in **mechanical engineering** has a vigorous program of advanced study and research in the areas of acoustics and noise control, applied mechanics, automatic controls, bioengineering, combustion, computer integrated and controlled manufacturing systems, dynamics and vibration, energy engineering, engineering and systems design, environmental quality control, fluid mechanics, heat transfer, lubrication, computer-aided design, computer-aided manufacturing, manufacturing engineering, materials processing, materials science, mechanisms (synthesis and analysis), rheology, robotics, vehicle propulsion, thermal systems, thermodynamics, transport processes, tribology, turbomachinery, and two-phase flows.

These graduate programs lead to the degrees Master of Science in Mechanical Engineering, Master of Science, and Doctor of Philosophy for qualified graduates having backgrounds in engineering, mechanics, mathematics, the physical sciences, or the biological sciences. The master's degree requires a minimum of 45 approved credit hours. Students may elect to earn 15 of these hours by writing a thesis, or they may earn all credit toward the degree through course work. Three hours of credit for a graduate course

taken as an undergraduate at Georgia Tech and used for credit toward the B.M.E. may be included in the M.S. program of study if the student graduated with an undergraduate grade point average of at least 3.3. Students must earn a graduate grade point average of at least 3.0 and satisfy all remaining requirements to be certified for the master's degree. Candidates for the Doctor of Philosophy degree must earn a graduate grade point average of at least 3.3. Students may obtain additional information about the programs by calling the School at (404) 894-3204 and requesting the *Mechanical Engineering Graduate Handbook*. Every student enrolled must consult this source of information with respect to special rules and degree requirements.

The graduate program in **nuclear engineering** leads to the degrees Master of Science in Nuclear Engineering, Master of Science, and Doctor of Philosophy. In nuclear engineering, students with the Bachelor of Science degree in engineering pursue the Master of Science in Nuclear Engineering degree, while students with a Bachelor of Science degree enroll for the Master of Science degree. Depending on the career objectives of the student, the School may encourage a thesis as part of the Master of Science program. Nuclear engineering students must earn a graduate grade point average of at least 3.0 and satisfy all remaining requirements to be certified for the master's degree or the Doctor of Philosophy degree. The doctoral program is designed with great latitude to capitalize on variations in experience and interests of individual students. The School encourages its students to enroll not only in nuclear engineering courses but also in courses related to their subject areas offered by other schools.

The graduate program in **health physics** leads to the degree of Master of Science in Health Physics. The program focuses on radiological and environmental protection. In addition to the traditional on-campus M.S. program, a video-based program leading to the M.S.H.P. degree is also offered to accommodate the needs of professionals in the field. A large number of health physics practitioners in government and industry participate in the video-based program. Three hours of credit for a graduate course taken as an undergraduate at Georgia Tech and used for credit toward an undergraduate degree in science

or engineering may also be included in the M.S. health physics program of study if the student graduated with an undergraduate grade point average of at least 3.3. Health physics students must earn a graduate grade point average of at least 3.0 and satisfy all remaining requirements to be certified for the master's degree.

### **Video-based Master's Programs**

The Woodruff School offers working professionals throughout the continental United States the opportunity to enroll in many of its graduate courses through video technologies. Qualified individuals can complete the requirements for the master's degrees in mechanical engineering and health physics utilizing the video-based delivery system. See page 16, Video-based Instruction.

### **Master of Science and Ph.D. in Bioengineering**

The Woodruff School is one of the participating schools in the interdisciplinary program leading to a Master of Science and Ph.D. in Bioengineering. The program curriculum was developed by a broadly based faculty group with research activities in bioengineering and the life sciences. The students in the program are enrolled in a participating school, such as the Woodruff School, as their home department. The program is mainly directed toward engineering graduates who wish to pursue a graduate degree in bioengineering rather than in a traditional field of engineering. This master's degree is complementary to that offered to graduate students in the Woodruff School in ME, NE, and HP. For more details on the degree requirements for the M.S. and Ph.D. in Bioengineering, see page 99.

### **Dual Degree in Management**

The School of Management allows a specified number of electives taken in another school at Georgia Tech to be applied toward the requirements for the Master of Science in Management (M.S.M.) degree. Persons interested in graduate degrees in management and in mechanical engineering should consult with advisers in the School of Management as well as the Woodruff School since admissions requirements for both programs must be met.

## **Multidisciplinary Programs**

Mechanical engineering students may plan electives that satisfy simultaneously the requirements of the degree program and a designated multidisciplinary field within the College of Engineering, thus earning both a graduate degree and a certificate indicating expertise in a related specialty. For a complete description of these and other multidisciplinary programs, see page 100.

## **School Facilities**

The Woodruff School of Mechanical Engineering has many types of specialized instruments and equipment associated with laboratories for the study of acoustics, bioengineering, tribology and rheology, material processing, fire hazard and combustion, energetics, heat transfer, vibration and thermal stress, computer-aided design, automatic control, machinery, microprocessor applications, manufacturing automation, noise, robotics, and other areas. The School is housed in a six building classroom/research complex. Part of this complex is a modern classroom/seminar conference building that serves the entire Institute. In addition, three research groups are located in the Fuller E. Callaway, Jr., Manufacturing Research Center. The buildings of the School house many remote terminals linked to the main campus research and teaching computers; also provided are extensive microcomputer facilities. The machine and instrumentation shops, supported by a full-time staff of technicians, enhance the School's research activities. The facilities available for the nuclear engineering program include the Neely Nuclear Reactor Center, which houses a 5-megawatt research reactor, a subcritical assembly, 1,000,000 curie cobalt-60 sources, several computers, hot cells for handling radioactive materials, a complete nuclear instrumentation laboratory, nuclear radiography equipment, radiochemical laboratories, and facilities for analyzing environmental samples by nuclear techniques.

# Bachelor of Mechanical Engineering Curriculum (Suggested Schedule)

## Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 1101-2</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>HIST 100X</b>			
U.S. History	3-0-3	.....	.....
<b>POL 1251</b>			
U.S. Government	.....	3-0-3	.....
<b>HPS 1040 or 1061</b>			
Health or Fitness	.....	.....	X-X-3
<b>Humanities/Social Sciences/Modern Languages Elective</b>	.....	.....	3-0-3
<b>TOTALS</b>	15-3-16	15-3-16	X-X-16

## Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>PHYS 2122</b>			
Electromagnetism	4-3-5	.....	.....
<b>PHYS 2123</b>			
Optics and Modern Physics	.....	4-3-5	.....
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3308</b>			
Differential Equations	.....	.....	5-0-5
<b>ESM 2211</b>			
Mechanics of Solids I	3-0-3	.....	.....
<b>ESM 3201</b>			
Dynamics	.....	.....	3-0-3
<b>ESM 3311</b>			
Mechanics of Solids II	.....	3-0-3	.....
<b>EE 3710</b>			
Intro. to Electronic Systems	.....	3-0-3	.....
<b>ME 2016</b>			
Computer Applications	.....	.....	2-3-3
<b>ME 3322</b>			
Thermodynamics I	.....	.....	3-0-3
<b>Humanities/Social Sciences/ Modern Languages Electives</b>	3-0-3	3-0-3	3-0-3
<b>TOTALS</b>	15-3-16	16-3-17	16-3-17

## Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
Branch Elective:			
<b>ME 3323</b>			
Thermodynamics II			
or	3-0-3	.....	.....
<b>ME 3760</b>			
Dynamics II			
<b>ME 3056</b>			
Experimental Methodology	.....	2-3-3	.....
<b>ME 3110</b>			
Creative Decisions & Designs	.....	3-0-3	.....
<b>ME 3115</b>			
System Dynamics	.....	.....	3-0-3
<b>ME 3213</b>			
Mechanical Behavior of Materials	.....	3-0-3	.....
<b>ME 3340</b>			
Fluid Mechanics I	.....	3-0-3	.....
<b>ME 3345</b>			
Conduction and Radiation			
Heat Transfer	3-0-3	.....	.....
<b>ME 3347</b>			
Fluid Flow and Convection	.....	.....	3-0-3
<b>MATE 3703</b>			
Engineering Materials	3-0-3	.....	.....
<b>EE 3741</b>			
Electronic Systems Laboratory	0-3-1	.....	.....
<b>EE 3703</b>			
Electric Power Conversion	.....	2-0-2	.....
<b>EE 4421</b>			
Senior Electrical Engineering Lab. II	.....	.....	0-3-1
<b>ISYE 4725</b>			
Engineering Economy	.....	.....	3-0-3
<b>MATH 3720</b>			
Statistics & Applic.	.....	.....	3-0-3
<b>ENGL 3015</b>			
Public Speaking			
or			
<b>ENGL 3020</b>			
Technical Writing	3-0-3	.....	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	.....	3-0-3	.....
<b>Free Electives</b>	3-0-3	.....	3-0-3
<b>TOTALS</b>	15-3-16	16-3-17	15-3-16

## Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ME 4110</b>			
Manufacturing Eng. and Technology	3-0-3	.....	.....
<b>ME 4445</b>			
Automatic Control	3-0-3	.....	.....
Branch Elective:			
<b>ME 4180</b>			

Mechanical Engineering Design			
or	3-0-3	.....	.....
<b>ME 4316</b>			
Thermal Systems Analysis			
Branch Elective:			
<b>ME 4052</b>			
Mechanical Systems Lab.			
or	.....	2-3-3	.....
<b>ME 4054</b>			
Thermal Sciences Lab.			
Branch Elective:			
<b>ME 4189</b>			
Structural Vibrations			
or	.....	3-0-3	.....
<b>ME 4350</b>			
Intermediate Fluid Flow & Heat Transfer			
<b>ME 4055</b>			
Experimental Engineering	.....	.....	0-6-2
<b>Design Project</b>			
<b>Electives</b>	.....	1-6-3	1-6-3
<b>Technical Electives</b>	3-0-3	3-0-3	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	.....	6-0-6
<b>Free Electives</b>	.....	3-0-3	3-0-3
<b>TOTALS</b>	15-0-15	12-9-15	10-12-14

**Total Credit Hours Required for Graduation = 191**

## Electives

### Humanities/Social Sciences/Modern Languages Electives

Eighteen credit hours of humanities and 18 credit hours of social sciences are required. See p. 33 for a list of acceptable courses. The courses selected to fulfill these requirements must provide both breadth and depth and should not be a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one course in each area. Students should consult with their academic adviser for course sequences that satisfy the depth requirement. All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

## Free Electives

The free electives may be taken at any time during the course of study. If ROTC is elected by the student, no more than six hours of basic ROTC courses may be used as free electives.

## Technical Electives

Technical electives must be chosen from the list of acceptable electives in the *Mechanical Engineering Undergraduate Handbook*. This list includes all 3000- and 4000-level ME courses as well as selected courses in other fields. ME courses at the 6000 level may also be scheduled provided the student has a grade point average of 3.0 or higher and prior consent is obtained from both the instructor and the associate director for Graduate Studies.

A student completing his or her junior year with a grade point average of 2.5 or higher may elect one technical elective from the special problems courses, 4901 through 4904.

## Branch Electives

All students must complete all of the courses in one of the following branches:

Mechanical Systems: ME 3760, ME 4180, ME 4052, and ME 4189

Thermal Systems: ME 3323, ME 4316, ME 4054, and ME 4350

Late in the junior year, a mechanical engineering student should decide which branch of the curriculum he or she wishes to pursue. Any branch course may be used as a technical elective by students selecting the other branch.

## Design Project Electives

For the six hours of engineering project electives, all students must choose from the three sequences: mechanical systems, ME 4182 and 4192; thermal systems, ME 4317 and 4392; and bioengineering systems, ME 4581 and 4582. If he or she desires, a student may substitute a design elective for the second quarter of the design project. A list of acceptable design electives is found in the *Mechanical Engineering Undergraduate Handbook*.

## **Bachelor of Nuclear Engineering Curriculum (Suggested Schedule)**

### **Freshman Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 1101-2</b> General Chemistry	4-3-5	4-3-5	.....
<b>MATH 1507-8-9</b> Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>PHYS 2121</b> Particle Dynamics	.....	.....	4-3-5
<b>NE 1100</b> Energy and Engineers in Society	3-0-3	.....	.....
<b>ENGL 1001-2</b> Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>POL 1251</b> U.S. Government	.....	3-0-3	.....
<b>HPS 1040 or 1061</b> Health or Fitness	.....	.....	X-X-3
<b>Humanities/Social Sciences Elective</b>	.....	.....	3-0-3
<b>TOTALS</b>	15-3-16	15-3-16	X-X-16

### **Sophomore Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ME 2016</b> Computer Applications	.....	.....	2-3-3
<b>PHYS 2122</b> Electromagnetism	4-3-5	.....	.....
<b>PHYS 2123</b> Optics and Modern Physics	.....	4-3-5	.....
<b>MATH 2507-8</b> Calculus IV, V	5-0-5	3-0-3	.....
<b>NE 3211</b> Elements of Nuclear Engineering	.....	.....	3-0-3
<b>MATH 3308</b> Differential Equations	.....	.....	5-0-5
<b>ESM 2211</b> Mechanics of Solids I	3-0-3	.....	.....
<b>ESM 3201</b> Dynamics	.....	.....	3-0-3
<b>ESM 3311</b> Mechanics of Solids II	.....	3-0-3	.....
<b>HIST 100X</b> U.S. History	3-0-3	.....	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	.....	3-0-3	3-0-3
<b>Free Elective</b>	.....	3-0-3	.....
<b>TOTALS</b>	15-3-16	16-3-17	16-3-17

### **Junior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>NE 3110</b> Nuclear Radiation Detection	.....	.....	2-6-4
<b>NE 4201-2</b> Nuclear Reactor Physics I and II	3-0-3	3-0-3	.....
<b>PHYS 3001</b> Radiation Physics	5-0-5	.....	.....
<b>HP 4412</b> Principles of Health Physics	.....	3-0-3	.....
<b>MATH 4582</b> Advanced Engineering Mathematics	3-0-3	.....	.....
<b>MATH 4581</b> Advanced Engineering Mathematics	.....	.....	3-0-3
<b>ME 3110</b> Creative Decision and Design	.....	.....	3-0-3
<b>ME 3322</b> Thermodynamics I	3-0-3	.....	.....
<b>ME 3340</b> Fluid Mechanics I	.....	.....	3-0-3
<b>ME 3345</b> Conduction and Radiation Heat Transfer	.....	3-0-3	.....
<b>EE 3710</b> Intro. to Electronic Systems	.....	3-0-3	.....
<b>EE 3741</b> Electronic Systems Laboratory	.....	.....	0-3-1
<b>ENGL 3015</b> Public Speaking or	.....	.....	.....
<b>ENGL 3020</b> Technical Writing	3-0-3	.....	.....
<b>Humanities/Social Sciences/Modern Language Electives</b>	.....	3-0-3	3-0-3
<b>TOTALS</b>	17-0-17	15-0-15	14-9-17

### **Senior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>NE 4211-2</b> Reactor Engineering I, II	3-0-3	3-0-3	.....
<b>NE 4205</b> Reactor Laboratory	1-6-3	.....	.....
<b>NE 4260</b> Radiation Transport and Shielding	.....	3-0-3	.....
<b>NE 4233-2</b> Nuclear Engineering Design, Applications	.....	3-0-3	0-9-3
<b>NE 4011-2-3</b> Nuclear Engineering Seminar	1-0-1	1-0-1	1-0-1

<b>MATE 3101</b>			
Engineering Materials Laboratory	.....	.....	0-3-1
<b>MATE 3705</b>			
Materials Engineering	.....	3-0-3	.....
<b>ISYE 4725</b>			
Engineering Economy	3-0-3	.....	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	.....	6-0-6
<b>Free Elective</b>	.....	3-0-3	.....
<b>Technical Electives</b>	3-0-3	.....	6-0-6
<b>TOTALS</b>	14-6-16	16-0-16	13-12-17

**Total Credit Hours Required for Graduation = 196**

## Electives

### Humanities/Social Sciences/Modern Languages Electives

Eighteen credit hours of humanities and 18 credit hours of social sciences are required. See p. 33 for a list of acceptable courses. The courses selected to fulfill these requirements must provide both breadth and depth and should not be a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one course in each area. Students should consult with their academic adviser for course sequences that satisfy the depth requirement. All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

### Free Electives

The free electives may be taken at any time during the course of study. If ROTC is elected by the student, no more than six hours of basic ROTC courses may be used as free electives.

### Technical Electives

Technical electives must be chosen from the list of acceptable electives in the *Nuclear Engineering Undergraduate Handbook*. NE courses at the 6000 level may also be scheduled provided the student has a grade point average of 3.0 or higher and prior consent is obtained from both the instructor and the associate director for the Graduate Programs.

A student completing his or her junior year with a grade point average of 2.5 or higher may elect

one technical elective from the special problems courses, 4901 through 4904.

## Courses of Instruction

### MECHANICAL ENGINEERING

#### ME 1600. Computers in Mechanical Engineering 1-6-3.

Introduction to use of personal computers in mechanical engineering. Operating systems, spreadsheets, equation solvers, graphics, communications, and networking. Some BASIC programming.

#### ME 2016. Computer Applications

2-3-3. Corequisites: MATH 3308 and computer literacy including programming.

Organization and application of digital computers. Application of numerical methods to the solution of mechanical engineering problems. Problem analysis, solution techniques, computer program organization, and error analysis are included.

#### ME 3056. Experimental Methodology

2-3-3. Prerequisites: MATH 3308, ME 3322, and ME 2016. Corequisite: EE 3741.

Presentation of experimental methodology and basic instrumentation used in mechanical engineering and its calibration and use, accuracy, error, and uncertainty in experimental measurements.

#### ME 3110. Creative Decisions and Design

2-3-3. Prerequisites: ESM 2211, MATH 3308, and ME 2016.

Basic concepts for creative decisions in engineering problem solving and design. Exposure to practicing engineers, their industries, and design problems.

#### ME 3113. Kinematics and Dynamics of Linkages

3-0-3. Prerequisites: ESM 3201 and ME 2016.

Kinematics and dynamics of linkages with emphasis on inertial forces. Balancing of rotating and reciprocating systems.

#### ME 3115. Systems Dynamics

3-0-3. Prerequisites: MATH 3308, ESM 3201, EE 3703, ME 2016. Corequisite: EE 4421.

Dynamic modeling of systems with mechanical, fluid, thermal, and/or electrical elements. Analysis including linearization, transient and frequency response, and stability. Vibration of mechanical systems.

#### ME 3213. Mechanical Behavior of Materials

3-0-3. Prerequisites: ESM 3311, MATE 3703, ME 2016.

Mechanical properties and behavior of metals, ceramics, polymers, and composites. Emphasis on material selection aspects based on considerations of resistance to plastic deformation, fatigue, fracture, and high temperature creep.

#### ME 3322. Thermodynamics I

3-0-3. Prerequisites: PHYS 2123, MATH 2508.

An introduction to thermodynamics. Thermodynamic properties, state postulate, work interactions, steady state and transient energy and mass conservation, entropy, and the second law.



## **ME 3323. Thermodynamics II**

3-0-3. Prerequisites: ME 3322, MATH 3308, ME 2016.

Continuation of ME 3322. Second-law analysis of thermodynamic systems, gas cycles, vapor cycles, thermodynamic relationships.

## **ME 3324. Thermodynamics III**

3-0-3. Prerequisites: ME 3323, ME 2016.

Continuation of ME 3323. Thermodynamic behavior of real gases, nonreacting gas mixtures, first- and second-law analysis of chemical reactions, chemical equilibrium.

## **ME 3340. Fluid Mechanics I**

3-0-3. Prerequisites: ESM 3201, 3311, MATH 3308, ME 3322, ME 2016.

Introduction to fluid mechanics, fluid statics, integral and differential control volume analyses with applications, study of similitude, simple laminar flows.

## **ME 3345. Conduction and Radiation Heat Transfer**

3-0-3. Prerequisites: MATH 3308, ME 3322, ME 2016.

Introduction to the study of heat transfer, transport coefficients, steady state conduction, transient conduction, radiative heat transfer.

## **ME 3347. Fluid Flow and Convection**

3-0-3. Prerequisites: ME 3340, 3345, ME 2016.

Transition and turbulence in fluid flow, laminar and turbulent boundary layers, forced and natural convection, one-dimensional compressible flow.

## **ME 3720. Thermodynamics**

4-0-4. Prerequisite: PHYS 2122. Not for ME students.

Fundamentals of engineering thermodynamics, thermodynamic properties of matter, the concept of conservation of energy, the second law of thermodynamics and application to engineering processes.

## **ME 3750. Introduction to Biofluid Mechanics**

3-0-3. Prerequisites: MATH 3308 and PHYS 2123, or consent of the instructor.

Introduces students to the study of blood flow in the cardiovascular system, with emphasis on the modeling of such flows and the potential of flow studies for clinical research application. Also taught as AE 3750, CHE 3750, and ESM 3750.

## **ME 3760. Dynamics II**

3-0-3. Prerequisites: ESM 3201, ME 2016.

Kinematics and kinetics of the three-dimensional motion of rigid bodies. Introduction to vibrations. Also taught as ESM 3760.

## **ME 4025. Engineering Analysis**

3-0-3. Prerequisite: consent of the 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.

## **ME 4041. Interactive Computer Graphics and Computer-aided Design**

2-3-3. Prerequisite: senior standing, ME 2016.

Principles of interactive computer graphics hardware and software. Programming for interactive graphics with application to the solution of thermal and mechanical design problems. Design projects.

## **ME 4052. Mechanical Systems Laboratory**

2-3-3. Prerequisites: ME 2016, 3056, 4110, 4445. Corequisite: ME 4189.

Observation, measurement, and analysis of basic phenomena in dynamics, vibrations, controls, and mechanics of materials. Special emphasis on the computer as a laboratory tool for data acquisition and analysis and for report preparation.

## **ME 4054. Thermal Sciences Laboratory**

2-3-3. Prerequisites: ME 2016, 3056, 3323, 3347. Corequisite: ME 4350.

Observation, measurement, and analysis of basic thermodynamic, fluid, and heat transfer phenomena. Special emphasis on the computer as a laboratory tool for data acquisition, reduction, analysis, and report preparation.

## **ME 4055. Experimental Engineering**

1-3-2. Prerequisite: ME 4052 or 4054, and ME 2016.

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.

## **ME 4091. Seminar**

1-0-1. Prerequisite: ME senior standing.

Civic and professional responsibilities and opportunities are brought to students by leaders in engineering, business, and community affairs.

## **ME 4110. Manufacturing Engineering and Technology**

3-0-3. Prerequisites: ME 2016, 3110, 3213, 3340, 3345, MATH 3720.

Fundamentals and applications of manufacturing. Advantages and limitations of a broad spectrum of manufacturing processes and their implications for product design; dimensional accuracy and tolerancing; design and planning of manufacturing processes and systems.

## **ME 4180. Mechanical Engineering Design II**

3-0-3. Prerequisites: ME 2016, 3110, 3213. Corequisite: ME 4110.

Application of the design process in the creation and selection of mechanical systems. Fasteners, welding, springs, bearings, shafts, gears, and other elements are utilized.

## **ME 4182. Mechanical Design Engineering**

1-6-3. Prerequisites: ME 2016, 4110, 4180, EE 4421, ISYE 4725.

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.

## **ME 4189. Structural Vibrations**

3-0-3. Prerequisites: ME 2016, 3115, 3760.

Single and multidegree-of-freedom systems as well as simple continuous systems are analyzed for their vibrational response characteristics using both exact and approximate methods.

## **ME 4192. Mechanical Design Engineering II**

1-6-3. Prerequisite: ME 4182.

Continued study of the design process for mechanical systems. Completion of the design project initiated in ME 4182.

**ME 4193. Design and Materials Selection for Tribological Applications**

3-0-3. Prerequisites: ME 3213, ME 3340.

Design, optimization of system tribological performance based on consideration of material properties, operating conditions, and available experimental data. Selection of materials for tribological applications.

**ME 4205. Manufacturing Processing: Casting and Joining**

2-3-3. Prerequisites: ME 2016, 4110, ESM 3311.

An intermediate-level treatment of two important manufacturing operations, emphasis on the engineering and technological aspects of these processes, applications and design criteria.

**ME 4212. Material Processes**

3-3-4. Prerequisites: ME 3213, 4110. Consent of the instructor for non-ME students.

Fundamentals of various techniques for solidification, working, and shaping materials. Machining, casting, joining, and metal forming are major topics. Laboratory practice supplements classroom treatment.

**ME 4265. Materials Science and Engineering**

3-0-3. Prerequisites: ME 2016, 3213.

Advanced studies of metals, polymers, ceramics. Atomic and molecular structure, crystal binding, defects, relationship of properties to microstructures. Phase equilibria, strengthening, failure, steel constituents, hardenability.

**ME 4316. Thermal Systems Analysis**

3-0-3. Prerequisites: ME 2016, 3323, 3347, 3110.

The application of the principles of thermodynamics and transport phenomena to the analysis of thermal systems and components, with examples from areas such as power generation, refrigeration, and propulsion. Computer simulation.

**ME 4317. Thermal Systems Design**

1-6-3. Prerequisites: ME 4110, 4316, EE 4421, ISYE 4725.

Design and optimization of thermal systems and components, with examples from areas such as power generation, refrigeration, and propulsion.

**ME 4321. Principles of Air Conditioning**

3-3-4. Prerequisites: ME 3323, 3347, or consent of the School.

Psychrometric principles. Thermal comfort. Load estimates. Environmental control. System design using load wedge and supply area concepts. Experiments to determine component and system performance.

**ME 4323. Internal Combustion Engines**

3-0-3. Prerequisites: ME 3323, 3347.

Principles, practice, and characteristics of internal combustion engines, with laboratory demonstrations in engine testing and performance.

**ME 4324. Power Plant Engineering**

3-0-3. Prerequisites: ME 2016, 3323, 3347, or consent of the School.

Steam and gas turbine power cycles. Modern power plants. Combined power plants. Energy and availability analysis. Economics of power generation. Design problems and field trips.

**ME 4326. Principles of Turbomachinery**

3-0-3. Prerequisites: ME 2016, 3347 or consent of the School.

Head, flow, and power relationships for turbomachines and their systems. Design of impellers and casings for various types of compressors, turbines, and pumps.

**ME 4329. One-dimensional Compressible Flow**

3-0-3. Prerequisites: ME 2016, 3347, 3323.

Fundamentals of one-dimensional steady and unsteady compressible flows. Isentropic flows, flows with friction and heat transfer and with shocks are examined.

**ME 4331. Refrigeration**

3-0-3. Prerequisites: ME 2016, 3323.

Refrigeration cycles and systems. Balanced design concepts in selecting components. System performance at off-design conditions. Heat pumps.

**ME 4339. Gas Turbines**

3-0-3. Prerequisites: ME 2016, 3323, 3347.

Applications of gas turbines, including limitations and advantages as compared with other prime movers. Design of compressor, combustor, and turbine components.

**ME 4343. Heating, Ventilating, and Air-conditioning Design**

3-0-3. Prerequisites: ME 2016, 4321.

Sizing of equipment for environmental control. Design of transportation and delivery systems. Energy recovery schemes. Total energy concepts and design features.

**ME 4350. Intermediate Fluid Flow and Heat Transfer**

3-0-3. Prerequisites: ME 2016, 3323, 3347.

A continuation of introductory fluid mechanics and heat transfer. Phase change, mass transfer, compressible flow, and the analysis, selection, and design of heat exchangers.

**ME 4392. Thermal Systems Design II**

1-6-3. Prerequisites: ME 2016, 4317.

Continued study of the design process for thermal systems. Completion of design projects initiated in ME 4317.

**ME 4445. Automatic Control**

3-0-3. Prerequisites: ME 2016, 3115.

Analysis and modeling of linear systems and compensation of feedback controlled systems using classical methods. Hydraulic, pneumatic, thermal, electrical, nuclear, chemical, and biomechanical examples.

**ME 4447. Microprocessors in Mechanical Systems**

2-3-3. Prerequisites: EE 3710 and 3703, ME 2016, 3056.

Design at the chip level and assembly language programming for measurement and control. Hands-on experience interfacing sensors and actuators with microprocessors and microcomputers.

**ME 4449. Numerical Control of Machine Tools**

3-0-3. Prerequisite: ME 2016; Corequisite: ME 4445.

Study of design and operation of typical digital control systems for machine tools, including path generation, CAD-oriented numerical control, machine synchronization, and feedback control applications.

## **ME 4581. Bioengineering Design I**

1-6-3. Prerequisites: ME 4180, 4110, EE 4421, ISYE 4725.

Creative design as applied to problems in medicine and biology. Physiological and environmental concerns. Materials selection and human factors. Applications of bioengineering design. Project.

## **ME 4582. Bioengineering Design II**

1-6-3. Prerequisite: ME 4581.

Continued study of design process. Student to complete a working prototype or component of design initiated in ME 4581.

## **ME 4752. Biomechanics**

3-0-3. Prerequisites: MATH 3308, ESM 3311.

The mechanics of living tissue, e.g., arteries, skin, heart muscle, and bone. Constitutive equations for tissues and some simple mechanical models. Biomechanical instrumentation.

## **ME 4760. Engineering Acoustics and Noise Control I**

3-0-3. Prerequisite: senior standing in engineering.

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.

## **ME 4771. Pulp and Paper Processes I**

3-0-3. Prerequisite: consent of the School.

A survey of the processes in a kraft pulp mill necessary to convert raw material to sulfate pulp. Wood preparation, wood chemistry, and morphology. The chemical and mechanical characteristics of kraft pulping and chemical recovery processes. Cross-listed with CHE.

Text: Britt, *Handbook of Pulp and Paper Technology*.

## **ME 4772. Pulp and Paper Processes II**

3-0-3. Prerequisite: consent of the School.

The major pulping processes other than kraft pulping. General knowledge of the various factors affecting each pulping process and pulp bleaching. The unique advantages and disadvantages of each pulping and bleaching process. Cross-listed with CHE.

Text: Britt, *Handbook of Pulp and Paper Technology*.

## **ME 4773. Paper Formation and Properties**

3-0-3. Prerequisite: consent of the School.

The processes in the fabrication of paper and paper products from pulp. The effects on paper properties of chemical and mechanical pretreatment of pulp. The measurement of paper properties. Cross-listed with CHE and TEX.

Text: Britt, *Handbook of Pulp and Paper Technology*.

## **ME 4780. Energy Conversion Engineering**

3-0-3. Prerequisite: ME 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.

## **ME 4791. Mechanical Behavior of Composites**

3-0-3. Prerequisites: MATE 2301, ESM 3311.

The stress-strain behavior of anisotropic composites structures and the elastic and plastic properties of matrix and reinforcing materials are covered for polymers, ceramics, and metals. Also taught as AE, CHE, CE, ESM, and TEX 4791.

## **ME 4792. Fundamentals of Fiber-reinforced**

### **Composites I: Structural Mechanics**

3-0-3. Prerequisite: ESM 3311.

Introduction to the mechanics of fiber-reinforced composite materials. Advantages and uses of composites. Property characterization methods. Lamina and laminate analysis. Failure mechanisms. Applications to structural components made of composites. Also taught as AE, CE, CHE, ESM, MATE, and TEX 4792.

## **ME 4793. Composite Materials and Processes**

3-0-3. Prerequisites: CHEM 1102 and PHYS 2123.

Basic principles of selecting component materials and manufacturing composites are presented. Polymeric, metallic, and ceramic systems are considered. Also taught as AE, CE, CHE, ESM, MATE, and TEX 4793.

## **ME 4794. Laboratory in Composite Manufacturing and Testing**

2-3-3. Prerequisites: ME 4791 or ME 4792, and ME 4793.

Covers major manufacturing processes and testing techniques involved in composites. Analysis, planning, and design of practical parts will also be covered. Also taught as AE, CE, CHE, ESM, MATE, and TEX 4794.

## **ME 4801-2-3-4-5. Special Topics, Mechanical Engineering**

1-0-1 to 5-0-5, respectively.

Special topic offerings of current interest not included in regular courses.

## **ME 4901. 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.

## **ME 6014. Engineering Instrumentation**

3-3-4. Prerequisite: ME 3056 or equivalent or graduate standing.

Methods and techniques of modern instrumentation in engineering research. Emphasis on analytical methods in planning and evaluation of experiments, integration of experimentation theory with practical aspects of instrumentation problems.

## **ME 6024-5. Variational Methods in Engineering I, II**

3-0-3 each. Prerequisite: ME 3347, ESM 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.

## **ME 6121. Advanced Dynamics of Machinery**

3-0-3. Prerequisite: consent of the School.

Design-oriented dynamics. Dynamics of systems with constraints, application of virtual work-minimum potential to systems, dynamical equations of Lagrange, Hamilton.

## **ME 6122. Machine Vibration**

3-0-3. Prerequisite: consent of the 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.

**ME 6123. Nonlinear Systems**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

The investigation of nonlinear systems including phase planes, describing functions, and analytical techniques. Examples are drawn from mechanics, fluid flow, and electric circuits.

**ME 6125. Mechanism Synthesis I**

3-0-3. Prerequisite: consent of the School.

Advanced topics in curvature theory. Finite displacement of a plane, Burmester theory. Current developments in kinematics. Graphic and analytic design methods.

**ME 6133. Elastic Yield Design of Machine Members**

3-0-3. Prerequisite: consent of the School.

The methods of strain-energy, virtual work, and Castigliano's theorem are applied to the design of machine members against excessive deformation.

**ME 6170. Engineering Design**

3-6-5. Prerequisite: consent of the School.

Design concepts, processes, and methodologies including quality and robustness. Group project.

**ME 6171. Designing Open Engineering Systems**

3-3-4. Prerequisite: graduate standing.

Decision-based design and the decision support problem technique; meta-design, decision support problems; robust design; modeling uncertainty; nature of critical analysis, verification and validation.

**ME 6175. Fundamentals of Computer-aided Design**

3-0-3. Prerequisites: graduate standing, ME 2016 and 4180 or 4316.

Fundamental techniques of CAD including geometric and solid modeling, parametric representations, features, and human-machine interactions. Applications to design, analysis, and manufacturing.

**ME 6176. Computer-aided Design Systems—Components and Techniques**

3-0-3. Prerequisite: ME 6175 or consent of the instructor.

An in-depth study of necessary hardware and software for development of computer-aided design systems, with special emphasis on human-machine interface.

**ME 6181. Rotor Dynamics**

3-0-3. Prerequisite: ME 6121.

Analysis and design of rotating shafts. Case studies include the effects of flexible bearings, instabilities due to asymmetric cross sections, hydrodynamic bearings, hysteresis, squeeze film dampers, and balancing.

**ME 6220. Principles of Continuum Mechanics**

3-0-3. Prerequisites: graduate standing, consent of the School, and familiarity with partial differential equations and vector mathematics.

Introductory treatment of the fundamental, unifying concepts of the mechanics of continua.

**ME 6239. Materials for Design**

3-0-3. Prerequisite: ME 4110 or equivalent.

Properties, behavior, and selection of materials for practical design applications. Topics include the behavior of metals, ceramics, polymers, composites, and the design process.

**ME 6271. Deformation of Metals**

3-0-3. Prerequisite: ME 4110 or equivalent.

Advanced study of atomic structure and imperfections in crystalline solids. Topics include plastic deformation, strain hardening, annealing processes, creep, fatigue, ductile and brittle fracture.

**ME 6274. Deformation Processing**

3-0-3. Prerequisites: ME 3213, 6220.

Bulk forming and sheet forming. Plastic flow and instability, yielding and metal working tribology. Various solution techniques including bound solutions, slab solutions, and slip-line fields.

**ME 6275. Inelastic Deformation of Solids**

3-0-3. Prerequisite: ME 6220 or ESM 6381.

Phenomenology and clarification of material behavior, rate independent and rate dependent plasticity. Finite deformation aspects, damage mechanics, numerical methods in plasticity.

**ME 6322. Thermodynamics I**

3-0-3. Prerequisite: undergraduate thermodynamics.

Thorough study of the principles of macroscopic formalism of thermodynamics. Thermodynamic systems, pure substance, multi-phase mixtures, reactive systems.

**ME 6323. Thermodynamics II**

3-0-3. Prerequisite: undergraduate thermodynamics.

Microscopic thermodynamics based on classical mechanics, quantum mechanics, and information theory. Prediction of macroscopic properties and system behavior from statistical considerations.

**ME 6324. Thermodynamics III**

3-0-3. Prerequisite: ME 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.

**ME 6332. Heat Transfer I**

3-0-3. Prerequisite: ME 3347 or consent of the School.

Conduction (steady state and transient), one- and multidimensional geometries. Emphasis on analytical methods, exact and approximate, and graphic techniques.

**ME 6333. Heat Transfer II**

3-0-3. Prerequisite: ME 6332 or consent of the School.

Convection (forced and free) in laminar and turbulent, internal and external flows. Analogy between momentum and heat transfer. Scaling laws and partial modeling.

**ME 6334. Heat Transfer III**

3-0-3. Prerequisite: graduate standing.

Radiation-electrodynamics, radiation optics, photon gas concept, black body radiation, surface characteristic, exchange in enclosures, radiation through continua, experimental methods.

**ME 6342. Fluid Flow I**

3-0-3. Prerequisite: ME 3340 or consent of the School.

A general development of the continuity, linear and angular momentum and energy equations followed by the fundamentals of perfect fluid theory.

**ME 6343. Fluid Flow II**

3-0-3. Prerequisite: ME 6342 or equivalent.

Viscous flow theory, including derivation of Navier-Stokes equations, a study of their general properties and their applications to creeping flow and to laminar and turbulent boundary layers.

**ME 6344. Fluid Flow III**

3-0-3. Prerequisite: ME 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.

**ME 6351. Direct Energy Conversion**

3-0-3. Prerequisite: graduate standing.

Analysis of performance characteristics, based on thermodynamic and fluid flow principles, of direct energy conversion devices such as thermionic, thermoelectrics, photovoltaic, magnetohydrodynamic, electrohydrodynamic generators, and fuel cells.

**ME 6352. Energy Conversion Systems**

3-0-3. Prerequisite: ME 3323 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.

**ME 6355. Combustion I**

3-0-3. Prerequisite: graduate standing.

Conservation laws and constitutive equations in reactive media. Reactions kinetics, laminar and turbulent diffusion flames.

**ME 6356. Combustion II**

3-0-3. Prerequisite: ME 6355 or equivalent.

Combustion of liquid and solid fuels. Combustion in laminar boundary layers.

**ME 6370. Thermal Environmental Control**

3-0-3. Prerequisite: consent of the School.

Thermodynamic relations of moist air. Air-conditioning processes. Environmental systems for thermal comfort. Direct and indirect contact transport processes.

**ME 6371. Advanced Refrigeration**

3-0-3. Prerequisite: consent of the School.

Development of design and performance characteristics of vapor compression, absorption, and several other work and heat input refrigeration cycles. Specification of desirable refrigerant properties.

**ME 6379. Turbines**

3-0-3. Prerequisite: ME 4339, 4326, or consent of the School.

Basic fluid mechanics and thermodynamics of the expansion processes in various types of radial and axial flow turbines. Current literature is discussed.

**ME 6383. Lubrication**

3-0-3. Prerequisite: consent of the 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.

**ME 6424. Feedback Control Systems I**

3-0-3. Prerequisite: ME 4445 or equivalent.

Linear systems. Integration of classical (root locus, frequency response) and modern (state feedback, observers) techniques. Mechanical, thermal, fluid, chemical, and nuclear examples.

**ME 6425. Feedback Control Systems II**

3-0-3. Prerequisite: ME 6424 or equivalent.

Non-linear system analysis (phase plane, describing functions, Lyapunov methods). Geometric control. Variable structure control. Adaptive control. Applications to robots and spacecraft.

**ME 6426. Feedback Control Systems III**

3-0-3. Prerequisite: ME 6424 or equivalent.

Optimal systems. Maximum principle and dynamic programming. Quadratic linear optimization. Kalman filtering. Computational methods.

**ME 6437. Digital Control I**

3-0-3. Prerequisite: ME 4445 or equivalent.

A comprehensive treatment of the representation, analysis, and design of discrete-time control systems. Z-transform and the discrete Fourier transform. Classical design via transform methods.

**ME 6438. Digital Control II**

3-3-4. Prerequisite: ME 6424 and ME 6437 or equivalent.

Analysis and synthesis of discrete-time control systems using classical and state-space methods. System identification and control by least-square and Kalman filters. Synthesis methods are reinforced with hands-on real-time laboratory experience.

**ME 6439. Control System Components**

2-1-3. Prerequisite: ME 4445 or equivalent.

The performance characteristics and application of microprocessors and analog electronics to modern mechatronic systems, particularly smart sensors, controllers, and actuators.

**ME 6450. Flexible Automation**

3-0-3. Prerequisite: ME 6790 or equivalent, or consent of instructor.

Modeling, analysis, and design of automated flexible manufacturing information and control systems and similar discrete event systems. Introduction to Markov chains, Petri nets, queuing analysis, and perturbation analysis.

**ME 6451. Machine Vision**

3-0-3. Prerequisite: graduate standing.

Design of and algorithms for machine vision systems for manufacturing, farming, construction, and the service industries. Electronics, optics, illumination software.

**ME 6530. Pathology for Bioengineers**

3-0-3. Prerequisite: graduate standing.

Human anatomy, physiology, and pathology of the cardiovascular and orthopedics systems. Emphasis will be on pathogenesis, diagnosis, and treatment of disease of these systems.

**ME 6735. Numerical Methods in Engineering**

3-0-3. Prerequisite: graduate standing.

Numerical methods for solution of engineering systems. Numerical approximations to mathematical operations. Application to initial eigenvalue and boundary value problems. Computational stability for ordinary and linear partial differential equations. Also taught as NE 6735.

**ME 6751. Complex Systems Design**

2-4-3. Prerequisite: graduate standing in engineering.

Interdisciplinary team design of systems of current interest to society that have large technological factors. Individual research and interaction with non-Institute resource persons and non-Institute faculty. Grades based on oral and written reports. Cross-listed with ESM and ISYE 6751.

**ME 6754. Engineering Data Base Management Systems**

3-0-3. Prerequisite: graduate standing and consent of the School.

Modeling and managing engineering information systems, integration of design and manufacturing functions in engineering product development, logical models of engineering product and processes.

**ME 6755. Polymer Structure and Mechanical Properties**

3-0-3. Prerequisite: CHE 4751 or TEX 4751.

Fundamental aspects of the development and analysis of structure, and molecular and phenomenological models of mechanical behavior of solid-like polymers are presented. Cross-listed with TEX 6765 and CHE 6765.

**ME 6756. Mechanical Properties of Polymers**

3-0-3. Prerequisite: CHE 4751 or TEX 4751.

Mechanics of deformation of anisotropic polymers; anisotropy and critical phenomena, such as yield, breaking, and fatigue, in the mechanical behavior of polymers; engineering applications. Cross-listed with TEX 6756 and CHE 6756.

**ME 6757. Industrial Robotics**

3-0-3. Prerequisite: EE 4015, ME 4445, or equivalent.

The hardware and software components of robotic systems are studied. Robot configurations, motion description and analysis, programming, sensors, controls, end-effectors, actuation, and applications.

**ME 6760-1. Acoustics I and II**

3-0-3 each. Prerequisite: partial differential equations or consent of the School.

Governing equations of sound waves from the conservation laws. Acoustic momentum, energy, and intensity. Propagation, reflection, absorption, and scattering. Effects of the physical properties. Application of the theory of sound to real systems. Transmission of sound in real media.

**ME 6762. Acoustics III**

3-0-3. Prerequisite: ME 6761.

Advanced duct acoustics, wave dispersion and attenuation, acoustics in moving media, geometrical acoustics, nonlinear acoustics.

**ME 6763. Noise Reduction and Control (Industrial Applications)**

3-0-3. Prerequisite: ME/AE/ESM 6760, ME 4025 or equivalent.

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.

**ME 6764. Ocean Acoustics**

3-0-3. Prerequisite: EAS 4300 or consent of the School. MATH 4321, 4582, ESM 6760 recommended.

Propagation of sound waves in the oceans, stress-strain relationships, asymptotic ray theory. Propagation in shallow water and deep water. Cross-listed with EAS and ESM 6764.

**ME 6781. Biosolid Mechanics**

3-0-3. Prerequisite: ESM 4351 or equivalent.

Mechanics as applied to living tissues. Bioviscoelastic solids: the constitutive equations of blood and vessels, muscle, cartilage, bone, and other tissues. Also taught as ESM 6781.

**ME 6785. Cellular Biomechanics**

3-0-3. Prerequisite: graduate engineering status.

A study of mammalian cell structure and mechanical properties, emphasizing their ability to respond and adapt to their physicochemical environment. Mechanical basis of cellular pathology.

**ME 6790. Computer Integrated Manufacturing Systems I**

3-0-3. Prerequisite: graduate standing. Priority will be given to CIMS students.

A broad overview of the functions, processes, and disciplines of computer integrated manufacturing. Also taught as EE 6790 and ISYE 6790.

**ME 6791. Computer Integrated Manufacturing Systems II**

3-0-3. Prerequisite: ME 6790.

An in-depth study of current issues, emerging technologies, and future developments in computer integrated manufacturing. Also taught as EE 6791 and ISYE 6791.

**ME 6792. Computer Integrated Manufacturing Systems Seminar**

1-0-1.

Guest speakers on a broad range of CIMS-related topics: research, applications, and technology. Also taught as EE 6792 and ISYE 6792.

**ME 7000. Master's Thesis****ME 7024. Perturbation Methods in Mechanics**

3-0-3. Prerequisites: graduate standing, knowledge of ordinary and partial differential equations.

Asymptotic techniques for the solution of regular and singular problems in mechanics.

**ME 7122. Advanced Machine Vibrations**

3-0-3. Prerequisite: ME 6122 or consent of the School.

Applications of vibration theory. Machinery response on resilient mounting. Kinematic and dynamic stability. Nonlinear systems in electromechanical and mechanical design.

**ME 7123. Nonlinear Acoustics**

3-0-3. Prerequisite: ME 6761.

Nonlinear plane waves in lossless fluids; Earnshaw and

Fubini solutions; weak shock theory; non-planar waves; sonic booms; Burgers' equation; parametric arrays; and radiation pressure.

## **ME 7140. Decision Theory for Engineering Design**

3-0-3. Prerequisite: MATH 3720 or 4215 or equivalent.

Use of information-theory decision analysis in solving practice problems in engineering design and reliability that cannot be effectively treated by any other method.

## **ME 7221. Fundamentals of Fatigue**

3-0-3. Prerequisites: ESM 3311 and MATE 3463, or equivalent.

Mechanical and microstructural aspects of nucleation and growth of cracks under cyclic loading conditions. Topics include stress- and strain-life approaches, notch effects, cumulative damage rules, consideration of variable loading histories, stress state effects, crack propagation laws, thermal fatigue, contact fatigue, and creep-fatigue interaction.

## **ME 7224. Micromechanics of Composite Materials**

3-0-3. Prerequisite: ME 6220.

Fundamental concepts of micromechanics of solids with emphasis on application to composite materials.

## **ME 7225. Constitutive Equations for Non-linear Behavior of Solids**

3-0-3. Prerequisite: ME 6220.

Advanced treatment of constitutive laws for non-linear behavior of solids. Couple thermomechanical laws and underlying physical bases. Viscous inelasticity of crystalline solids and behavior of structured media.

## **ME 7338. Advanced Topics in Heat Transfer**

3-0-3. Prerequisites: ME 6332, 6333, 6334.

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.

## **ME 7341. Transport Phenomena in Two-phase Flow**

3-0-3. Prerequisite: consent of the 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.

## **ME 7753. Fundamentals of Fracture Mechanics**

3-0-3. Prerequisites: ESM 3311, MATE 3463, and ESM 6321 or 6341 or consent of the instructor.

Advanced study of failure of structural materials under load, mechanics of fracture, and microscopic and macroscopic aspects of the fracture of engineering materials. Also taught as MATE 7753.

## **ME 7754. Advanced Fracture Mechanics**

3-0-3. Prerequisites: ME 7753, ESM 6621 or ESM 6341, and consent of the instructor.

Nonlinear fracture mechanics including fracture under elastic-plastic conditions, concepts of time-dependent fracture mechanics, advanced test methods, J-integral theory, creep crack growth, fatigue crack growth under gross plasticity. Also taught as MATE 7754.

## **ME 7780. Biofluid Mechanics**

3-0-3. Prerequisite: ME 3347 or equivalent.

A unified treatment on hemorheology, hemodynamics, pulsatile flows, microcirculation, joint lubrication, pulmonary physiology, etc., with emphasis on a quantitative approach. Also taught as ESM 7780, CHE 7780.

## **ME 7791. Damage and Failure in Composites**

3-0-3. Prerequisite: ME, AE, MATE, TFE, CE, CHE 4791 or 4792 or AE 4120.

Methods for analysis and failure of fiber reinforced composite material systems. Treatment of mechanisms of toughening, multiple cracking mechanisms. Failure in woven fabric, braided and special geometry composites. Cross-listed with AE, MATE, TFE, CE, CHE 7791.

## **ME 7792. Mechanics of Composites**

3-0-3. Prerequisite: ME, AE, MATE, TFE, CE, CHE 4792 or AE 4120, ESM 6321 or ESM 4351 or equivalent.

Anisotropic elasticity, hygrothermal behavior, stress analysis of laminated composites including 3D effects, stress concentrations, free-edge effects, thick laminates, adhesive and mechanical connections, fracture of composites. Cross-listed with AE, MATE, TFE, CE, CHE 7792.

## **ME 7793. Manufacturing of Composites**

3-0-3. Prerequisite: ME/AE/MATE/TFE/CE/CHE 4793.

Major manufacturing techniques for metal-, ceramic-, and polymer-matrix composites. Modelling of processes with emphasis on fundamental mechanisms and effects. Cross-listed with AE, MATE, TFE, CE, CHE 7793.

## **ME 7798. Teaching Practicum**

1-6-3. Prerequisite: consent of the School

Supervised teaching for doctoral students in mechanical engineering. Discussion of teaching techniques, course and curriculum design, and student evaluation methods and criteria. Students may, in some instances, prepare and present lectures under the supervision of a faculty member.

## **ME 7999. Preparation for Doctoral Qualifying Exam**

Audit only. Prerequisite: consent of the School.

## **ME 8010-1-2-3. Seminars in Mechanical Engineering**

1-0-1. Prerequisite: graduate standing.

Seminars involving current research projects presented by graduate students, ME faculty, and invited industrial speakers.

## **ME 8039. Heat Transfer Seminar**

1-0-1.

Two presentations by each student of current research activities: thesis work and special problems, presentation of thesis proposals. Attendance in curriculum-related seminars.

## **ME 8041-2-3-4-5. Fluid Mechanics Seminar**

1, 2, 3, 4, 5 credit hours, respectively. Prerequisite: consent of the School.

Advanced current topic in fluid mechanics and fluid engineering, including applications of interest to mechanical engineering.

## **ME 8101-2-3-4-5. Special Topics in Design**

1, 2, 3, 4, 5 credit hours, respectively. Prerequisite: consent of the School.

Special topic offerings of current interest not included in regular courses.

**ME 8201-2-3-4-5. Special Topics in Materials**

1, 2, 3, 4, 5 credit hours, respectively. Prerequisite: consent of the School.

Special topic offerings of current interest not included in regular courses.

**ME 8301-2-3-4-5. Special Topics in Energetics**

1, 2, 3, 4, 5 credit hours, respectively. Prerequisite: consent of the School.

Special topic offerings of current interest not included in regular courses.

**ME 8401-2-3-4-5. Special Topics in Systems and Controls**

1, 2, 3, 4, 5 credit hours, respectively. Prerequisite: consent of the School.

Special topic offerings of current interest not included in regular courses.

**ME 8451-2-3-4. Special Topics in Bioengineering**

1, 2, 3, 4 credit hours, respectively. Prerequisite: consent of the School.

Special topic offerings of current interest not included in regular courses.

**ME 8501. Special Problems in Mechanical Engineering**  
Credit to be arranged. Prerequisite: consent of the School.

Individual studies in certain specialized areas and mathematical analyses and/or experimental investigations of problems of current interest in mechanical engineering.

**ME 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**ME 9000. Doctoral Thesis****NUCLEAR ENGINEERING****NE 1010. Computer Programming for Nuclear Engineers**

3-0-3.

FORTRAN computer programming, graphics, and elementary numerical methods for NE freshmen will be taught using terminals to interact with the main computer on campus.

**NE 1100. Energy and Engineers in Society**  
2-3-3.

Deals with the concept of energy, society's requirements, the sources of supply, power generation methods, and related environmental influences.

**NE 3110. Nuclear Radiation Detection**

2-6-4. Prerequisite: HP 4410.

A laboratory introduction to the principles and characteristics of basic detectors for nuclear radiations and the electronic systems associated with them.

**NE 3211. Elements of Nuclear Engineering**

3-0-3. Prerequisite: PHYS 2123. Corequisite: MATH 3308.

An introduction to the field of nuclear engineering. Topics include nuclear physics, reactor physics, heat removal, nuclear power systems, and reactor licensing, safety, and the environment.

**NE 4011-2-3. Nuclear Engineering Seminar**

1-0-1 each.

A regularly scheduled course required of NE seniors.

Various topics presented by guest speakers, faculty members, and graduate students.

**NE 4115. Nuclear Engineering Calculations with Digital Computers I**

2-0-1.

Introduction to computer programming with emphasis on solution of problems relevant to nuclear engineering.

**NE 4201. Nuclear Reactor Physics I**

3-0-3. Prerequisites: HP 4410, NE 3211. Corequisite: MATH 4582.

The course covers the physical principles of nuclear reactors. Major topics include nuclear physics, neutron diffusion theory, criticality and multigroup theory.

**NE 4202. Nuclear Reactor Physics II**

3-0-3. Prerequisite: NE 4201.

The course covers the physical principles of nuclear reactors. Topics include neutron moderation and thermalization, heterogeneity effects, reactor kinetics, and reactivity changes.

**NE 4205. Reactor Laboratory**

1-6-3. Prerequisite: NE 4202. Students registering for NE 4205 must receive an access permit to the nuclear reactor from the director of the Nuclear Research Center one quarter prior to taking the course.

Covers measurement methods of reactor parameters: approach to criticality, control rod calibration, flux mapping, material reactivity coefficients, temperature coefficient, power calibration, activation analysis, cross sections measurement, and reactor checkouts and operations.

**NE 4210. Reactor Operations**

1-6-3. Prerequisites: senior standing and consent of the School. Students registering for NE 4210 must receive an access permit to the nuclear reactor from the director of the Nuclear Research Center one quarter prior to taking the course.

The course is designed to provide experience and knowledge of the reactor and its operation sufficient to satisfy the requirements of the USNRC to become an applicant for a Reactor Operator's License.

**NE 4211. Reactor Engineering I**

3-0-3. Prerequisites: ME 3322 and 3340.

Thermodynamics of nuclear power systems; nuclear heat generation; thermal analysis of fuel elements; pressure drop and heat transfer in a single phase flow.

**NE 4212. Reactor Engineering II**

3-0-3. Prerequisites: NE 4211 and ME 3345.

Continuation of NE 4211. Thermal-hydraulics of nuclear power systems. Two-phase flow, pressure drop, heat transfer, and dynamics. Pool and flow boiling.

**NE 4232. Nuclear Engineering Design Applications**

0-9-3. Prerequisites: NE 4202, 4212, 4233.

A complete design project of a section of a nuclear power plant or of a nuclear fuel cycle facility.



**NE 4233. Nuclear Engineering Design**

3-0-3. Prerequisite: NE 4201.

Introduction to design to provide experience in synthesis of principles of nuclear engineering in the design of instruments and facilities for nuclear applications.

**NE 4260. Radiation Transport and Shielding**

3-0-3. Corequisite: NE 4201 or equivalent.

Radiation transport and attenuation in homogeneous and heterogeneous bulk media. Emphasis on neutron and gamma-ray shielding. Shielding materials and shield design.

**NE 4265. Light Water Reactor Technology**

3-0-3. Prerequisites: NE 4202 and 4212.

A systematic survey of the technology of both pressurized and boiling water reactors, with emphasis on the nuclear steam supply system and its associated safety and control systems.

**NE 4301. Nuclear Fuel Cycle**

3-0-3. Prerequisite: senior standing in science or engineering.

Systematic review of technologies used at fuel cycle facilities. Introduction to the economic, environmental, safety, and licensing aspects of the nuclear fuel industry.

**NE 4610. Introduction to Fusion Power**

3-0-3. Prerequisite: senior standing in science or engineering.

An introduction to magnetic confinement fusion. Topics include basic plasma physics, magnetic confinement concepts, fusion technology, and a review of the current status of fusion research.

**NE 4720. Nuclear Technology and the Environment**

3-0-3. Prerequisite: senior standing in science or engineering or consent of the School. No credit to NE or HP students.

Survey of technical and social aspects of nuclear technology and their environmental and public health impacts and effects.

**NE 4780. Energy Conversion Engineering**

3-0-3. Prerequisite: ME 3322 or equivalent.

Energy sources, demand and supply; large electric generating systems (fossil, hydro, nuclear); energy storage, advanced generating systems (solar, geothermal, fusion) direct energy conversion (thermoelectric, thermionic, MHD, fuel cells).

**NE 4801-2-3. Special Topics**

3-0-3. Prerequisite: consent of the School.

The purpose of this course is to permit the Nuclear Engineering Program to offer formal courses on topics of special interest on an ad hoc basis.

**NE 4901-2-3-4. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

Special engineering problems will be assigned to the student according to his or her needs and capabilities to foster individual effort and experience in research techniques.

**NE 6101. Introduction to Nuclear Materials**

3-0-3. Prerequisite: graduate standing.

Metallurgy and physical properties of uranium, ceramic fuels, cladding, structural, tritium breeding, and control materials. Properties of coolants. Radiation damage effects.

**NE 6102. Nuclear Fuel Elements**

3-0-3. Prerequisite: NE 6101 or consent of the School.

Reactor fuel technology, including fuel preparation, assembly, and testing. In-core performance of fuel elements and fuel design procedures.

**NE 6103. Nuclear Reactor Analysis I**

3-0-3. Prerequisite: NE 4202 or equivalent.

Covers nuclear reactor physics at the graduate level. Topics include neutron reaction rates, neutron energy distribution, criticality, neutron diffusion theory, and neutron resonance absorption.

**NE 6104. Nuclear Reactor Analysis II**

3-0-3. Prerequisite: NE 6103.

Covers nuclear reactor physics at the graduate level. Topics include fuel depletion, nuclear reactor kinetics, neutron transport theory, multigroup diffusion theory, heterogeneous cores and advanced topics.

**NE 6105. Analysis of Experimental Data**

3-3-4. Prerequisite: graduate standing.

An introduction to the techniques of data reduction and error analysis used by practicing experimental engineers and scientists. Topics include precision and accuracy of data and data distribution, propagation of error, error estimation, least-squares fitting of data, goodness of fit, and nonlinear fitting of experimental data. FORTRAN programming to analyze the data will be emphasized.

**NE 6113. Radiation Effects on Materials**

3-0-3. Prerequisite: NE 6101 or equivalent.

Covers the effects of nuclear radiations on fuel and structural material in fission and fusion reactors. The heating effect of and the chemical changes resulting from nuclear radiations are also covered.

**NE 6126. Monte Carlo Methods in Nuclear Engineering**

3-0-3. Prerequisite: consent of the 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.

**NE 6140. Advanced Nuclear Fuel Cycle**

3-0-3. Prerequisite: consent of the School.

Survey of the nuclear fuel cycle. Technologies of raw materials production, uranium conversion and enriching, fuel fabrication and reprocessing, waste management, economic and safety analyses.

**NE 6201. Advanced Nuclear Reactor Physics I**

3-0-3. Prerequisite: NE 6104.

Covers the transport equation and methods to solve it. Specifically, the course covers derivation of the transport equation and its solution by integral, spherical harmonic, discrete ordinate, and Monte Carlo Methods.

**NE 6202. Advanced Nuclear Reactor Physics II**

3-0-3. Prerequisite: NE 6104.

Covers resonance self-shielding, adjoint transport equation, perturbation theory, variational techniques, thermalization of neutrons, and Doppler broadening.

### **NE 6212. Nuclear Reactor Technology II**

3-0-3. Prerequisite: NE 4212 or 6211.

Application of principles of reactor engineering to analysis of plant designs. Examples drawn from both fission and fusion technology.

### **NE 6232. Nuclear Fuel Management**

3-0-3. Prerequisite: graduate standing.

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.

### **NE 6235. Nuclear Reactor Safety**

3-0-3. Prerequisites: NE 4202 or equivalent and NE 4211 or 6211.

This course covers the physical mechanisms that can cause reactor transients and the methods used in their analysis, the containment of accidents, and the quantitative methods of risk analysis.

### **NE 6237. Fast Reactor Physics and Technology**

3-0-3. Prerequisite: NE 6104.

The course covers reactor physics and design topics of importance for fast breeder reactors.

### **NE 6261. Radiation Shielding Design**

2-3-3. Prerequisite: NE 6201.

Shielding of nuclear power plants and other highly radioactive sources. Emphasis on the use of modern computational methods to design shields.

### **NE 6601. Radioisotope Engineering I**

3-0-3. Prerequisite: PHYS 6011 or equivalent.

Production and handling of radioisotope sources. Industrial and medical applications of tracer methods and radiation sources. Design procedures for radiation gauges and high-level irradiation facilities.

### **NE 6623. Fusion Plasma Analysis I**

3-0-3. Prerequisite: NE 4610 or consent of the School.

Covers the physics of magnetically confined plasmas at the graduate level. Topics include fundamental properties, motion of charged particles, confinement concepts, kinetic and fluid theories, equilibrium and transport.

### **NE 6624. Fusion Plasma Analysis II**

3-0-3. Prerequisite: NE 6623.

Covers the physics of magnetically confined plasmas at the graduate level. Topics include waves and instabilities, heating and fueling, radiation, plasma-wall interaction, and power balance.

### **NE 6625. Fusion Reactor Technology**

3-0-3. Prerequisite: NE 4610 or consent of the School.

Technology of magnetic fusion. Topics include magnets, rf and neutral beam heating, energy storage and transfer, interaction and radiation with matter, tritium breeding blankets, tritium and vacuum systems, and reactor design.

### **NE 6626. Plasma Equilibrium and Transport**

3-0-3. Prerequisite: NE 6623.

An advanced treatment of magnetic and pressure surfaces and of transport processes in magnetically confined plasmas.

### **NE 6627. Plasma Waves and Instabilities**

3-0-3. Prerequisites: NE 6623 and 6624, or permission of the instructor.

Study of the plasma as a dielectric medium. Normal modes and wave propagation in plasmas. Instabilities in homogeneous and inhomogeneous plasmas.

### **NE 6628. MHD Instabilities**

3-0-3. Prerequisites: NE 6623 and 6624, or permission of the instructor.

Study of current and pressure MHD-driven instabilities in plasmas.

### **NE 6629. Plasma Diagnostics**

3-0-3. Prerequisite: NE 6623.

An introduction to the techniques of measuring various plasma parameters, including density, electron temperature, ion temperature, conductivity, and plasma pressure. Nonperturbing techniques are emphasized.

### **NE 6631. Fusion Nuclear Engineering I**

3-0-3. Prerequisite: NE 4610 or consent of the School.

The technology of liquid and solid tritium breeding blankets, hybrid blankets, tritium fuel cycle processing systems, first wall, high heat flux components and shields in fusion experiments and future reactors.

### **NE 6735. Numerical Methods in Engineering**

3-0-3. Prerequisite: graduate standing.

Numerical methods for solution of engineering systems. Numerical approximations to mathematical operations. Application to initial eigenvalue and boundary value problems. Computational stability for ordinary and linear partial differential equations. Also taught as ME 6735.

### **NE 6750. Radiation Detection I**

2-6-4. Prerequisite: PHYS 6011 or equivalent.

Introduction to measurement of radioactivity. Principles of radiation detection systems in common use. Application of radiation detectors for specific purposes. Also taught as HP 6750.

### **NE 6751. Advanced Radiation Detection**

3-0-3. Prerequisite: HP 6750 or NE 6750 or equivalent.

Selected topics on modern radiation detection methods and fast pulse-circuit systems. Emphasis on neutron detection methods, scintillation detectors, and semiconductor devices. Also taught as HP 6751.

### **NE 6753. Advanced Nuclear/Radiological Engineering Design**

2-6-4. Prerequisites: NE 4202 and 4212 or HP 6402.

Course intended to give experience in the synthesis of principles of nuclear/radiological engineering in the design of nuclear reactors and other facilities. Also taught as HP 6753.

## **NE 6760. Financial Management and Economics of Nuclear Power**

3-0-3. Prerequisite: consent of the School.

Topics include nuclear reactor and fuel cycle, electrical power systems and utility economics, financial management and system modeling. Identical to ECON 6760.

## **NE 7000. Master's Thesis**

Credit to be arranged.

## **NE 7798. Teaching Practicum**

1-6-3. Prerequisite: consent of the School.

Supervised teaching for doctoral students in nuclear engineering/health physics. Discussion of teaching techniques, course and curriculum design, and student evaluation methods and criteria. Students may, in some instances, prepare and present lectures under the supervision of a faculty member.

## **NE 7999. Preparation for Doctoral Qualifying Examination**

Audit only. Prerequisite: consent of the School.

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.

## **NE 8011-2-3. Seminar**

1-0-1 each.

Regularly scheduled course required of all NE majors. Various topics presented by guest speakers, faculty members, and graduate students.

## **NE 8110-1-2-3. Special Topics**

3-0-3. Prerequisite: consent of the School.

Purpose of this course is to permit the Nuclear Engineering Program to offer formal courses on topics of special interest on an ad hoc basis.

## **NE 8501-2-3-4. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

The student is encouraged to exercise resourcefulness and originality in attacking a problem of special interest to himself or herself and a member of the NE faculty.

## **NE 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

## **NE 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

## **NE 8999. Doctoral Dissertation Preparation**

Audit only.

## **NE 9000. Doctoral Dissertation**

Credit to be arranged.

## **HEALTH PHYSICS**

### **HP 4410. Radiation Physics**

3-0-3. Prerequisites: MATH 3308, PHYS 2123.

The study of radioactivity and other nuclear phenomena; the interaction of ionizing radiation with matter; and the basics for developing a philosophy of radiation protection.

### **HP 4412. Principles of Health Physics**

3-0-3. Prerequisite: HP 4410 or PHYS 3001.

Course emphasizes the biophysical basis of radiation protection and the development of protection criteria.

### **HP 4440. Effect of Nonionizing Radiation and Protection Standards**

3-0-3. Prerequisites: consent of the School and HP 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.

### **HP 6402. Introduction to Radiation Protection**

3-0-3. Prerequisite: PHYS 6011 or equivalent.

An evaluation of radiation protection standards, their development, and applications for effective control. The course covers topics such as biological effects of radiation, standards development, dosimetry, internal and external exposures, mitigation and control programs, and the practice of health physics.

### **HP 6405. Health Physics Practice**

1-6-3. Prerequisite: HP 6402 or equivalent.

A review of many types of radiation problems—both basic and applied—relating to the qualifications of a certified health physicist.

### **HP 6410. Radiation Dosimetry**

3-0-3. Prerequisites: HP 6402 and HP 6750 or equivalent.

Fundamental principles of dosimetry of ionizing radiation: photons, charged particles, and neutrons. Cavity and interface theory. Measurements and calculation of exposure and absorbed dose.

### **HP 6414. Radiation Technology Laboratory**

2-6-4. Prerequisite: HP 6750.

Advanced laboratory course in radiochemical and instrumental analysis of radioactivity.

### **HP 6427. Internal Dosimetry**

3-0-3. Prerequisite: HP 6402.

Introduction to the internal dosimetry techniques geared toward health physicists and bioengineers. Includes models for inhalation and ingestion, maximum permissible concentrations, retention and excretion equations, submersion in a gas cloud, gastrointestinal models, respiratory models, bone models, MIRD computational scheme, bioassay measurements.

### **HP 6430. Radiation Protection in Nuclear Facilities**

3-0-3. Prerequisite: HP 6405.

Review of radiation protection requirements at nuclear facilities, radiation monitoring, environmental surveillance planning, and procedures for sample analyses and waste management.

**HP 6442. Applied Health Physics Laboratory**

1-6-3. Corequisite: HP 6430.

A laboratory course covering practical aspects of monitoring problems in nuclear facilities and environmental surveillance analyses.

**HP 6641. Environmental Surveillance and Radioactive Waste Disposal**

3-0-3. Prerequisite: consent of the School.

Advanced course on environmental radioactivity and environmental aspects of nuclear power. Radioactive waste treatment, reactor effluents, and waste disposal.

**HP 6643. Environmental Impact of Nuclear Power Stations**

3-0-3. Prerequisite: HP 6641 or consent of the School.

Specific impact of nuclear facilities on the environment. Practical and regulatory aspects of reactor siting and the preparation of environmental impact statements.

**HP 6735. Numerical Methods in Engineering**

3-0-3. Prerequisite: graduate standing.

Numerical methods for solution of engineering systems. Numerical approximations to mathematical operations. Application to initial eigenvalue and boundary value problems. Computational stability for ordinary and linear partial differential equations. Also taught as NE 6735.

**HP 6750. Radiation Detection I**

2-6-4. Prerequisite: PHYS 6011 or equivalent.

Introduction to measurement of radioactivity. Principles of radiation detection systems in common use. Application of radiation detectors for specific purposes. Also taught as NE 6750.

**HP 6751. Advanced Radiation Detection**

3-0-3. Prerequisite: HP 6750 or NE 6750 or equivalent.

Selected topics on modern radiation detection methods and fast pulse-circuit systems. Emphasis on neutron detection methods, scintillation detectors, and semiconductor devices. Also taught as NE 6751.

**HP 6753. Advanced Nuclear/Radiological Engineering Design**

2-6-4. Prerequisites: NE 4202 and NE 4212, or HP 6402.

Course intended to give experience in the synthesis of principles of nuclear/radiological engineering in the design of nuclear reactors and other facilities. Also taught as NE 6753.

**HP 6800. Industrial Health Protection Survey**

2-3-3.

A survey of the major physical and chemical hazards in the industrial environment emphasizing recognition, monitoring technology, engineering control methodology, best practice, and current regulations.

**HP 7000. Master's Thesis**

Credit to be arranged.

**HP 7798. Teaching Practicum**

1-6-3. Prerequisite: consent of the School

Supervised teaching for doctoral students in nuclear engineering/health physics. Discussion of teaching techniques, course and curriculum design, and student evaluation methods and criteria. Students may, in some instances, prepare and present lectures under the supervision of a faculty member.

**HP 8111-2-3-4. Special Topics in Health Physics**

1-0-1 through 4-0-4. Prerequisite: consent of the Program.

The purpose of this course is to permit the Health Physics Program to offer courses on topics of special interest on an ad hoc basis.

**HP 8501. Special Problems**

Credit to be arranged. Prerequisite: consent of the Program.

The student is encouraged to exercise resourcefulness and originality in attacking a problem of special interest to himself or herself and a member of the faculty.

**HP 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**HP 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

## School of Textile and Fiber Engineering

**School of Textile & Fiber Engineering  
Established in 1897**

**Location: Hightower Building**

**Telephone: 404-894-2490**

*Director and Professor*—Fred L. Cook; *Associate*

*Director and Associate Professor*—L. Howard

Olson; *Professors*—W. Denney Freeston,

Sundaresan Jayaraman, Malcolm B. Polk, Behnam

Pourdehimi, Wayne C. Tincher; *Associate*

*Professors*—Wallace W. Carr, Prashant Desai, J.

Lewis Dorrity, Satish Kumar, Youjiang Wang;

*Assistant Professors*—Haskell W. Beckham, Karl

L. Jacob, Mary Lynn Reallff; *Adjunct Professor*—

Agaram S. Abhiraman; *Research Scientists*—

Abraham M. Kotliar, Radhakrishnaiah Parachuru,

Mathew E. Sikorski.

## General Information

Textiles, one of humankind's oldest commercial ventures, continues to find new applications in the modern world. Engineered fibrous structures have many varied uses in our everyday life and are playing critical roles in novel complex systems in the fields of space, aeronautics, automobiles, medicine, safety, environmental control, transportation, and construction. Textile engineering encompasses the synthesis of polymers by nature and humans, fiber fabrication processes, assembling of fibers into one-, two-, and three-dimensional structures, modification of structural properties through dyeing, finishing, and coating, and measurement of complex aesthetic and mechanical properties of fiber-based systems. New polymers and fibers, new methods of assembling fibers into useful products, and new applications of fibers are continually developing.

The School of Textile & Fiber Engineering prepares students for rewarding careers in the polymer-fiber-textile industrial complex. Graduates obtain positions in plant and design engineering, manufacturing, 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 decision-making positions at a young age.

The textile industry is by far the largest manufacturing industry and employer in the Southeast. If apparel, fiber, and other associated segments are included, the textile-based industry is the largest in the United States, representing one out of every eight manufacturing jobs (over two million). The textile industry's needs for university graduates each year far exceed the number available.

## Multidisciplinary Programs

See table on page 100.

## Curricula

Three study programs are available, leading to the degrees Bachelor of Textile Engineering, Bachelor of Science in Polymer and Textile Chemistry, and Bachelor of Science in Textiles.

Students may pursue each degree in a regular four-year program or the five-year cooperative plan.

Because of the multidisciplinary nature of polymers, fibers, and textiles, the curricula stress broad backgrounds. Emphasis in the freshman and sophomore years is on mathematics, chemistry, and physics, and in the junior and senior years on materials science, polymer and textile chemistry and engineering, applied mechanics, business administration, and application of each field to the broad range of problems encountered in textiles and fibers. All three programs allow the student to select courses from a wide range of general and technical electives.

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

Since most of the textile/polymer course work is concentrated in the last two years of the programs, students from junior and community colleges can readily transfer into the School of Textile and Fiber Engineering. The Regents' Engineering Transfer Program (RETP) facilitates such transfers.

## Certificate Programs for Nontextile Majors

A substantial number of students graduating in other nontextile majors at Georgia Tech enter the textile and allied industries. Certificate programs in Textile Engineering, Textile Chemistry, and Textiles have been implemented to impart a basic understanding of, and an operating degree of proficiency in, textile nomenclature, processes, structures, chemistry, and mechanics for the nonmajor considering this industrial complex as a career entry point. Attainment of a certificate requires completion of 15-16 credit hours of specified and elective courses. Listings of the three certificate course sequences are available in the School's main office.

## Graduate Programs

The School of Textile and Fiber Engineering offers graduate programs leading to the degrees Master

of Science in Textile Engineering, Master of Science in Textile Chemistry, Master of Science in Polymers, Master of Science in Textiles, Master of Science, and Doctor of Philosophy. 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 School participates in the Graduate Course Option Program (see p. 29).

The graduate course offerings encompass advanced study and research in polymer synthesis, mechanics of structured fibrous materials, process dynamics, CIMS, dye synthesis and transport, formation-structure-property relationships, properties of fibrous materials, polymer flow, polymer environmental stability, computer process control, composites and nonwovens. The School has a variety of active research programs in which students participate.

### Facilities

The School of Textile and Fiber Engineering is centered in the Manufacturing-Related Disciplines Complex, an ultramodern classroom and laboratory facility. The building contains equipment representing most major types of fiber and textile processing. Well-equipped laboratories are also available for the chemical and physical characterization of polymers, fibers, and fibrous assemblies. Specialized equipment is available for fabric flammability studies, polymer environmental stability experiments, polymer synthesis, fiber-reinforced composite formation and testing, carbon and other high-performance fiber development, electrostatic chemical deposition, energy conservation, and water pollution studies. Machine shop and instrumentation facilities with supporting technicians are also housed within the building.

## Bachelor of Textile Engineering Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 1101-2</b> General Chemistry	4-3-5	4-3-5	.....
<b>EGR 1170</b> Visual Communication and Engineering Design	.....	2-3-3	.....
<b>MATH 1507-8-9</b> Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>PHYS 2121</b> Particle Dynamics	.....	.....	4-3-5
<b>Health and Performance Sciences</b> (requirements, p. XX)	.....	.....	X-X-3
<b>TEX 1040</b> Computer-aided Problem Solving for Engineers	.....	3-3-4	.....
<b>TEX 2190</b> Introduction to Textile Manufacturing	.....	.....	2-0-2
<b>ENGL 1001-2</b> Analysis of Literature and Language I, II	3-0-3	.....	3-0-3
<b>Humanities/Social Sciences/Modern Languages Elective</b>	3-0-3	.....	.....
<b>TOTALS</b>	15-3-16	14-9-17	X-X-18

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ESM 2211</b> Mechanics of Solids I	3-0-3	.....	.....
<b>ESM 3201</b> Dynamics I	.....	3-0-3	.....
<b>MATH 2507-8</b> Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3308</b> Differential Equations	.....	.....	5-0-5
<b>TEX 2191</b> Textile Manufacturing Lab I	0-3-1	.....	.....
<b>PHYS 2122-3</b> Electromagnetism, Optics, and Modern Physics	4-3-5	4-3-5	.....
<b>TEX 2105</b> Introduction to Textile/ Polymer Chemistry	3-0-3	.....	.....
<b>TEX 2300</b> Fiber Science and Engineering	.....	4-0-4	...
<b>Humanities/Social Sciences/Modern Languages Electives</b>	.....	3-0-3	3-0-3
<b>Electives</b>	.....	.....	9-0-9
<b>TOTALS</b>	15-6-17	17-3-18	17-0-17

## Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ESM 3311</b>			
Mechanics of Solids II	3-0-3	.....	.....
<b>CE 3053</b>			
Fluid Mechanics I	.....	3-0-3	.....
<b>CE 3061</b>			
Fluids Laboratory	.....	0-3-1	.....
<b>CE 3063</b>			
Fluid Mechanics II	.....	.....	3-0-3
<b>*Materials Eng. Series</b>			
<b>ME 3322-3</b>	.....	3-0-3	.....
Thermodynamics I, II	3-0-3	3-0-3	.....
<b>ISYE 4725</b>			
Engineering Economy	.....	.....	3-0-3
<b>TEX 4211</b>			
Yarn Formation Processes	3-0-3	.....	.....
<b>TEX 4212</b>			
Fabric Formation Processes I	.....	3-0-3	.....
<b>TEX 4214</b>			
Mechanics of Textile Structures	.....	.....	3-0-3
<b>TEX 3490</b>			
Textile Manufacturing Lab II	0-3-1	.....	.....
<b>ME 3110</b>			
Creative Decisions and Design	.....	.....	2-3-3
<b>ENGL 3020</b>			
Technical Writing	.....	.....	3-0-3
<b>MATH 3720</b>			
Statistics and Applications	.....	.....	3-0-3
<b>TEX 3600</b>			
Elementary Heat and Mass Transfer	.....	3-3-4	.....
<b>EE 3710</b>			
Intro. to Electronic Systems	3-0-3	.....	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	3-0-3	.....	.....
<b>TOTALS</b>	15-3-16	15-6-17	17-3-18

## Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>EE 3741</b>			
Electronic Systems Laboratory	0-3-1	.....	.....
<b>EE 3703</b>			
Electric Power Conversion	.....	2-0-2	.....
<b>EE 4421</b>			
Senior Electrical Engineering Laboratory II	.....	0-3-1	.....
<b>TEX 4313-14</b>			

Capstone Textile Engineering Design I, II	1-9-4	1-9-4	....
<b>TEX 4309</b>			
Monitors and Controls in Textile Manufacturing	....	....	3-0-3
<b>TEX 4325</b>			
Preparation, Coloration & Finishing of Textiles	3-0-3	.....	....
<b>TEX 4326</b>			
Laboratory in Chemical Processing of Textiles	0-3-1	.....	....
<b>TEX 4420</b>			
Analysis of Textile Materials	3-3-4	.....	.....
<b>TEX 4751</b>			
Polymer Science and Engineering II	3-0-3	.....	.....
<b>Humanities/Social Sciences/Modern Languages Electives</b>	.....	9-0-9	9-0-9
<b>Elective</b>	.....	.....	3-0-3
<b>TOTALS</b>	10-18-16	12-12-16	15-0-15

**Total Credit Hours Required for Graduation = 201**

### \*Materials Engineering Series

Students in the B. Textile Engineering curriculum are required to take one of the following materials engineering courses (3 hours):

MATE 3702. Materials Engineering for Structural and Thermal Systems

MATE 3703. Materials Engineering for Electronic, Magnetic, and Electro-optic Systems

MATE 3704. Materials Engineering for Chemical Systems

### Electives

#### Humanities/Social Sciences/Modern Languages Electives

Eighteen credit hours of humanities and 18 credit hours of social sciences are required. See p. 33 for a list of acceptable courses. The courses selected to fulfill the humanities and social sciences requirements must provide both breadth and depth and should not be a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one of each. Students should see their academic adviser for course sequences that satisfy the depth requirement. All students are required to pass

examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

### Technical and Free Electives

Six hours of technical electives must be approved by the School. The remaining free electives may be taken at any time during a student's course of study.

## Bachelor of Science in Polymer and Textile Chemistry Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 1101</b>			
General Chemistry	4-3-5	.....	.....
<b>CHEM 1112</b>			
General Chemistry II	.....	4-3-5	.....
<b>TEX 2190</b>			
Introduction to Textile Manufacturing	.....	.....	2-0-2
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>TEX 1040</b>			
Computer-aided Problem Solving for Engineers	.....	3-3-4	.....
<b>Humanities/Social Sciences/Modern Languages Elective</b>	.....	.....	3-0-3
<b>Health and Performance Sciences</b>			
(requirements, p. 311)	X-X-3	.....	.....
<b>Electives</b>	.....	.....	6-0-6
<b>TOTALS</b>	X-X-16	15-6-17	16-0-16

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 3311-2-3</b>			
Organic Chemistry	3-0-3	3-0-3	3-0-3
<b>CHEM 3381-2</b>			
Organic Chemistry Laboratory	.....	0-6-2	0-6-2
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3709</b>			
Mathematics for System Engineering	.....	.....	3-0-3
<b>TEXT 2191</b>			
Textile Manufacturing Lab I	0-3-1	.....	.....
<b>PHYS 2121</b>			

Particle Dynamics	4-3-5	.....	.....
<b>PHYS 2122</b>			
Electromagnetism	.....	4-3-5	.....
<b>PHYS 2123</b>			
Optics and Modern Physics	.....	.....	4-3-5
<b>TEX 2300</b>			
Fiber Science and Engineering	.....	4-0-4	.....
<b>Electives</b>	3-0-3	.....	3-0-3
<b>TOTALS</b>	15-6-17	14-9-17	13-9-16

### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 3412-3</b>			
Physical Chemistry	3-0-3	3-0-3	.....
<b>CHEM 3481</b>			
Physical Chemistry Laboratory	.....	0-6-2	.....
<b>MATH 3720</b>			
Statistics and Applications	3-0-3	.....	.....
<b>ENGL 3020</b>			
Technical Writing	.....	3-0-3	.....
<b>TEX 3103</b>			
Yarn Manufacturing	3-0-3	.....	.....
<b>TEX 3118</b>			
Knit and Nonwoven Processes/Properties	.....	.....	3-0-3
<b>TEX 3490</b>			
Textile Manufacturing Lab II	0-3-1	.....	.....
<b>TEX 4491</b>			
Textile Manufacturing Lab III	.....	.....	0-3-1
<b>TEX 3600</b>			
Elementary Heat and Mass Transfer	.....	3-3-4	.....
<b>TEX 3110</b>			
Woven Structures I	.....	3-0-3	.....
<b>Electives</b>	6-0-6	3-0-3	9-0-9
<b>CHEM 3281</b>			
Instrumental Analysis for Engineers	.....	.....	3-3-4
<b>TOTALS</b>	15-3-16	15-9-18	15-6-17

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>TEX 4492</b>			
Textile Manufacturing Lab IV	.....	0-3-1	.....
<b>TEX 4420</b>			
Analysis of Textile Materials	3-3-4	.....	.....
<b>TEX 4300</b>			
Chemistry and Chemical Processing of Fibers and Textiles I	3-0-3	.....	.....



<b>TEX 4304</b> Chemistry & Chemical Processing of Textiles II	3-0-3	.....	.....
<b>TEX 4326</b> Laboratory in Chemical Processing of Textiles	0-3-1	.....	.....
<b>TEX 4302</b> Textile Finishing Processes	.....	3-0-3	.....
<b>TEX 4303</b> Physical Chemistry and Mass Transport in Coloration Processes	.....	.....	3-0-3
<b>TEX 4503</b> Science of Color	.....	3-0-3	.....
<b>TEX 4504</b> Fiber Extrusion, Drawing, and Texturing	.....	3-0-3	.....
<b>TEX 4750</b> Polymer Science and Engineering I	3-0-3	.....	.....
<b>TEX 4751</b> Polymer Science and Engineering II	3-0-3	.....	.....
<b>TEX 4760</b> Polymer Science and Engineering Laboratory	.....	.....	1-6-3
<b>Polymer Elective</b>	.....	.....	3-0-3
<b>TEX 4900-1</b> Special Problems	.....	0-3-1	0-3-1
<b>*Environmental Elective</b>	.....	3-0-3	.....
<b>Elective</b>	.....	.....	6-0-6
<b>TOTALS</b>	<b>15-6-17</b>	<b>12-6-14</b>	<b>13-9-16</b>

**Total Credit Hours Required for Graduation = 197**

\*The Environmental Elective must be one of the following courses: CHEM 3511 (3-0-3) Biochemistry, BIOL 4413 (3-0-3) Air & Water Pollution, or CE 4100 (4-0-4) Environmental Engineering Systems. Students electing to take CE 4100 may use one of its credit hours towards their technical or free elective requirements.

## Electives

### Humanities/Social Sciences/Modern Languages Electives

Eighteen credit hours of humanities and 18 credit hours of social sciences are required. See p. 33 for a list of acceptable courses. The courses selected to fulfill the humanities and social sciences requirements must provide both breadth and depth and should not be a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one of each. Students should see their academic adviser

for course sequences that satisfy the depth requirement. All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

## Technical and Free Electives

Three hours of technical electives must be approved by the School. The remaining free electives may be taken at any time during a student's course of study. One course is designated as a polymer elective. This course must not be one in the required curriculum and must be approved by the School.

## Bachelor of Science in Textiles Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 1101-2</b> General Chemistry	4-3-5	4-3-5	.....
<b>ENGL 1001-2</b> Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>MATH 1711-2-3</b> Mathematics for Management I, II, III	5-0-5	5-0-5	5-0-5
<b>TEX 1040</b> Computer-aided Problem Solving for Engineers	.....	.....	3-3-4
<b>TEX 2190</b> Introduction to Textile Manufacturing	.....	.....	2-0-2
<b>Humanities/Social Sciences/Modern Languages Elective</b>	.....	3-0-3	.....
<b>Health and Performance Sciences</b> (requirements, p. 311)	X-X-3	.....	.....
<b>Electives</b>	.....	.....	4-0-4

<b>TOTALS</b>	<b>X-X-16</b>	<b>15-3-16</b>	<b>14-3-15</b>
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### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>PHYS 2011-2-3</b> Elementary Physics I, II, III	4-0-4	3-0-3	3-0-3
<b>ECON 2000-1</b> Economic Principles and Problems	.....	3-0-3	3-0-3
<b>MGT 2000-1</b> Accounting I, II	3-0-3	3-0-3	.....

**TEX 2105**

Introduction to Textile/

Polymer Chemistry

3-0-3 .....

**TEX 2191**

Textile Manufacturing

Laboratory I

0-3-1 ....

**TEX 2300**

Fiber Science and

Engineering

.... 4-0-4 ....

**Textile Elective**

.... 3-0-3

**Electives**

5-0-5 3-0-3 8-0-8

**TOTALS**

15-3-16 16-0-16 17-0-17

**Junior Year**
*Course*
*1st Q. 2nd Q. 3rd Q.*
**TEX 3103**

Yarn Manufacturing

3-0-3 .....

**TEX 3118**

Knit and Nonwoven

Processes/Properties

.... 3-0-3

**TEX 4122**

Chemical Structures and

Physical Properties of

Polymers

3-0-3 .....

**TEX 4300**

Chemistry and Chemical

Processing of Fibers

and Textiles I

.... 3-0-3

**MGT 3060**

Financial Management

.... 3-0-3

**MGT 3300**

Marketing I

3-0-3 ....

**MATH 3720**

Statistics and

Applications

3-0-3 ....

**TEX 3490**

Textile Manufacturing

Laboratory II

.... 0-3-1 ....

**TEX 3110**

Woven Structures I

.... 3-0-3 ....

**ENGL 3020**

Technical Writing

.... 3-0-3

**PSY 3303**

General Psychology I

.... 3-0-3 ....

**ISYE 3305**

Total Quality

Management

.... 3-0-3 ....

**Electives**

3-0-3 6-0-6 3-0-3

**TOTALS**

15-0-15 15-3-16 15-0-15

**Senior Year**
*Course*
*1st Q. 2nd Q. 3rd Q.*
**TEX 4420**

Analysis of Textile

Materials

3-3-4 .....

**TEX 4100**

Textile Management

Decision Making

.... 2-3-3 ....

**TEX 4101**

Planning and Control in

Textile Production Systems

..... 3-0-3

**MGT 4101**

Social and Regulatory

Environment

..... 3-0-3

**ISYE 3215**

Design and Measurement

of Work Methods

3-0-3 .....

**MGT 3150**

Industrial Management

Principles

3-0-3 .....

**TEX 4304**

Chemistry &amp; Chemical

Processing of Textiles II

3-0-3 .....

**TEX 4326**

Laboratory in Chemical

Processing of Textiles

0-3-1 .....

**TEX 4302**

Textile Finishing

Processes

..... 3-0-3 .....

**TEX 4503**

Science of Color

..... 3-0-3 .....

**TEX 4491**

Textile Manufacturing

Laboratory III

..... 0-3-1 .....

**TEX 4492**

Textile Manufacturing

Laboratory IV

..... 0-3-1 .....

**TEX 4495**

Textile Management

Practices

..... 0-3-1

**TEX 4900-1**

Special Problems

0-3-1 ..... 0-3-1

**\*Specialization Series**

3-0-3 6-0-6 3-0-3

**Elective**

..... 6-0-6

**TOTALS**

15-9-18 14-9-17 15-6-17

**Total Credit Hours Required for Graduation = 194**
**\* Specialization Series**

Students in the B.S. Textiles curriculum are required to complete one of the following specialization series options (12 hours):

Option Title

Required Courses

A Computer Aided Management MGT 3050, 4053, 4750, 3052

B International Business ECON 3001, 3002, MGT 4155,

4160

C Human Resources Management MGT 4100, 4140, 4101, PSY 4410

D Alternatively, the specialization requirement may be satisfied by completing 12 or more hours of courses within the core courses or recommended electives leading to one of the following certificates offered by the Ivan Allen College: Economics, Accounting, Marketing, Operations Management, Information Systems, and Finance.

Suggested elective courses to provide the interested student with further breadth and depth in the A-C option areas above are:

## Option Suggested Elective Courses

A	MGT 4051, 4054
B	ECON 3410, 4300; MGT 4335;
and	a foreign language course
C	MGT 4110, 4201; PSY 3304

## Electives

### Humanities/Social Sciences/Modern Languages Electives

Eighteen credit hours of humanities and 18 credit hours of social sciences are required. See p. 33 for a list of acceptable courses. The courses selected to fulfill the humanities and social sciences requirements must provide both breadth and depth and should not be a selection of unrelated introductory courses. The humanities and social sciences courses taken must include six credit hours at the 3000 or 4000 level. This requirement can be satisfied with two humanities courses, two social sciences courses, or one of each. Students should see their academic adviser for course sequences that satisfy the depth requirement. All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

### Free Electives

Free electives may be taken at any time during a student's course of study. One course is designated as a textile elective. This course must not be one in the required curriculum and must be approved by the School.

## Courses of Instruction

### TEX 1040. Computer-aided Problem Solving for Engineers

3-3-4. Prerequisite: MATH 1711 or 1507 or consent of the School. Not open to textile majors

Introduction to computers, FORTRAN programming and a variety of software tools for problem solving in engineering applications and information/knowledge management.

### TEX 1100. Introduction to Textile Engineering

3-0-3. Prerequisite: consent of the School, not open to textile students.

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.

### TEX 2105. Introduction to Textile/Polymer Chemistry

3-0-3. Prerequisite: CHEM 1102.

An introduction to the chemistry of polymers and textile fibers, preparation agents, dyes, and finishes. Not open to majors requiring organic chemistry courses in their curricula.

### TEX 2190. Introduction to Textile Manufacturing

2-0-2. Prerequisites: CHEM 1101, MATH 1711, or MATH 1507. Not open to non-textile majors.

Textile industry overview and orientation to textile manufacturing operations.

### TEX 2191. Textile Manufacturing Laboratory I

0-3-1. Prerequisite: TEX 2190 or consent of the School.

Principles and machinery for yarn and fabric formation processes.

### TEX 2300. Fiber Science and Engineering

4-0-4. Prerequisites: TEX 1100 or 2190, PHYS 2121 or 2111, TEX 2105, or CHEM 3311, or consent of the School.

The physical structure and properties of fibers are examined and related to end-use performance.

### TEX 2500. Survey of Apparel Manufacturing

3-0-3. Prerequisite: consent of the School.

Apparel engineering and manufacturing, from planning and receipt of raw materials to the distribution of finished garments.

### TEX 2700. Survey of Polymer and Fiber Technology

3-0-3. Not open to textile students.

An introduction to the history, structure, properties, fabrication, and use of polymers in the textile and related industries.

### TEX 2701. Textile Industry Survey

3-0-3. Not open to textile students.

An overview of textiles, fibers, and polymers and the associated complex of industries from raw materials to finished products, including textile arts and textile management. Credit cannot be obtained for both TEX 1100 and TEX 2701.

### TEX 2702. Survey of Fibrous Materials

3-0-3. Not open to textile students.

A survey of natural and man-made fibers used in the textile industry.

### TEX 3103. Yarn Manufacturing

3-0-3. Prerequisites: TEX 2300 and PHYS 2011 or PHYS 2121.

Fundamental principles and manufacturing technologies for producing staple, natural/synthetic fiber yarns, and basic properties of spun yarns.

### TEX 3110. Woven Structures I

3-0-3. Prerequisite: TEX 3103.

The weaving process and woven fabric construction, design, and properties are studied.

### TEX 3111. Woven Structures II

3-0-3. Prerequisite: TEX 3110.

Dynamics, operating characteristics, and economics of new weaving machines.

### TEX 3118. Knit and Nonwoven Processes/ Properties

3-0-3. Prerequisite: TEX 3103.

Design, production processing, and properties of knits and nonwoven fabrics.

**TEX 3490. Textile Manufacturing Laboratory II**

0-3-1. Pre- or corequisite: TEX 2190, or consent of the School.

Machine shop practices and textile process maintenance.

**TEX 3500. Jacquard Design and Weaving**

2-3-3. Prerequisite: TEX 3110.

The designing of Jacquard patterns and the techniques involved in the transfer of design to the fabric.

**TEX 3510. Materials Preparation, Pattern Analysis, and Cutting in Garment Manufacture**

3-0-3. Prerequisite: TEX 2500.

Methods, mechanics, and analysis of materials preparation, pattern drafting, and cutting in garment manufacture, with emphasis on new methods and automation.

**TEX 3511. Garment Assembly**

4-0-4. Prerequisite: TEX 2500.

Formation and mechanics of seaming, including thread properties, stitch formation, sewing machines, heat sealing and ultrasonic, radio frequency, infrared and adhesive bonding.

**TEX 3512. Apparel Production, Planning, and Engineering**

4-0-4. Prerequisite: TEX 3510 or consent of the School.

Analysis and design of apparel production from raw materials to finished product, with emphasis on maximizing quality and productivity and minimizing time, cost, and waste.

**TEX 3513. Apparel Shaping and Finishing**

2-3-3. Prerequisite: TEX 3512 or consent of the School.

Principles and analysis of processes for shaping and finishing apparel, with emphasis on design of systems and equipment for maximizing the quality/cost ratio.

**TEX 3600. Elementary Heat and Mass Transfer**

3-3-4. Prerequisites: MATH 3308 or 3709, and ME 3322 or CHEM 3412.

Unit operations of chemical engineering emphasizing applications to fibers and textiles.

**TEX 3700. Survey of Fiber Processing**

3-0-3. Not open to textile students.

A survey course in yarn manufacturing covering principles of processing natural and synthetic fibers.

**TEX 3701. Survey of Fabric Production**

3-0-3. 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.

**TEX 3702. Survey of Dyeing and Finishing of Textile Materials**

3-0-3. Not open to textile students.

Dyeing and finishing of textile materials made from natural and synthetic fibers.

**TEX 3800. Special Topics**

1-0-1. Prerequisite: consent of the School.

Studies of topics of current interest and concern to the textile industry.

**TEX 4100. Textile Management Decision Making**

2-3-3. Prerequisite: junior or senior standing, or consent of the School.

Students practice making management decisions in a competitive market using computer simulations of textile manufacturing operations.

**TEX 4101. Planning and Control in Textile Production Systems**

3-0-3. Prerequisites: TEX 3110 and 4100, senior standing.

A study of the basic planning and control functions required in textile production systems, including design of production facilities, analysis, and control of inventory systems and production planning.

**TEX 4122. Chemical Structures and Physical Properties of Polymers**

3-0-3. Prerequisite: CHEM 1102 or consent of the School.

Not open to textile chemists, chemists, or chemical engineers. A fundamental review of organic polymers, including polymerization methods, chemical structures, and structure/property relationships.

**TEX 4211. Yarn Formation Processes**

3-0-3. Prerequisites: TEX 2191 and 2300, or consent of the School.

Processing principles, dynamics and design of yarn formation systems.

**TEX 4212. Fabric Formation Processes I**

3-0-3. Prerequisites: TEX 2191 and 2300, or consent of the School.

Processing principles, dynamics and design of woven fabric formation systems.

**TEX 4213. Fabric Formation Processes II**

3-0-3. Prerequisites: TEX 2191 and 2300, or consent of the School.

Processing principles, dynamics and design of knit and nonwoven fabric formation systems.

**TEX 4214. Mechanics of Textile Structures**

3-0-3. Prerequisites: TEX 4211, 4212, and ESM 3311, or consent of the School.

Mechanics of yarns, fabrics, and other flexible bodies. Topics include yarn and fabric geometry, response to tensile and bending deformation, and fabric shear and drape.

**TEX 4300. The Chemistry and Chemical Processing of Fibers and Textiles I**

3-0-3. Prerequisites: TEX 4750 or 4122 and CHEM 3311 or TEX 2105, or consent of the School.

The structure and purification of natural and synthetic fibers with emphasis on the relationship of fiber structure and behavior during chemical processing.

**TEX 4302. Textile Finishing Processes**

3-0-3. Prerequisites: TEX 4750 or 4122 and CHEM 3311 or TEX 2105, or consent of the School.

The chemical and mechanical finishing of textile materials to impart desired properties, with emphasis on the relationship of fiber structure and response of textiles to these processes.

**TEX 4303. Physical Chemistry and Mass Transport in Coloration Processes**

3-0-3. Prerequisites: TEX 3600, 4304, and 4750-1, or consent of the School.

Detailed, molecular view of coloration processes, emphasizing physico-chemical laws of mass transport of chromophores through solution, interface, and solid-state phases.

## **TEX 4304. Chemistry and Chemical Processing of Textiles II**

3-0-3. Prerequisites: TEX 2300, TEX 4750 or TEX 4122, and CHEM 3311 or TEX 2105, or consent of the School

The dyeing and printing of textile materials with emphasis on the relationship of fiber structures and response to their processes.

## **TEX 4309. Monitors and Controls in Textile Manufacturing**

3-0-3. Prerequisites: EE 3710 and EE 3741, or consent of the School.

Analyzes textile process variables and evaluates basic techniques used to monitor and control such processes.

## **TEX 4313. Capstone Textile Engineering Design I**

1-9-4. Prerequisites: ME 3110, TEX 4211, 4212, and 4214, or consent of the School.

The planning, engineering design, and control of textile dry processes and plants.

## **TEX 4314. Capstone Textile Engineering Design II**

1-9-4. Prerequisites: ME 3110, TEX 3600, 4325, and CE 3053, or consent of the School.

Design of equipment and processes/plants used in the wet processing of textile structures.

## **TEX 4325. Preparation, Coloration, and Finishing of Textile Materials**

3-0-3. Prerequisites: TEX 2105 and 2300, or consent of the School.

The chemical, thermal, and mechanical processes used in the preparation, coloration, and finishing of textile structures.

## **TEX 4326. Laboratory in Chemical Processing of Textiles**

0-3-1. Pre- or corequisites: TEX 4304 or 4325, or consent of the School.

Laboratory experiments in the preparation and coloration of textile structures.

## **TEX 4401. Introduction to Textile Literature**

1-0-1. Prerequisite: TEX 1100 or 2190.

Sources of textile information and an introduction to search techniques for the textile information system.

## **TEX 4420. Analysis of Textile Materials**

3-3-4. Prerequisites: TEX 2300 and 4122 or 4750 or 4751, MATH 3720, or consent of the School.

The methods used in the textile industry for assessing the effects of process variables on the end use performance of textile products are examined.

## **TEX 4481. Advanced Problems in Textile Management**

0-3-1. Pre- or corequisites: TEX 4495.

Supervision of one of the student-operated enterprise's staff level departments.

## **TEX 4482. Product Innovation**

0-3-1. Pre- or corequisite: TEX 4495.

The student is part of a small entrepreneurial team developing new products for the student-operated enterprise.

## **TEX 4483. Special Problems in Textile Industrial Operations**

0-6-2. Prerequisite: TEX 1100 or TEX 2190, 2191, 3490, and junior or senior standing, or consent of the School. Not

available to nontextile students.

Available to textile students who want to engage in special projects that involve the personnel or facilities of the student-operated enterprise.

## **TEX 4491. Textile Manufacturing Laboratory III**

0-3-1. Prerequisites: TEX 2190 and 4420, or consent of the School.

Quality assurance practices in textile manufacturing.

## **TEX 4492. Textile Manufacturing Laboratory IV**

0-3-1. Prerequisites: TEX 2190, TEX 4304 or 4325, and TEX 4326, or consent of the School.

Principles and machinery for dyeing, printing, and finishing processes.

## **TEX 4495. Textile Management Practices**

0-3-1. Prerequisites: TEX 2190, 2191, 3490, 4491 and 4492, or consent of the School.

Management practice in textile manufacturing operations.

## **TEX 4500. Technology of Carpet Manufacturing**

3-0-3. Prerequisite: TEX 1100 or 2190 and 2300, or consent of the School.

A study of materials and production systems used in carpet manufacturing. Carpet performance characteristics, dyeing, backcoating, and nonwoven carpet manufacturing methods are examined.

## **TEX 4502. Fiber-reinforced Materials**

3-0-3. Prerequisites: TEX 2300 and 4751, or consent of the School.

Principles and engineering behavior of flexible and rigid fiber-reinforced composites. Topics include influence of matrix, interface and voids, fabrication, fracture and fatigue characterization, evaluation of specific composite systems.

## **TEX 4503. Science of Color**

3-0-3. Prerequisite: CHEM 1102 or 1112, PHYS 2013 or 2123, or consent of the School.

The physical, chemical, and biological principles involved in perception, measurement, and specification of color.

## **TEX 4504. Fiber Extrusion, Drawing, and Texturing**

3-0-3. Prerequisites: TEX 3600 and 4751, or consent of the School.

Rheology, mechanics, energetics, kinetics, phase transitions, and polymer structure in fiber formation by melt, dry, wet and reactive spinning, and drawing and texturing of fibers.

## **TEX 4505. Structure and Mechanics of Knit Fabrics**

3-0-3. Prerequisite: TEX 3118 or 4211 or consent of the School.

The basic geometries of fabrics produced by warp and weft knitting, overall physical properties of knit fabrics, and fabric stress distribution.

## **TEX 4600. High Performance Fibers**

3-0-3. Prerequisites: TEX 4122 or TEX 4751, or consent of the School.

Processing, properties, and structure of reinforcing fibers, industrial fibers, fibers for optical communications, and electrical-conducting fibers are covered.

## **TEX 4750. Polymer Science and Engineering I**

3-0-3. Prerequisites: CHEM 1102 or 1112, CHEM 3311, and

PHYS 2123, or consent of the School.

An introduction to the chemistry and structure of polymers. Polymerization processes, major polymer systems, and methods of identification of polymers are presented.

**TEX 4751. Polymer Science and Engineering II**

3-0-3. Prerequisites: CHEM 1102 or 1112 and PHYS 2123, or consent of the School.

An introduction to the physical states and transitions, fabrication processes, and mechanical properties of polymers.

**TEX 4753. Survey of Pulp and Paper Technology**

3-0-3. Prerequisite: CHEM 1102 or 1112, or consent of the School.

The mechanical systems used in paper manufacture. Chemistry of pulp preparation and nonfibrous additives.

**TEX 4760. Polymer Science and Engineering Laboratory**

1-6-3. Prerequisite: TEX 4751.

Experiments in polymerization, processing, and property evaluation of polymers. Also taught as CHE 4760.

**TEX 4773. Paper Formation and Properties**

3-0-3. Prerequisite: consent of the School.

The processes in the fabrication of paper and paper products from pulp. The effects on paper properties of chemical and mechanical pretreatment of pulp. The measurement of paper properties.

**TEX 4791. Mechanical Behavior of Composites**

3-0-3. Prerequisites: MATE 2301 or AE 4813, MATE 3463 or ESM 3301 or AE 2201.

The stress-strain behavior of anisotropic composites structures and the elastic and plastic properties of matrix and reinforcing materials are covered for polymers, ceramics, and metals.

**TEX 4792. Fundamentals of Fiber-reinforced Composites I**

3-0-3. Prerequisite: AE 2102 or ESM 3301.

Introduction to the mechanics of fiber-reinforced composite materials. Advantages and uses of composites. Property characterization methods. Lamina and laminate analysis. Failure mechanisms. Applications to structural components made of composites.

**TEX 4793. Composite Materials and Processes**

3-0-3. Prerequisites: CHEM 1102 or 1112, PHYS 2123.

Basic principles of selecting component materials and manufacturing composites are presented. Polymeric, metallic, and ceramic systems are considered.

**TEX 4794. Laboratory in Composites Manufacturing and Testing**

2-3-3. Prerequisites: TEX 4791 or 4792, and TEX 4793.

Covers major manufacturing processes and testing techniques involved in composites. Analysis, planning, and design of practical parts will also be covered.

**TEX 4811-12-13-14-15. Special Topics in Textile/Polymer Science and Engineering**

1-5 hours credit, respectively. Prerequisite: consent of the School.

Special topic offerings of current interest in polymers and textiles and not included in regular courses.

**TEX 4900-1. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

Special problems involving analytical and/or experimental investigations in the field of textiles.

**TEX 6100. Advanced Fiber Science**

3-0-3. Prerequisite: TEX 2300 or equivalent, or consent of the School.

Physical properties, mechanical properties, and microstructure of polymeric fibers are examined and related to end-use performance.

**TEX 6101. Textile Testing and Evaluation**

3-3-4. Prerequisite: TEX 4420 or equivalent, and graduate standing.

Study of methods used to characterize properties that are important to an understanding of behavior of fibers, yarns, and fabrics.

**TEX 6201. Process Control in the Textile Industry**

3-0-3. Prerequisites: EE 3400 and 3702 or consent of the School.

Computer techniques are applied to problems in scheduling production equipment and in control of quality, inventories, and production. Topics include interfacing, costs, and programming.

**TEX 6210. Dynamics of Fiber Processing Systems I**

3-0-3. Prerequisites: TEX 4211 or consent of the School.

The dynamic interaction of fibers and fiber assemblies during processing is examined. The effects of fiber and bundle properties on processing variables are analyzed.

**TEX 6211-2. Dynamics of Fiber Processing Systems II, III**

3-0-3 each. Prerequisite: TEX 4211-2 or consent of the School.

The dynamics of fabric forming mechanisms are examined. Weaving, knitting, sewing, heating, and drying are typical processes that are considered.

**TEX 6300. Preparation and Reactions of Polymers**

3-0-3. Prerequisite: TEX 4750.

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.

**TEX 6320. Fundamental Aspects of Dyeing Processes**

3-0-3. Prerequisites: TEX 4304 or 4325, and TEX 4122, 4750, or 4751, or consent of the School.

Models required for the interpretation of the dyeing behavior of textile materials are examined in order to provide useful semiquantitative descriptions of dye processes.

**TEX 6321. Chemical Technology of Stabilization Processes**

3-0-3. Prerequisite: TEX 4302 or 4325, or consent of the School.

A comprehensive treatment of finishing processes used in the textile industry to impart desirable end-use performance characteristics to textile materials.

## **TEX 6400. Information Processes in Textile Science and Engineering**

3-0-3. Prerequisite: TEX 1040 or consent of the School.

Information aspects of textile science and technology; use of computers in acquisition, processing, and utilization of information and knowledge in textile research and production.

## **TEX 6755. Polymer Structure and Mechanical Properties**

3-0-3. Prerequisite: TEX 4751 or consent of the School.

Fundamental aspects of the development and analysis of structure and molecular and phenomenological models of mechanical behavior of solid-like polymers. Also taught as CHE 6755 and ME 6755.

## **TEX 6756. Mechanical Properties of Polymers**

3-0-3. Prerequisite: TEX 4751 or consent of the School.

Mechanics of deformation of anisotropic polymers, such as yield, breaking, and fatigue in the mechanical behavior of polymers; engineering applications. Also taught as CHE 6756 and ME 6756.

## **TEX 6757. Rheology of Non-Newtonian Fluids**

3-0-3. Prerequisites: an undergraduate course in fluid mechanics and TEX 4751, or a polymer rheology and processing course, or consent of the instructor.

Linear and nonlinear models for non-Newtonian viscous and viscoelastic behavior of polymer fluids; theoretical predictions and their comparison with experimental response. Also taught as CHE 6757.

## **TEX 6758. Instrumental Characterization of Polymers**

3-0-3. Prerequisite: graduate standing or consent of the instructor.

This course introduces the student to surface, near-surface, and structural methods of polymer analysis. Specialized techniques critical to large-molecule analyses are emphasized.

## **TEX 6790. Computer Integrated Manufacturing Systems I**

3-0-3. Prerequisite: graduate standing. Priority will be given to CIMS students.

A broad overview of the functions, processes, and disciplines of computer integrated manufacturing.

## **TEX 6791. Computer Integrated Manufacturing Systems II**

3-0-3. Prerequisite: TEX 6790.

An in-depth study of current issues, emerging technologies, and future developments in computer integrated manufacturing.

## **TEX 6792. Computer Integrated Manufacturing Systems Seminar**

1-0-1.

Guest speakers on a broad range of CIMS-related topics: research, applications, and technology.

## **TEX 7000. Master's Thesis**

## **TEX 7210. Recent Advances in Textile Manufacturing**

3-0-3. Prerequisite: TEX 4204 or consent of the School.

A detailed review of significant new processes, techniques, and machines in the textile industry.

## **TEX 7220. Fiber Mechanics**

3-0-3. Prerequisite: TEX 4204 or consent of the School.

The tensile, compressive, bending, and torsional response of fibers. Fiber anisotropy and linear and nonlinear time-dependent response are studied.

## **TEX 7221. Mechanics of Linear Assemblies**

3-0-3. Prerequisite: TEX 4214 or consent of the School.

The tensile, bending, and torsional response of continuous filament, staple and blended single yarns, the tensile response of plied yarns, cords, and ropes, the tensile response of braided cords.

## **TEX 7222. Mechanics of Planar Assemblies**

3-0-3. Prerequisite: TEX 4214 or consent of the School.

A state-of-the-art study of woven, knit, and nonwoven fabric mechanics.

## **TEX 7311. Polymer Degradation**

3-0-3. Prerequisite: TEX 4750, or 4751, or consent of School.

A study of the physical and chemical changes in polymeric materials exposed to hostile environments during processing and use.

## **TEX 7313. Dye Synthesis**

3-0-3. Prerequisite: consent of the School.

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.

## **TEX 7751. Energetics**

3-0-3. Prerequisite: consent of the School.

Energetics applied to polymers and fibers using Newtonian mechanics, thermodynamics, statistical thermodynamics, and quantum mechanics to relate macroscopic and molecular descriptions of processes and materials.

## **TEX 7752. Kinetics**

3-0-3. Prerequisite: consent of the School.

Kinetics applied to polymers and fibers, including fluid flow, viscoelasticity, heat transfer, diffusion, electrical conductivity, rates of chemical reactions and phase changes, and irreversible thermodynamics.

## **TEX 7777. Polymer Solutions and Surfaces**

3-0-3. Prerequisite: consent of the School.

Study of polymer solutions, absorptions, sorptions, plasticization, molecular weights, molecular weight distribution, and interfacial phenomena, using thermodynamics, statistical mechanics, information and fluctuation theories, and relaxation methods. Also taught as CHE 7777.

## **TEX 7791. Damage and Failure in Composites**

3-0-3. Prerequisite: consent of the School.

Methods for analysis and failure of fiber reinforced composite material systems. Treatment of mechanisms of toughening, multiple cracking mechanisms. Failure in woven fabric, braided, and special geometry composites.

## **TEX 7792. Mechanics of Composites**

3-0-3. Prerequisite: consent of the School.

Anisotropic elasticity, hygrothermal behavior stress analysis of laminated composites including 3D effects, stress concentrations, free-edge effects thick laminates, adhesive and mechanical connections, fracture of composites.

**TEX 7793. Manufacture of Composites**

3-0-3. Prerequisite: consent of the School.

Major manufacturing techniques for metal-, ceramic-, and polymer-matrix composites. Modeling of processes with emphasis on fundamental mechanisms and effects.

**TEX 7999. Preparation for Doctoral Qualifying Exams**

**TEX 8003-4-5. Seminar**

1-0-1 each. Audit only.

**TEX 8111-12-13-14-15. Special Topics in Textile/Polymer Science and Engineering**

1-5 credit hours. Prerequisite: consent of the School.

Special topic offerings of current interest in polymers and textiles not included in regular courses.

**TEX 8500-1-2. Special Problems in Textiles and Textile Engineering**

Credit to be arranged. Prerequisite: consent of the School.

Graduate-level special problems involving analytical and/or experimental investigations in the fields of polymers, fibers, and/or textiles.

**TEX 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**TEX 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**TEX 9000. Doctoral Thesis**





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# THE IVAN ALLEN COLLEGE OF MANAGEMENT, POLICY, AND INTERNATIONAL AFFAIRS

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*Dean*—Robert G. Hawkins; *Associate Dean for Academic Affairs*—Gregory H. Nobles; *Associate Dean and Director for Executive and Professional Programs*—Peter Vantine; *Assistant Dean*—Andrew Jackson Cooper III; *Regents' Professor*—Naresh K. Malhotra.

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## General Information

The Ivan Allen College is a unique configuration of schools and departments that links the study of management, social sciences, and humanities, as well as Georgia Tech's three ROTC departments. Six of the schools within the College offer a wide range of undergraduate and graduate degrees that are described under the appropriate school heading in this catalog.

Georgia Tech has offered degrees—first in commerce and then in management—for over 75 years. Today, Tech offers innovative, market-sensitive programs for managerial leadership, with the aim of empowering graduates to become national leaders in managing the fast-moving forces of technology and global change.

The College also offers a number of other degree programs that link the humanities and social sciences to the world of technology and science and that broaden the range of majors available to Tech students. Students are prepared for leadership in business, government, and a wide range of other professional careers. Study in these fields also prepares students for advanced studies in management, law, and the humanities and social sciences.

In addition to its degree programs, the Ivan Allen College provides all Tech students with instruction in the humanities, social sciences, and management. The College's course offerings and certificate programs enable students, regardless of major, to broaden their educational experience and to better understand the cultural underpinnings of their professional and personal lives and the international context in which they live and work.

## Getting Started

Freshmen may enter directly into any of the undergraduate programs of the College, or they may enter as Undecided Ivan Allen College (UIAC) students and receive advisement from the Office of the Dean. In any case, the course requirements for the first year of study are virtually identical among all the majors in the College, so it is easy to postpone or change a decision about the major within the first year.

Undergraduate students in programs other than those in management and management science will complete a "non-major cluster" (similar to a minor) and a "capstone experience" consisting of a senior thesis or seminar paper. Both the non-major cluster and the capstone experience can be specially designed to fit the interests of the individual student.

## Certificate Programs

The schools and departments of the Ivan Allen College offer certificates in a variety of areas for students in any major. Most certificates require 18 hours of course work. The currently available certificates, listed by unit, are as follows:

### School of Economics

Economics

### School of History, Technology, and Society

History

Sociology

### School of International Affairs

International Affairs

### School of Literature, Communication, and Culture

American Literature

Drama and Film

Science, Technology, and Culture

Technical and Business Communications

Western Literary Traditions

## School of Management

- Management of Technology (graduate)
- Accounting
- Marketing
- Operations Management
- Information Systems
- Finance
- International Management

## School of Public Policy

- Public Policy

## Department of Modern Languages

- French
- German
- Spanish
- Linguistics
- French for Business and Technology
- German for Business and Technology
- Spanish for Business and Technology

Additional certificates offered by the College:

- Political Science
- Philosophy of Science and Technology

Note: The graduate certificate in Computer Integrated Manufacturing Systems (CIMS) is housed in the College of Engineering but involves Management faculty and students.

## Department of Air Force Aerospace Studies

**Established in 1946**

**Location: D. M. Smith Building**

**Telephone: 404-894-4175**

*Professor and Head*—Colonel William P. Cobb;  
*Assistant Professors*—Major Janice A. Benham,  
Captain Valerie Dunham, Captain Chris Paterick,  
Captain Reed Racette.

## General Information

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

## Four-year Program

Students entering the four-year program enroll in AFROTC courses in the same manner in which

they register for other undergraduate courses. A formal application is not required. Students enrolled in the G.M.C. incur no military obligation unless they are on an AFROTC scholarship. Those students desiring to become commissioned officers in the Air Force must compete for entry into the P.O.C., which is normally taken during the last two years of college. Between the sophomore and junior years, cadets normally attend a four-week field training session conducted at an Air Force base. Students accepted for the P.O.C. become members of the Air Force Reserve and receive a tax-free subsistence allowance of \$150 per month.

## Two-year Program

The two-year program and the last two years of the four-year program are identical in academic content. The basic requirement for entry into this program is that the student must 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 selection of 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 and be recommended to enter the P.O.C. upon their return to campus.

## AFROTC College Scholarship Program

AFROTC college scholarships are available on a competitive basis 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 tax-free subsistence allowance of \$150 per month.

## Leadership Laboratory

Leadership laboratory is a separate course requiring two hours per week throughout the cadet's enrollment in AFROTC. It involves a study of Air Force customs and courtesies, drills and ceremonies, professional development opportunities in the Air Force, and the life and work of an Air Force junior officer. Students develop their leadership potential in a practical, supervised laboratory, which may include field

trips to Air Force installations and presentations by Air Force personnel.

## **Courses of Instruction**

### **AS 1110. Introduction to Today's Air Force** 1-0-1.

United States Air Force doctrine, mission, and organization, and the responsibilities of an Air Force officer.

### **AS 1111. Introduction to the Air Force I - Laboratory** 0-2-1. Corequisite: AS 1110.

Air Force customs and courtesies, drill and ceremonies, and introduction to the military environment. Grading is Pass/Fail only.

### **AS 1120. Air Force Operational Activities** 1-0-1.

United States Air Force strategic and general purpose forces, geographical awareness, and an introduction to aerodynamics.

### **AS 1121. Introduction to the Air Force II - Laboratory** 0-2-1. Corequisite: AS 1120.

Air Force customs and courtesies, drill and ceremonies, and introduction to the military environment. Grading is Pass/Fail only.

### **AS 1130. Air Force Operational Activities** 1-0-1.

A survey of supporting Air Force activities, including the Air Force installation.

### **AS 1131. Introduction to the Air Force III - Laboratory** 0-2-1. Corequisite: AS 1130

Air Force customs and courtesies, drill and ceremonies, and introduction to the military environment. Grading is Pass/Fail only.

### **AS 2210. Air Power, the Early Years** 1-0-1.

A study of the principles of manned flight and doctrine of air power from the seventeenth century through the 1930s.

### **AS 2211. Advanced Followership GMC I - Laboratory** 0-2-1. Corequisite: AS 2210.

Air Force customs and courtesies, drill and ceremonies, and an introduction to Air Force leadership. Grading is Pass/Fail only.

### **AS 2220. Air Power, World War II to Korea** 1-0-1.

An examination of the development of air power doctrines in World War II, the Berlin airlift, and the Korean War.

### **AS 2221. Advanced Followership GMC II - Laboratory** 0-2-1. Corequisite: AS 2220.

Air Force customs and courtesies, drill and ceremonies, and an introduction to Air Force leadership. Grading is Pass/Fail only.

### **AS 2230. Air Power, the Later Years** 1-0-1.

An examination of the role of air power in contemporary times, including the Middle East, Cuba, and Southeast Asia.

### **AS 2231. Advanced Followership GMC III - Laboratory** 0-2-1. Corequisite: AS 2230.

Air Force customs and courtesies, drill and ceremonies, and an introduction to Air Force leadership. Grading is Pass/Fail only.

### **AS 3310. Air Force Leadership and Management** 3-0-3.

Introduction to Air Force leadership and management, including different leadership styles, situational leadership, and effective management techniques.

### **AS 3311. Leadership Development I - Laboratory** 0-2-1. Corequisite: AS 3310.

Emphasis on developing the leadership and interpersonal skills needed of Air Force officers. Grading is Pass/Fail only.

### **AS 3320. Air Force Ethics and Core Values** 3-0-3.

Introduction to Air Force ethics and decision making in combat and daily life. Includes case studies, proper leadership and followership decisions, study of ethics, and effective communication.

### **AS 3321. Leadership Development II - Laboratory** 0-2-1. Corequisite: AS 3320.

Emphasis on developing the leadership and interpersonal skills needed of Air Force officers. Grading is Pass/Fail only.

### **AS 3330. Air Force Quality Leadership** 3-0-3.

Introduction to Air Force "Quality Leadership." Introduces quality management techniques and how to apply them in Air Force organizations.

### **AS 3331. Leadership Development III - Laboratory** 0-2-1. Corequisite: AS 3330.

Emphasis on developing the leadership and interpersonal skills needed of Air Force officers. Grading is Pass/Fail only.

### **AS 4410. Civil-Military Relations** 3-0-3.

A study of the environment of current and historical civil military relations and the sociological aspects of the military profession.

### **AS 4411. Advanced Leadership Development I - Laboratory** 0-2-1. Corequisite: AS 4410.

Emphasis on developing top-level management skills to include the planning, organizing, and implementation of Aerospace Studies military training. Grading is Pass/Fail only.

### **AS 4420. United States Defense Policy** 3-0-3.

An organizational behavior investigation of the formulation and implementation of United States defense policy.

### **AS 4421. Advanced Leadership Development II - Laboratory** 0-2-1. Corequisite: AS 4420.

Emphasis on developing top-level management skills to include the planning, organizing, and implementation of Aerospace Studies military training. Grading is Pass/Fail only.

### AS 4430. Military Justice

3-0-3.

Functions of the military justice system. Stresses differences and similarities between civil and military law.

### AS 4431. Advanced Leadership Development III - Laboratory

0-2-1. Corequisite: AS 4430.

Emphasis on developing top-level management skills to include the planning, organizing, and implementation of Aerospace Studies military training. Grading is Pass/Fail only.

## School of Economics

**Established in 1990**

**Location: The Habersham Building**

**781 Marietta Street**

**Telephone: 404-894-4919/4917**

*Acting Director and Professor*—William A. Schaffer; *Associate Director and Associate Professor*—Marilyn H. McCarty; *Professors*—W. Carl Biven (emeritus), Richard Cebula, Kong Chu, Mack A. Moore (emeritus), Fred A. Tarpley, Jr. (on leave); *Associate Professors*—Willie J. Belton, Jr., Thomas D. Boston, Ian E. Novos, Peter G. Sassone, Radwan A. Shaban; *Assistant Professors*—Ray Y. Chou, Janusz Mrozek.

### General Information

The School of Economics provides high quality programs of study leading to a Bachelor of Science degree in Economics and to a Certificate in Economics for students in other disciplines. The program focuses on skills and knowledge critical for a life of learning and leading to careers in management, the public sector, and the professions. A degree in economics is especially appropriate for students intending to pursue advanced degrees in the social sciences and in professional schools of management, law, and public administration.

Modern economics is analytically rigorous, requiring a background in mathematics and statistics. At the same time, it is critically linked with the other social sciences and humanities, as well as to the more practical management and policy studies. The undergraduate curriculum provides a strong and broadening overview of economic thought and policy and is intended to prepare students for productive careers, for useful roles in society, and for satisfying personal lives in a technologically complex, culturally

diverse world.

The School of Economics also offers graduate courses leading to a Master of Science degree and in support of Ph.D. programs in management, public policy, international affairs, and city planning.

### Certificate in Economics

The School of Economics offers a Certificate in Economics for students in all disciplines at Georgia Tech. The certificate program provides a general acquaintance with economic thought and is especially appropriate for students considering graduate work in law or business administration. The certificate program should also be attractive to students who wish to broaden their education and to understand the forces that shape the modern world.

The certificate requires a minimum of 18 quarter hours of economics courses in which a grade of C or better is earned. Courses should include the following:

ECON 2000	Principles of Economics (Micro)
ECON 2001	Principles of Economics (Macro)
ECON 3000	Intermediate Microeconomics
ECON 3001	Intermediate Macroeconomics
or	
ECON 3002	Money and Banking
and two or more electives from the following:	
ECON 3001	Intermediate Macroeconomics
or	
ECON 3002	Money and Banking
ECON 3095	Seminar in Economic Policy
ECON 3100	Econometrics I
ECON 3410	Economic Development
ECON 4000	Topics in Advanced Microeconomics
ECON 4050	Monetary Theory and Policy
ECON 4110	Mathematical Economics
ECON 4120	Economic Forecasting
ECON 4230	Economics of the Labor Market
ECON 4231	Labor History
ECON 4235	Protective Labor Legislation
ECON 4265	Labor Relations Law
ECON 4300	International Economics
ECON 4310	Public Finance
ECON 4320	Managerial Economics
ECON 4330	Regional Economics
ECON 4331	Urban Economics

ECON 4340	Economics of Industrial Competition
ECON 4341	Economics of Regulated Industries
ECON 4400	History of Economic Thought
ECON 4410	Industrial Development in Latin America
ECON 4803	Special Topics in Economics

## The Bachelor of Science in Economics

The program of study provides a thorough grounding in science, the humanities, and mathematics, a broad grasp of the tools of economic analysis and decision-making, and an understanding of the institutional milieu in which tomorrow's leaders must operate. In addition, the curriculum provides ample opportunities for career-oriented studies in such fields as accounting, finance, management science, public policy, and international affairs; life-enriching studies in history and literature are also available.

## Bachelor of Science in Economics Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Science Electives</b>	X-X-4	X-X-4	X-X-4
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>ENGL 2110, 2201, 2310, or 2401</b>			
Introduction to Literature or Drama and Film	.....	.....	3-0-3
<b>Mathematics</b>	5-0-5	5-0-5	5-0-5
<b>History 1001 or 1002</b>	3-0-3	.....	.....
<b>Political Science 1251</b>	.....	3-0-3	.....
<b>MGT 2050</b>			
Management Applications of Info. Technology	.....	.....	2-3-3
<b>Health and Performance Sciences</b>	.....	.....	X-X-3
<b>TOTALS</b>	X-X-15	X-X-15	X-X-18

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Engineering Electives</b>	X-X-3	X-X-3	.....
<b>Humanities Electives</b>	3-0-3	3-0-3	3-0-3
<b>MGT 2000-1</b>			
Accounting I, II	3-0-3	3-0-3	.....

<b>ECON 2000-1</b>			
Principles of Economics I, II	3-0-3	3-0-3	.....
<b>Social Sciences Electives</b>	3-0-3	3-0-3	3-0-3
<b>International Elective</b>	.....	.....	3-0-3
<b>MSCI 3100</b>			
Survey of Statistics	.....	.....	3-0-3
<b>Free Elective</b>	.....	.....	3-0-3
<b>TOTALS</b>	X-X-15	X-X-15	15-0-15

### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ECON 3000</b>			
Economic Theory of the Firm	3-0-3	.....	.....
<b>ECON 3001</b>			
National Income Analysis	.....	3-0-3	.....
<b>ECON 3002</b>			
Money and Banking	.....	.....	3-0-3
<b>MSCI 3400</b>			
Analytical Methods in Management I	3-0-3	.....	.....
<b>MGT 3060-1</b>			
Finance I, II	3-0-3	3-0-3	.....
<b>ECON 3100</b>			
Econometrics I	.....	.....	3-0-3
<b>ECON 4000</b>			
Topics in Advanced Microeconomics	.....	.....	3-0-3
<b>ENGL 3015</b>			
Public Speaking	.....	3-0-3	.....
<b>Social Sciences Elective</b>	3-0-3	.....	.....
<b>Cluster Electives</b>	3-0-3	6-0-6	3-0-3
<b>Free Elective</b>	.....	.....	3-0-3
<b>TOTALS</b>	15-0-15	15-0-15	15-0-15

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ECON 4300</b>			
International Economics	3-0-3	.....	.....
<b>ECON 4400</b>			
History of Economic Thought	.....	3-0-3	.....
<b>ECON 3095</b>			
Economic Policy	.....	.....	3-0-3
<b>ECON 4901</b>			
Individual Research Project	.....	3-0-3	.....
<b>Cluster Elective</b>	3-0-3	.....	.....
<b>Economics Electives</b>	3-0-3	.....	6-0-6
<b>Free Electives</b>	9-0-9	9-0-9	6-0-6
<b>TOTALS</b>	18-0-18	15-0-15	15-0-15

Total Credit Hours Required for Graduation = 186

## **Requirements**

### **Mathematics**

The mathematics requirement may be satisfied by one of the following sequences: MATH 1711-2-3; MATH 1507-8 and 1711; MATH 1507-8-9 and 2507-8. Students will not receive credit for both MATH 1712 and 1507 or MATH 1713 and 1508.

### **Science and Engineering Electives**

A laboratory sequence in biology, chemistry, or physics must be completed along with six hours of electives offered in the College of Engineering for a total of 18 hours.

### **Social Sciences Electives**

All students must complete 18 hours of electives in the social sciences (see p. 33). All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement and count toward the 18-hour elective requirement.

### **Health and Performance Sciences Electives**

Students must take three hours of physical education in the freshman year and may receive the Institute-allowed maximum credits in physical education as free electives.

### **Humanities Electives**

Students are required to complete nine hours of humanities selected from the list of approved courses on p. 33 of this catalog. These courses plus the freshman English sequence satisfy the Institute's humanities requirements.

### **International Elective**

Any course offered by the School of International Affairs satisfies this requirement.

### **Cluster Electives**

At least 15 hours of credit must be taken in a planned cluster in a discipline other than economics. This requirement is most easily satisfied through a certificate program. Any other concentration must be approved by the faculty of the School of Economics. The student must earn a grade of C or better in these courses.

### **Individual Research Project**

Each student is required to take ECON 4901, producing a formal research paper in the senior year. This requirement may be satisfied with ENGL 4020, Advanced Technical Writing.

### **Free Electives**

Other courses (normally bearing 30 hours credit) must be taken, bringing the number of credit hours received up to 186. Only free electives may be taken on a pass/fail basis, subject to Institute limitations.

### **Master of Science**

The School of Economics offers a Master of Science degree for students interested in studying economics at a more advanced level. The degree requires a minimum of 50 hours of credit subject to the following restrictions: 1) a minimum of 18 credit hours in economics, 2) a minimum of 18 credit hours at the 6000 to 9000 level, and 3) a thesis for 15 hours.

The program of study is flexible and intended to prepare students for further study in economics or for assuming analytical positions in private industry or the public sector.

## **Courses of Instruction**

### **ECONOMICS**

#### **ECON 2000. Principles of Economics I (Microeconomics)**

3-0-3. Prerequisite: sophomore standing.

The behavior of economic units in a market economy. Examines economic institutions and consequences of alternative market structures.

#### **ECON 2001. Principles of Economics II (Macroeconomics)**

3-0-3. Prerequisite: sophomore standing.

National income, employment, money and banking, and international trade. Relates consumer, business, government, and international sectors to the aggregate economy.

#### **ECON 3000. Economic Theory of the Firm**

3-0-3. Prerequisites: ECON 2000-1.

Intermediate microeconomic theory with applications to managerial problems.

#### **ECON 3001. National Income Analysis**

3-0-3. Prerequisites: ECON 2000-1.

Intermediate macroeconomic theory. Enables the student to analyze the national economic environment relative to the firm and to stabilization of the national economy.

**ECON 3002. Money and Banking**

3-0-3. Prerequisites: ECON 2000-1.

An analysis of money's role in the economic system and the problems of administering monetary policy, both domestically and internationally.

**ECON 3095. Seminar in Economic Policy**

3-0-3. Prerequisites: ECON 3000-1.

Topics focus application of economic theory on substantive problems. Designed for economics majors.

**ECON 3100. Econometric Methods I**

3-0-3. Prerequisite: MSCI 3100.

An introduction to statistical methods for estimating quantitative relationships among economic variables. Topics include model specification, parameter estimation, prediction, and verification.

**ECON 3400. The Process of American Industrial Development**

3-0-3. Prerequisites: ECON 2000-1.

The forces, unique characteristics, and problems associated with American industrialization.

**ECON 3401. European Economic History**

3-0-3. Prerequisites: ECON 2000-1.

An economic survey of major institutions, inventions, the agricultural revolution, and the industrial revolution in Europe.

**ECON 3410. Economic Development**

3-0-3. Prerequisites: ECON 2000-1.

General theories of economic development. Each student will analyze the economy of a developing country.

**ECON 3500. Scope and Method of Political Economy**

3-0-3. Prerequisites: ECON 2000-1.

The logical structure of scientific theory as it applies to knowledge about political and economic situations and events.

**ECON 3501. Political Economy: Public Policy Analysis I**

3-0-3. Prerequisites: ECON 2000-1.

A theoretical perspective to explain and predict the effects of actual and proposed public policy and to generate standards of evaluation.

**ECON 4000. Topics in Advanced Microeconomics**

3-0-3. Prerequisites: ECON 3000-1.

Selected topics in advanced microeconomics. Designed for economics majors.

**ECON 4050. Monetary Theory and Policy**

3-0-3. Prerequisite: ECON 3001.

Elements of monetary theory; issues in monetary policy, including Federal Reserve strategy and its effects on financial practices; the behavior of interest rates; and international monetary problems.

**ECON 4110. Mathematical Economics**

3-0-3. Prerequisites: ECON 2000-1.

The application of mathematical tools to economic analysis. Topics include static analysis, comparative-static analysis, optimization, and dynamic analysis.

**ECON 4120. Economic Forecasting**

3-0-3. Prerequisites: ECON 2000-1.

Empirical analysis of cyclical fluctuations in the total economy. Methods of forecasting national and industry performance.

**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; wage and hour legislation.

**ECON 4265. Labor Relations Law**

3-0-3. Prerequisite: MGT 4200.

An examination of labor legislation, court decisions, and NLRB rulings on labor-management relations.

**ECON 4300. International Economics**

3-0-3. Prerequisites: ECON 2000-1.

Foreign trade and commercial policy, international finance, and current problems of international economic relations.

**ECON 4310. Public Finance**

3-0-3. Prerequisite: ECON 3000.

Government's role in resource allocation, income distribution, stabilization and growth through its 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 nonprofit goals of the firm, unstructured managerial decisions.

**ECON 4330. Regional Economics**

3-0-3. Prerequisites: ECON 2000-1.

Theories and models of income determination and regional growth, spatial economic structure, central-place theory, and regional effects of public policy.

**ECON 4331. Urban Economics**

3-0-3. Prerequisites: ECON 2000-1.

The economic dimensions of the processes and problems associated with urbanization.

**ECON 4332. Economics of Industrial Location**

3-0-3. Prerequisite: ECON 3000.

Economic factors influencing industrial location. Consideration will be given to location patterns, the impact of transfer processing costs, and land use competition.

**ECON 4340. Economics of Industrial Competition**

3-0-3. Prerequisites: ECON 2000-1.

The competitive structure of the American economy in terms of economic models, alternative public policy goals, and antitrust legislation.



**ECON 4341. Economics of Regulated Industries**

3-0-3. Prerequisites: ECON 2000-1.

The problems and policy options associated with government regulation of particular industries.

**ECON 4400. History of Economic Thought**

3-0-3. Prerequisites: ECON 2000-1.

A historical survey of schools of economic thought. The main body of the course is concerned with classical, neoclassical, Marxist, Keynesian, and modern economic thought.

**ECON 4410. Industrial Development in Latin America**

3-0-3. Prerequisites: ECON 2000-1.

The principles of industrial development in emerging nations. The student prepares an analysis of the problems in a specific Latin American country.

**ECON 4420. Comparative Economic Systems**

3-0-3. Prerequisites: ECON 2000-1.

A critical study of the methods by which various economic systems deal with common problems of production, exchange, distribution, and capital formation.

**ECON 4500. Political Economy: Nonmarket Decision Making I**

3-0-3. Prerequisites: ECON 2000-1.

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 4501. Political Economy: Nonmarket Decision Processes II**

3-0-3.

The economics and politics of change; technological progress; price effects on innovation; and trade-offs between economic efficiency and political expediency in national policies for energy, research, etc.

**ECON 4801-2-3. Special Topics in Economics**

3-0-3 each.

Courses in areas of economics not otherwise offered by the School.

**ECON 4811-2-3-4-5. Special Topics in Economics**

1-0-1 through 5-0-5 respectively.

Courses designed to permit students and a professor to pursue a specialized interest in an area of economics not extensively treated in the offerings of the School.

**ECON 4901-2-3. Individual Research in Economics**

Credit to be arranged.

Designed to permit independent study with a faculty member. To register, the student must obtain written approval by the director and by the sponsoring professor.

**ECON 4990. Georgia Internship Program**

Credit to be arranged. Prerequisite: consent of the School.

Broadens the scope of the College curriculum by offering students a community-based learning experience that stresses the completion of specific tasks.

**ECON 6000. Economic Analysis for Management I**

3-0-3. Prerequisite: consent of the School.

An intensive treatment of economic concepts that enables

the prospective managers to understand the microeconomic environment within which firms operate.

**ECON 6001. Economic Analysis for Management II**

3-0-3. Prerequisite: consent of the School.

Topics in macroeconomic analysis providing a framework for contemporary managerial decision making.

**ECON 6005. Cost-Benefit Analysis**

3-0-3. Prerequisite: ECON 6000.

Methods for public project evaluation, including decision criteria, identifying and quantifying costs and benefits, sensitivity analysis, and procedures for performing a cost-benefit analysis.

**ECON 6050. Money and Capital Markets**

3-0-3. Prerequisite: ECON 6001.

The functions of and relationships between financial markets and institutions, the behavior of interest rates, and the impact of monetary policy on financial markets.

**ECON 6120. Economic Forecasting**

3-0-3. Prerequisite: ECON 6001.

Macroeconomic theory and the analysis of economic conditions with relevance to current business and economic problems.

**ECON 6230. Collective Bargaining**

3-0-3. Prerequisite: previous course in labor relations.

Case study involving contract negotiations, grievance handling, and arbitration.

**ECON 6266. Wage and Employment Theory**

3-0-3. Prerequisites: ECON 6000, 6001.

An analysis of the economic theories and institutional developments explaining the terms, conditions, and levels of employment.

**ECON 6300. International Trade and Finance**

3-0-3. Prerequisite: ECON 6001.

Foreign exchange market, foreign trade and commercial policy, international finance, and current problems of international economics.

**ECON 6320. Managerial Economics**

3-0-3. Prerequisite: ECON 6000.

Relationships between economic concepts and managerial decisions. Topics covered include nonprofit goals of the firm, unstructured managerial problems, and the determinants of managerial decisions.

**ECON 6330. Regional Economics**

3-0-3.

Survey of the economics of regions, emphasizing region delineation, systems of cities, and measurement of regional activity, theories of regional income, employment, and economic growth.

**ECON 6331. Economics of Industrialization**

3-0-3.

An examination of long-run growth processes seeking causes of underdevelopment, exploring theories of economic growth, and applying these explanations to developed and underdeveloped economies.

**ECON 6335. The Economics of Environmental Quality**

3-0-3. Prerequisite: consent of the School.

Topics include market failure in the provision of a high-quality environment, amenity resources, and extra-market values.

**ECON 6340. Industry and Government**

3-0-3. Prerequisite: ECON 6000.

Organization and structure of American industry, beginning with price theory under various forms of market structure.

**ECON 6400. Public Issues in Economic Policy**

3-0-3.

Major public issues from the viewpoint of American economic history.

**ECON 6410. Development of Economic Thought**

3-0-3. Prerequisites: ECON 6000-1, consent of the College.

Development of the various schools of economic thought and their contributions to the present body of economic theory. Credit not given for both ECON 4400 and 6410.

**ECON 6750. The Changing Economy**

3-0-3.

Long-run forces within the economy that support economic growth and rising standards of living. Changes in these sources of growth due to the recent performance of the economy.

**ECON 7000. Master's Thesis**

**ECON 7010. Advanced Microeconomic Analysis**

3-0-3. Prerequisite: consent of the School.

An analysis of consumer and firm decision making in order to facilitate model building of individual choice processes.

**ECON 7011. Seminar in Microeconomics**

3-0-3. Prerequisite: consent of the School.

Interrelationships among the major sectors of a national economy, with special emphasis on institutions in the United States.

**ECON 7020. Advanced Macroeconomic Analysis**

3-0-3. Prerequisites: ECON 7010 and consent of the School.

Analysis of recent developments in national income analysis.

**ECON 7021. Seminar in Macroeconomics**

3-0-3. Prerequisites: ECON 7011 and consent of the School.

Designed to provide students an opportunity to pursue in depth some topic in macroeconomics.

**ECON 7100. Econometrics**

3-0-3. Prerequisite: consent of the School.

Advanced treatment of the specification, estimation, forecasting, and policy evaluation of static and dynamic managerial models. Techniques, applications, and problems associated with both single-equation and simultaneous-equation models are included.

**ECON 7101. Seminar in Econometrics**

3-0-3. Prerequisites: ECON 7100 and consent of the School.

Empirical economic research.

**ECON 8401-2-3-4-5-6. Special Topics**

1-0-1 through 6-0-6. Prerequisite: consent of the School.

Topics of current interest in the field of economics.

**ECON 8501-2-3-4. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

Project work experience in the field of economics.

**ECON 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**ECON 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**ECON 9000. Doctoral Thesis**

## **School of History, Technology, and Society**

**Established in 1990**

**Location: D. M. Smith Building**

**Telephone: 404-894-2182**

*Director and Professor*—Robert C. McMath, Jr.;

*Melvin Kranzberg Professor of the History of Technology*—Bruce Sinclair; *Professors*—

Ronald H. Bayor, James E. Brittain, August W.

Giebelhaus, Jonathan Schneer, Dorothy Cowser

Yancy; *Associate Professors*—Lawrence Foster,

Mary Frank Fox, Kenneth J. Knoespel (Joint

Appointment), Gregory H. Nobles, Germaine M.

Reed, Sandra W. Thornton, Steven P. Vallas;

*Assistant Professors*—Alice Bullard, Hanchao Lu,

Daniel L. Kleinman, Joan F. Sokolovsky, John L.

Tone.

## **General Information**

The School of History, Technology, and Society is an interdisciplinary unit within the Ivan Allen College of Management, Policy, and International Affairs. The School is comprised of historians, political scientists, and sociologists who share a teaching and research focus in historical and societal studies. The School has the dual mission of providing quality instruction in the social sciences for all Georgia Tech undergraduates as part of their general graduation requirements, and for offering programs leading to the degree of Bachelor of Science in History, Technology, and Society.

Programs aim to develop an understanding of the complex social issues associated with the

development of the modern world, especially as they relate to science, technology, and industry. Although course work primarily focuses on the period from 1500 to the present in Europe and the United States, attention is also given to the historical roots of modern society and to the development of non-Western cultures. Courses are designed to develop an appreciation of our multicultural and multiracial past, and an understanding of the historical context of current changes in our technologically advanced society. Efforts are made to provide students, both those enrolled in the School's degree program and those fulfilling general education requirements, with an integrated view of human society.

### **United States History Graduation Requirements**

The state of Georgia requires all students to take courses or pass an examination on the history of the United States and Georgia. Either HIST 1001 or 1002, both offered within the School, normally satisfies this requirement and must be taken prior to graduation. The School administers alternative exemption examinations each quarter to students who are qualified (typically transfer and second degree students who have met the history requirements of another school.)

### **Certificate Programs**

For those not majoring in History, Technology, and Society, the School offers an opportunity to obtain a level of concentration in the social sciences through certificate programs. Certificates in history and sociology are administered by the School, and HTS faculty participate in other interdisciplinary certificates within the College offered in international affairs, philosophy, political science, science, technology, society, and urban studies. All of these certificates require a minimum of 15 hours of concentration.

Each program provides for the systematic acquisition of ideas and opinions that enrich the students' understanding of the social dimensions and cultural roots of their professional majors. Students planning graduate study in law, medicine, or business will also find a certificate an excellent way to strengthen their background by allowing them to gain competence in areas additional to their majors. Additionally, other majors within the Ivan Allen College will be able

to use HTS certificate programs to satisfy their "non-major cluster" degree requirement.

### **Bachelor of Science in History, Technology, and Society**

Although comparable to more traditional degrees in history or sociology, the undergraduate program has several attributes that make it unique. Unlike standard liberal arts degrees, the HTS program requires broad-based training including course work in mathematics, science, and engineering, that is consistent with the overall mission of Georgia Tech as a technological university.

The undergraduate degree program should appeal to students interested in majoring in the humanities and social sciences. For those students interested in a teaching career, it is possible to augment the program of study with education credits from Georgia State University aimed at Georgia public school certification. Graduates of the HTS program also will be uniquely qualified to enter a number of private and public sector jobs traditionally open to liberal arts and social sciences majors holding the bachelor's degree. Because of their additional training in mathematics, science, and engineering, however, HTS graduates should enjoy an advantage in the job market. Those students intent on entering professional schools in law or business, or graduate programs in the social sciences will also be well prepared to pursue such disciplinary training.

### **Requirements for the Bachelor of Science in History, Technology, and Society**

#### **Mathematics**

The mathematics requirement may be satisfied by one of the following sequences: MATH 1711-2-3; MATH 1507-8-9; MATH 1507-8 and 1711. Students will not receive credit for both MATH 1712 and 1507 or MATH 1713 and 1508.

#### **Science and Engineering**

Students must complete 10 to 12 hours of laboratory science. Typically, this will be a sequence in biology, chemistry, or physics (BIOL

1110-1-2; CHEM 1101 and 1102 or 1112; PHYS 2011-2-3). Additionally, all students will take a minimum of six hours (two courses) in engineering electives selected from an approved list.

### **Humanities**

Students are required to complete 18 hours of course work in the humanities, including ENGL 1001 and 1002 and at least one English course at the 2000 level. Additional courses may be selected from the approved list on p. 33 of this catalog. Although not required, the study of foreign language is highly recommended for HTS majors.

### **Social Sciences**

Students must take POL 1251 or 3200 as part of their 18-hour social sciences requirement; HIST 1001 and HIST 1002, either of which meet the basic graduation requirement in United States and Georgia history, are both required for HTS majors. Additional social sciences courses may be selected from the approved list on p. 33 of this catalog.

### **International Course**

Each student must take a minimum of one three-hour course that is internationally oriented. Most courses bearing the INTA designation (International Affairs) as well as other courses in the social sciences such as European History will meet this requirement.

### **Health and Performance Sciences**

No student may receive credit for more than three hours of physical education towards the degree. See "Department of Health and Performance Sciences" in this catalog for physical education requirements and approved courses.

### **Other Lower Division Courses**

All HTS majors are required to take 24 hours of designated lower division course work as follows: HIST 1001 and 1002 (one course taken as general history graduation requirement); two of the following: HIST 2001-2-3; SOC 1375; ECON 2000 and ECON 2001; and PST 1127.

### **Non-major Cluster**

All students must take a 15-hour concentration from a unit other than History, Technology, and

Society. This requirement may be met by an existing certificate program or by a 15-hour concentration approved by the School and meeting the following requirements: 1) 12 hours must be over and above the required courses and distribution requirements in the core curriculum; 2) all courses must either be in one discipline or be part of an interdisciplinary cluster grouped around a particular topic; and 3) the cumulative average for the concentration must be at least a 2.0.

### **Designated Upper Division Courses in Major**

All students must take the following five courses: either HIST 3062 or 3063; HTS 3401; HTS 4401-2-3-4-5 or approved disciplinary comparative course; HTS 4410 and HTS 4411 (senior thesis).

### **Upper Division Technology and Society HTS Electives**

All students must take a minimum of 12 hours from a list of courses having a focus on some aspect of technology and society. These courses include HIST 3025, 3027, 3037, 3038, 3043, 3044, 3045, 3061, 3062, 3063, 4007, 4009, 4015, 4016, and 4075; INTA 3460, 4100, 4110, 4120; PST 4757; POL 4210, 4212; SOC 3336, 3350, 3355, 3360. Additional technology and society courses offered by other units on campus may be substituted with the consent of the School.

### **Additional HTS Electives**

A minimum of 12 additional hours must be selected from the variety of HTS courses listed in the catalog (history or sociology courses at the 3000 level or above). The student should take courses that relate to a particular interest that he or she has developed in the course of study.

### **Free Electives**

Each student must have accumulated at least 183 hours of credit toward the Bachelor of Science degree in History, Technology, and Society. Therefore, in addition to the requirements listed above, the student must take a sufficient number of elective courses either within or outside the major to reach 183 hours. Typically, this will be in the range of 32-34 hours for most students.

# **Bachelor of History, Technology, and Society Curriculum (Suggested Schedule)**

## **Freshman Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>ENGL 1001-2</b> Analysis of Literature and Language	3-0-3	3-0-3	.....
<b>HIST 1001-2</b> History of U.S.	3-0-3	3-0-3	.....
<b>POL 1251</b> American Government	.....	.....	3-0-3
<b>Laboratory Science</b>	4-3-5	4-3-5	.....
<b>Mathematics</b>	5-0-5	5-0-5	5-0-5
<b>PST 1127</b> Science, Technology, Values	.....	.....	3-0-3
<b>ENGL 2XXX</b>	.....	.....	3-0-3
<b>Health &amp; Performance Sciences</b> (requirements, p. 311)	.....	.....	X-X-3
<b>TOTALS</b>	15-3-16	15-3-16	X-X-17

## **Sophomore Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Engineering Course</b>	3-0-3	.....	3-0-3
<b>HIST 2001-2</b> European History	3-0-3	3-0-3	.....
<b>SOC 1375</b> Intro. to Sociology	3-0-3	.....	.....
<b>SOC 2378</b> Social Issues	.....	3-0-3	.....
<b>International Course</b>	.....	.....	3-0-3
<b>ECON 2000-1</b> Principles in Economics I, II	.....	3-0-3	3-0-3
<b>Non-major Cluster</b>	3-0-3	3-0-3	3-0-3
<b>HIST 3062</b> History of Technology to 1900	3-0-3	.....	.....
<b>Humanities Elective</b>	3-0-3	3-0-3	3-0-3
<b>TOTALS</b>	18-0-18	15-0-15	15-0-15

## **Junior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Non-major Cluster</b>	3-0-3	.....	3-0-3
<b>HTS Electives</b> (Technology and Society)	3-0-3	3-0-3	3-0-3
<b>HTS Electives</b> (General electives)	3-0-3	3-0-3	3-0-3
<b>HTS Elective</b> (General elective)	.....	3-0-3	.....
<b>HTS 3401</b> Logic of Research	.....	.....	3-0-3
<b>Free Electives</b>	6-0-6	6-0-6	3-0-3
<b>TOTALS</b>	15-0-15	15-0-15	15-0-15

## **Senior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Comparative Course</b>	3-0-3	.....	.....
<b>HTS 4410-11</b>	.....	3-0-3	3-0-3
<b>Senior Thesis</b>	.....	3-0-3	3-0-3
<b>HTS Electives</b> (General Electives)	3-0-3	3-0-3	3-0-3
<b>HTS Electives</b> (Tech. and Society)	3-0-3	3-0-3	.....
<b>Free Electives</b>	6-0-6	6-0-6	6-0-6
<b>TOTALS</b>	15-0-15	15-0-15	12-0-12

**Total Credit Hours Required for Graduation = 183**

## **Graduate Program**

The School offers a program of graduate study in the history of technology at both the master's and doctoral level. The two-year master's program consists of foundation courses in history, sociology, and policy studies, as well as more specialized reading and research seminars. The program emphasizes the development of a strong general background in American and European history, with a special emphasis in the history of technology. Moreover, graduate courses stress the acquisition of skills in historical research, analysis, and writing.

The basic course requirement of 72 hours (for both the M.S. and Ph.D.) consists of 33 hours of core courses, which include six hours credit for a major research paper, plus 39 additional hours of elective courses. Students pursuing the Ph.D. will normally enroll for a third year of graduate course work in preparation for the comprehensive examination at the end of that academic year. The examination will cover material from four fields of study, one of which must be chosen from either philosophy, sociology, public policy, or an alternative field selected with the faculty's approval. The remaining two fields will be chosen from the following: history of science; economic history; and additional specialization in either American or European history.

In addition to satisfactory performance in the comprehensive examination, students must also pass a foreign language examination (normally in French or German) before being admitted to candidacy for the Ph.D. Having met these requirements, the candidate will submit a dissertation proposal, which must meet the approval of his or her dissertation committee. The

candidate will then proceed to the final requirement for the degree—the completion of the Ph.D. dissertation and its successful defense by oral examination.

## **Courses of Instruction**

### **HISTORY**

**HIST 1001. History of the United States to 1865**  
3-0-3.

A survey of the social, political, and economic history of the United States through the Civil War, with emphasis on selected topics. Gives exemption from United States and Georgia history examination.

**HIST 1002. History of the United States from 1865 to the Present**  
3-0-3.

A survey of the social, political, and economic history of the United States from the Civil War to the present, with emphasis on selected topics. Gives exemption from United States and Georgia history examination.

**HIST 1028. Introduction to the History of Science and Technology**  
3-0-3.

An introductory survey of the development of science and technology from antiquity to the present. Emphasis placed on sociocultural context and scientific and technological revolutions.

**HIST 2001. Seedbed of Modernity: Europe from the Renaissance to the Enlightenment**  
3-0-3.

An examination of the social, economic, and political currents of early modern Europe. Among the themes covered are social developments and religious conflict, the emergence of a modern world economy, state centralization, and the advent of the scientific revolution.

**HIST 2002. Age of Revolution and Imperialism: Europe from 1789 to 1914**  
3-0-3.

This course traces the development of political ideologies, industrialization labor activism, modern nation-state building, and imperialism from the French Revolution to World War I.

**HIST 2003. The Age of Total War: Europe Since 1914**  
3-0-3.

Various 20th-century European themes to be examined in this course include the crisis of global war, communism, fascism, and the movement of European integration.

**HIST 3005. Classical Greek History, c. 3000 to 323 B.C.**  
3-0-3.

The political, economic, cultural, and religious development of Classical Greek society, including Minoan and Mycenaean civilizations, Periclean Athens, and the era of Alexander the Great.

**HIST 3006. Roman History, c. 31 B.C. to 400 A.D.**  
3-0-3.

The political, economic, cultural, and religious development of Imperial Rome, including the accomplishments of Roman civilization, early Christianity, collapse of the Western empire, and formation of the Byzantine empire.

**HIST 3007. Early Middle Ages, 350 to 1050**  
3-0-3.

The political, economic, and cultural development of Western Europe, including the demise of the Roman Empire, the barbarian kingdoms, the explosion of Islam, monasticism, and the empire of Charlemagne.

**HIST 3008. High Middle Ages, 1050 to 1400**  
3-0-3.

The political, economic, and cultural development of Western Europe, including the blossoming of medieval culture, the struggle between church and state, European monarchies, and the Crusades.

**HIST 3009. Colonial American History**  
3-0-3.

Settlement and growth of the English colonies in North America, with emphasis on the foundation of American political and economic institutions.

**HIST 3014. The American Revolution and the Constitution**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

An analysis of the intellectual, political, and social context of the creation of the United States as an independent republic.

**HIST 3017. History of the Old South to 1865**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

A study of social, political, and economic developments in the South from the colonial period through the Civil War.

**HIST 3018. History of the New South Since 1865**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

An examination of social, political, and economic developments from the Reconstruction period to the present.

**HIST 3020. American Diplomatic History**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

A survey of American diplomatic history since the Spanish-American War, with emphasis on the period since World War II.

**HIST 3022. Afro-American History**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Historical analysis of the black American from the ancient African beginnings to the present.

**HIST 3024. The American Civil War**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Origins, events, and consequences of the American Civil War, with due attention to social, political, and economic developments as well as military operations.

**HIST 3025. American Economic History**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Special attention given to the rise of technology, our industrial system, the westward movement, development of our banking system, and government regulation of industry.

**HIST 3026. History of American Business**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Focuses on the development of business institutions from the colonial period up to the present. Themes stressed include the role of the entrepreneur, the emergence of "big business," the evolution of new business structures, government-business relations, and business and society.

**HIST 3027. History of Energy**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

The historical development of major energy sources, history of alternative energy technologies, and evolution of public policy in energy-related areas.

**HIST 3029. American History through Biography**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Examines American history through the lives of people who helped to shape it. Lectures, oral presentations, class discussions, and term project.

**HIST 3032. American Social History**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

An examination of major issues and topics in American social history.

**HIST 3033. Social Reform Movements in America**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

An examination of the development and impact of major social reform movements in America, using case studies of key movements.

**HIST 3034. The Frontier in American History**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Explores the westward movement, the frontier thesis, and a variety of frontier experiences including trapping, trading, mining, transportation, agriculture, Indian relations, and land policy.

**HIST 3035. The Family, Sexuality, and Social Change in America**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

An analysis of changing patterns of family life and sex roles in America from colonial times to present.

**HIST 3036. New Religions and Cults in America**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

An examination of the social and intellectual impact of new religious movements in America, using case studies of key groups.

**HIST 3037. Technology and the Shaping of American Culture**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

A study of the ways in which American culture has been defined by its technology, with emphasis on popular literature, industrial exhibitions, and the movies.

**HIST 3038. American Environmental History**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Environmental attitudes and practices from the 17th Century to the 20th Century, with special attention to native American and European notions of land use; the response to industrialization; and the rise of the conservation/preservation movement.

**HIST 3041. Revolutionary Movements in the Modern World**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

A comparative analysis of the origin, development, and impact of major revolutionary movements, especially during the 20th Century.

**HIST 3042. Outposts of Empire: Studies in Comparative British Colonialization**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

A comparative examination of British colonialism, with emphasis on colonies of settlement such as Australia, New Zealand, Canada, and South Africa.

**HIST 3043. History of Science, 1500-1700**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

An interpretative study of the scientific revolution, including the social, economic, and cultural context and origins of science in America.

**HIST 3044. History of Science, 1700-1900**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

The evolution of science and scientific institutions in Europe and the United States, including the rise of industrial research.

**HIST 3045. Industrialization in the United States**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

The process of industrialization and its impact on work, technology, and society. Special attention is paid to the social context of economic development.

**HIST 3050. Modern Britain from the Industrial Revolution to 1914**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Traces developments in British history from roughly 1815-1914, including the Industrial Revolution and the movements for and against Irish Home Rule and political and social reform.

**HIST 3051. Modern Britain from 1914 to the Present**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Traces and analyzes developments and events in Britain since 1914, including both world wars, and the movements for and against political and social reform.

### **HIST 3052. The French Revolution**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

A history of the Revolution that reshaped Europe and gave birth to the modern state, with emphasis on the terror and the career of Napoleon.

### **HIST 3053. Modern Spain**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Spain's deformed modernization, from the wars of liberation against Napoleon, through anarchist and fascist experiments, to the resurgence of democratic, socialist Spain after Franco's death.

### **HIST 3054. History of Modern Germany**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Examines German history from unification under Bismarck in 1871 to the collapse of the Berlin Wall in 1989, focusing on the development of German economy, society, and politics.

### **HIST 3055. European Intellectual History**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Explores the exciting theoretical breakthroughs arising during the last half of the 19th Century and first two decades of the 20th Century, focusing on Marx, Darwin, Nietzsche, Freud, and Weber.

### **HIST 3060. American Intellectual History**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

An examination of the major intellectual traditions of the United States, with an emphasis on the recent period of history.

### **HIST 3061. History of Technology to 1700**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

The development of technology from our beginnings up through the Renaissance, emphasizing the relationship between technology and society.

### **HIST 3062. History of Technology, 1700-1900**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

The development of technology in the early industrial era, with emphasis on the social context of technological change.

### **HIST 3063. History of Technology Since 1900**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

The history of technological development in the 20th century world, with an emphasis on technological innovation, research and development, and the impact of technology on society.

### **HIST 3786. America's Immigrant and Ethnic Experience**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Focuses on the variety of people who make up the United

States. Major migrations will be discussed, including those of the English, Scandinavians, Afro-Americans, Irish, Germans, Jews, Italians, Hispanics, and Asians. Topics covered include life in the old world, assimilation, immigration policy, racism and nativism, politics, and culture from the colonial period to the present.

### **HIST 4001. The Uses of History for Policy Makers**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Historical analysis of case studies in governmental policymaking at the federal and state level, 1960s to the present. Includes research in the Carter Presidential Library.

### **HIST 4007. History of American Technology to 1876**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Treats the history of American technology from the colonial era to the U.S. Centennial Exhibition to 1876, emphasizing the social effect of technical change.

### **HIST 4009. History of American Technology Since 1876**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Treats the history of American technology since the U.S. Centennial Exhibition of 1876, emphasizing engineering and industrial developments, mass production technology, and their social effects.

### **HIST 4015. Engineers in American Life**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

A study of engineering from its early concentration on transportation to the emergence of special fields and professional societies, with specialized forms of education.

### **HIST 4016. History of Electrical Sciences and Technology**

3-0-3.

The origins and evolution of electrical science, technology, and engineering. Emphasis placed on impact of major innovations in power, communications, and electronics.

### **HIST 4025. The United States Since 1917**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

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 4030. New Perspectives on German Nazism**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Addresses the rise and meaning of National Socialism, Hitler's consolidation of power, German society under fascism, and the fate of European Jewry.

### **HIST 4050. Twentieth Century Black History**

3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

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, or consent of the School.



Examines the historical background of the American city beginning with the colonial period. Topics covered include city planning, urban technology and city services, neighborhoods, race relations, and other factors that shaped the modern city.

**HIST 4076. The Development of Industrial Cities**  
3-0-3. Prerequisite: HIST 1001, 1002, or consent of the School.

Focuses on the growth and development of industrial cities concentrating on an in-depth analysis of a few cities to note the impact and interaction of industrialization and urbanization.

**HIST 4875-6-7. Special Topics in History**  
3-0-3.

**HIST 4925-6-7-8-9. Special Problems in History**  
Credit to be arranged.

## **HISTORY, TECHNOLOGY, AND SOCIETY**

**HTS 3401. The Logic of Historical and Social Research**  
3-0-3. Prerequisites: HIST 1001 or 1002 and SOC 1375.

An introduction to varying approaches to historical and social analysis, this course surveys major schools of social analysis, historiography, and alternative methodologies used in the social sciences.

**HTS 4401-2-3-4-5-6. Comparative Studies in History and Society**  
3-0-3. Prerequisites: HIST 1001 or 1002; HIST 2001 or 2002 or 2003; SOC 1375; or consent of the instructor.

Comparative analysis of selected topics, with a special emphasis on the different perspectives of western and nonwestern cultures in different historical eras.

**HTS 4410-11. HTS Thesis/Senior Project**  
3-0-3. Completion of HTS core requirements (HIST 1001, 1002; SOC 1375, 2377; HIST 200-01-02 (6 hrs.); ECON 2000, 2001; PST 1127; HIST 3048 or 3049; HTS 3401).

Individual research and writing project directed by a faculty member or members over two quarters; both HTS 4410 and 4411 are required for all majors in History, Technology, and Society.

**HTS 4875-6-7. Special Topics in History, Technology, and Society**  
3-0-3. Prerequisites: HIST 1001 or 1002, and SOC 1376 or consent of the School.

**HTS 4925-6-7. Special Problems in History, Technology, and Society**  
3-0-3. Prerequisites: HIST 1001 or 1002 and SOC 1376 or consent of the School.

## **HISTORY**

**HIST 6001. Theories of History and Historiography**  
3-0-3.

Track the development of the historical sciences from antiquity to the present day. The course will also consider the development of modern historical "schools," eg. Whig, Marxist, Annals, as they have applied to the history of specific countries.

**HIST 6002. Proseminar in the History of Technology I**  
3-0-3.

An introduction to the literature and historiography of the history of technology, this course will familiarize the student with major themes in technological development as well as the social impact of technological change.

**HIST 6003. Proseminar in the History of Technology II**  
3-0-3.

The second half of the required introduction to the literature and historiography of the history of technology. This course will familiarize the student with major themes in technological development as well as the social impacts of technological change.

**HIST 6004. Proseminar on European Social History**  
3-0-3.

European society in the age of industrialization. Emphasis is on changes in the nature of work, community, material culture, private life, and the family.

**HIST 6005. Proseminar in European Industrial History**  
3-0-3.

This course will trace European industrial development to the first World War and examine selected ramifications of that important process, eg. its impact in human terms, the political conflicts to which it gave rise, its meaning for the rest of the world.

**HIST 6006. Proseminar in American Social History**  
3-0-3.

This course introduces students to the literature and central themes of the "new" social history, focusing especially on family, gender, and ethnic relations; social and occupational mobility; and urbanization and industrialization.

**HIST 6007. Proseminar in American Industrial History**  
3-0-3.

This course introduces students to the basic fields in industrial history: business history, history of technology, labor history, and industrial archaeology.

**HIST 6100. Industrial Germany**  
3-0-3.

This course will trace the first and second industrial revolutions in Germany and the social forces to which they gave rise.

**HIST 6200. Great Britain: From the Industrial Revolution to the General Strike**  
3-0-3.

Britain was the first country to undergo an industrial revolution, and therefore became the world's leading industrial power for most of the nineteenth century. This course in the history of labor and industry examines how Britain's particular evolution effected the British working class.

**HIST 6250. European Agriculture and the Industrial Revolution**  
3-0-3.

A comparative history of European peasantry. Focus is on the impact of modernization on rural communities and on peasant resistance movements in modern times.

**HIST 6300. Seminar in the History of American Technology**

3-0-3.

The seminar will study a selected number of important articles and books on the subject, also considering the methodological and historiographical issues this literature raises.

**HIST 6400. History for Policy Makers**

3-0-3.

Historical analysis of case studies in governmental policy making at the federal and state level, 1960s to the present. Includes research in the Carter Presidential Library.

**HIST 6410. Industrial Archaeology**

3-0-3.

Industrial archaeology involves studying the physical remains of industrial and engineering activities, such as textile mills, railroad stations, and bridges. Special attention is given to sites in Georgia with field trips to selected sites.

**HIST 6420. Urban America**

3-0-3.

This reading course will analyze the historiographical literature regarding the development of America's cities and the urban problems faced in the last three centuries.

**HIST 6430. American Labor and Working Class History**

3-0-3.

This course studies the secondary literature from the "old" labor history, with its institutional emphasis on labor organizations, and the "new" labor history, with a broader emphasis on the workplace, community, and family.

**HIST 6440. American Economic History**

3-0-3.

A survey of the literature in American economic history, with particular attention to the differing approaches and methodologies practiced in the field. The course focuses on major topical themes in economic development from the colonial period to the present.

**HIST 7001. Research Seminar I**

3-0-3.

First half of a two-quarter research and writing seminar focusing on a topic arising from core course work taken during the first year of graduate study and normally taken during the second year.

**HIST 7002. Research Seminar II**

3-0-3.

Second half of a two-quarter research and writing seminar focusing on a topic arising from core course work taken during the first year of graduate study and normally taken during the second year.

**HIST 7020. Seminar in the History of Technology**

3-0-3.

This course trains students to conduct original research. They will select topics, report on the relevant literature and present the results of their investigation.

**HIST 7030. Seminar in Urban History**

3-0-3.

Using Atlanta as a laboratory of urban research, this seminar

will focus on the history and development of this city as a way of understanding the forces which shape American cities.

**HIST 7050. Seminar in Modern European Labor History**

3-0-3.

This research course will analyze the various labor movements which have arisen in modern Europe and the debates surrounding their aims and practices.

**HIST 7060. Seminar in American Business and Industrial History**

3-0-3.

Students will undertake a directed research and writing project in a selected area of business and economic history. Projects will demonstrate a facility with primary as well as secondary sources.

**HIST 8121-2-3-4-5. Special Topics in History**

1-0-1 through 5-0-5, respectively.

**HIST 8545-6-7-8-9. Special Problems in History**

Credit to be arranged.

**HIST 8997. Teaching Assistantship**

For graduate students holding graduate teaching assistantships.

**HIST 8998. Research Assistantship**

For graduate students holding graduate research assistantships.

**HIST 9000. Doctoral Thesis.**

**SOCIOLOGY**

**SOC 1375. Introduction to Sociology**

3-0-3.

A study of basic social relations, including social structure and functions, analysis of social processes, the foundations of personality, and analysis of social organization.

**SOC 2377. Social Institutions**

3-0-3. Prerequisite: SOC 1375.

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 2378. Social Issues and Public Policy**

3-0-3. Prerequisite: SOC 1375, or consent of the instructor.

A survey of major social issues and an analysis of various public policy responses to them, including the economy, race, gender, the environment, criminal justice, and the military.

**SOC 3300. Social Theory and Social Structure**

3-0-3. Prerequisite: SOC 1375.

Theories of industrial society as they bear on religion, classes, the state and social control, with special emphasis on works by Marx, Weber, and Durkheim.

**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 3320. Sociology of Gender**

3-0-3. Prerequisite: SOC 1375.

An examination of the importance of gender in varying institutional contexts, including the family, work, politics, and education.

**SOC 3331. Sociology of Race and Ethnicity**

3-0-3. Prerequisite: SOC 1375.

An introduction to the impact of race and ethnicity on society and culture, focusing mainly on the United States since WWII.

**SOC 3334. Social Stratification and Mobility**

3-0-3. Prerequisite: SOC 1375.

Provides an overview of social theory and research on the causes and consequences of stratification and mobility, with an emphasis on historical and cross-national perspectives.

**SOC 3336. Sociology of Work and Industry**

3-0-3. Prerequisite: SOC 1375, or consent of the instructor.

The social organization of work in historical and comparative perspective, centering on variations in workplace authority, industrial conflict and change, alienation and inequality at work.

**SOC 3337. Culture and Personality**

3-0-3. Prerequisite: SOC 1375, or consent of the instructor.

Explores both cultural and historical variations in human character and temperament within primitive, traditional, and modern societies.

**SOC 3339. Urban Sociology**

3-0-3. Prerequisite: SOC 1375.

Introduces students to basic concepts of sociology as applied to urban phenomena, nature of urbanism, and consequences for social relations and human personality.

**SOC 3341. Organizations and Society**

3-0-3. Prerequisite: SOC 1375.

Analysis of the structure and dynamics of complex organizations. Topics include the functions and dysfunctions of bureaucracy, informal work groups, organizational environments, and organizational redesign.

**SOC 3350. Sociology of Science**

3-0-3. Prerequisite: SOC 1375.

Introduction to science and technology as a social and cultural phenomenon. Topics include the cultural contexts of the roles played by scientists and engineers in contemporary society and the institutional tensions between science and government.

**SOC 3355. Technology and Society**

3-0-3. Prerequisite: SOC 1375.

Analysis of social conditions that promote or retard technological activity. Particular emphasis on the social role of the scientific and engineering professions in that development.

**SOC 3360. Automation and the Future of Work**

3-0-3. Prerequisite: SOC 1375.

The relation between new technologies and the social organization of work, with special attention to changes in skill

requirements, authority, gender relations, and technological unemployment.

**SOC 3510. Social Movements and Social Change**

3-0-3. Prerequisite: SOC 1375.

An examination of the role of social movements in supporting or resisting social change. Topics include workers, peasants, civil rights, and anti-war movements.

**SOC 3520. Politics and Society**

3-0-3. Prerequisite: SOC 1375.

An examination of power and political systems in comparative perspective. Topics include the study of liberal democracy, classes and elites, voting and political ideologies.

**SOC 3526. Sociology of Development**

3-0-3.

This course is designed to familiarize students with competing perspectives on international development and to survey some of the crucial socioeconomic and political issues facing the Third World today.

**SOC 4335. Historical Sociology**

3-0-3. Prerequisite: SOC 1375.

An application of sociological theories and methods to analyzing historical events and processes, such as the rise of slavery and the emergence of welfare states in Europe.

**SOC 4875-6-7. Special Topics in Sociology**

3-0-3.

Topics to be selected.

**SOC 4999. Special Problems in Sociology**

Credit to be arranged.

**SOC 6010. Social Theory and Modern Society**

3-0-3.

An introduction to the theories of Marx, Durkheim, and Weber as intellectual responses to industrialization and modernization.

**SOC 6011. Social Theory and Social Structure**

3-0-3.

A consideration of modern social theories, with special focus on interactionist, functionalist, structuralist, and critical theories of culture, class, and social change.

**SOC 6500. Sociology of Work, Industry, and Society**

3-0-3.

Theory and research on the relation between work and society, with special attention to forms of labor control, new technologies, and industrial attitudes and behavior.

**SOC 6510. Gender, Work, and Social Inequality**

3-0-3.

Historical and sociological research on the relation between gender inequality and the rise of modern industry.

**SOC 6520. Development and Underdevelopment**

3-0-3.

Examines theoretical and empirical work on the sociology of development, especially "modernization" and "dependency" perspectives.

**SOC 6530. Society, Culture, and Technology**

3-0-3.

Examines relationships of technology to other aspects of society and culture, including social change, risk assessment, technology policy.

**SOC 6540. Science and Society**

3-0-3.

An introduction to the sociology of science and scientific knowledge.

**SOC 7070. Seminar in Industry and Society**

3-0-3.

An application of industrial sociology to student research projects, with an emphasis on such topics as alienation from work, industrial conflict, and patterns of workplace authority.

**SOC 8121-2-3-4-5. Special Topics in Sociology**

1-0-1 through 5-0-5, respectively.

**SOC 8545-6-7-8-9. Special Problems in Sociology**

Credit to be arranged.

## School of International Affairs

**Established in 1990**

**Location: Habersham Building**

**781 Marietta Street**

**Telephone: 404-894-3195**

*Director and Professor*—Linda P. Brady;

*Professors*—John E. Endicott, John W. Garver, Patrick Kelly, Robert Kennedy, Daniel S. Papp, Michael D. Salomone; *Associate Professors*—

William J. Long, David Wilsford; *Assistant*

*Professors*—Peter Brecke, William Roberts Clark, Colin R. Flint, Fei-Ling Wang, Katja Weber, Brian Woodall.

*Jointly Appointed Professors*—John P. Crecine, John R. McIntyre, Edmun B. Richmond, Richard D. Teach; *Jointly Appointed Associate Professors*—Arthur C. Nelson, David H. Ray, Sandra W. Thornton.

### General Information

Instruction in international affairs provides students with an understanding of the interdependent and multicultural world in which they live. Course work in international affairs also provides students with a set of quantitative and qualitative skills for analyzing issues in international security policy and international

political economy. Study in international affairs complements career-specific managerial, technological, and scientific training at Georgia Tech.

The School offers the Bachelor of Science in International Affairs, which is designed to provide graduates with the capabilities to engage in strategic planning and analysis in an international context. The curriculum is based on a common core, which includes courses in international affairs, modern languages, history, economics, and philosophy. At the upper-division level, students may specialize in international security policy or international political economy. Most graduates will pursue advanced graduate and professional education, obtain private sector employment in internationally oriented firms, or obtain public sector employment in internationally oriented positions.

### Certificate Program

The School also offers the Certificate in International Affairs, which is awarded upon graduation to students who have completed a 15-hour cluster of approved courses in international affairs. Ivan Allen College majors may choose to fulfill the non-major cluster requirement by pursuing a Certificate in International Affairs. The Certificate provides general background in international affairs and is especially useful for students in engineering, management, and architecture who anticipate graduate training or work experience in internationally oriented fields.

### Bachelor of Science in International Affairs

Students interested in careers in internationally oriented business, government, or public service fields, or in pursuing graduate study in business, international affairs, law, public policy, or related fields, will benefit from this degree program. In addition to core work in introductory and advanced courses, the program allows students to concentrate their study in international political economy or international security policy.

## **Requirements for the Bachelor of Science in International Affairs**

### **Mathematics**

The mathematics requirement may be satisfied by one of the following sequences: MATH 1711-12-13; MATH 1307-8 and 1711; MATH 1507-8 and 1711; MATH 1307-8-9 or MATH 1507-8-9. Students may not receive credit for MATH 1307 and 1712 or 1507 and 1712. Credit may not be received for MATH 1308 and 1713 or 1508 and 1713. Courses must be taken and passed in sequence; concurrent registration for two or more of these courses is not permitted. Transfer majors into the School must consult with the School to determine their mathematics requirement at the time of transfer.

### **Sciences and Engineering**

Students are required to complete 12 hours of a laboratory science sequence and nine hours of engineering-oriented courses. The sciences requirement may be satisfied by one of the following sequences: BIOL 1110-11-12; CHEM 1101 and 1102 or 1112; PHYS 2011-12-13. The engineering-oriented course requirement is satisfied by CS 1501 and 1502.

### **Humanities and Fine Arts**

Students are required to complete 18 hours in humanities and fine arts, including ENGL 1001 and 1002; ENGL 2110, 2201, 2310, or 2401. Students must also complete 18 hours of a modern foreign language. Students are encouraged to complete additional study in foreign language.

### **Social Sciences**

The 18-hour social sciences requirement should be satisfied by POL 1251 or 3200; HIST 1001 or 1002; and 12 additional hours of social sciences electives selected from a list of courses on p. 33 of this catalog.

### **Statistics Course**

Students are required to complete MSCI 2100.

### **Health and Performance Sciences**

All students must take three hours of health and performance sciences, but no student may receive

credit for more than three hours of physical education toward degree requirements. See "Curricula and Courses of Instruction," Department of Health and Performance Sciences, p. 311 of this catalog.

### **Other Lower Division Courses**

Students are required to complete 18 hours of additional course work; 1000- and 2000-level modern foreign language courses may be included.

### **Non-Major Cluster**

The Ivan Allen College non-major cluster requirement may be satisfied by (1) a certificate of at least 15 hours offered by a unit other than the School of International Affairs; or (2) a 15-hour concentration outside International Affairs, including 12 hours (over and above required courses) within one discipline or an interdisciplinary cluster, in which the student has earned at least a 2.0 grade point average.

### **Gateway Curriculum**

Students are required to complete 21 hours of introductory, gateway courses in international affairs, including INTA 1000, INTA 1100, INTA 2000, INTA 2200, HIST 2003, ECON 2000, and ECON 2001.

### **Advanced Curriculum**

Students are required to complete 27 hours of advanced instruction in international affairs including INTA 3000, INTA 3100, INTA 3200, INTA 3300, INTA 3400, INTA 4100, ECON 4300, INTA 4581, and INTA 4582.

### **Advanced Specialization Curriculum (Electives within the Major)**

Students must take at least nine hours from a group of courses designated "Comparative Cultures and Societies," and nine hours from one of two policy-oriented groups of courses, designated "International Security Policy" and "International Political Economy." A list of courses that may be used to satisfy these requirements is available from the School office.

### **Nonspecified Electives**

Students must have at least 186 hours of credit to receive a Bachelor of Science degree in

International Affairs. Additional to those requirements listed above, students must therefore take a sufficient number of elective courses either within or outside the major so that upon graduation they have at least 186 hours of credit.

## Bachelor of Science in International Affairs Curriculum (Suggested Schedule)

### Freshman Year

Course	1st Q.	2nd Q.	3rd Q.
<b>Mathematics</b>	5-0-5	5-0-5	5-0-5
<b>Modern Languages</b>	3-0-3	3-0-3	3-0-3
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>POL 1251</b>			
Government of the United States	3-0-3	.....	.....
<b>INTA 1000</b>			
Introduction to International Relations	.....	3-0-3	.....
<b>INTA 1100</b>			
Comparative Politics	.....	.....	3-0-3
<b>HIST 1001 or 1002</b>			
History of the U.S.	.....	.....	3-0-3
<b>Health and Performance Sciences</b>	.....	.....	X-X-3
<b>TOTALS</b>	14-0-14	14-0-14	17-0-17

### Sophomore Year

Course	1st Q.	2nd Q.	3rd Q.
<b>Science</b>	X-X-4	X-X-4	X-X-4
<b>Modern Languages</b>	3-0-3	3-0-3	3-0-3
<b>ECON 2000-1</b>			
Principles of Economics I, II	3-0-3	3-0-3	.....
<b>HIST 2003</b>			
The Age of Total War: Europe Since 1914	.....	.....	3-0-3
<b>INTA 2000</b>			
International Relations of the Great Powers	3-0-3	.....	.....
<b>INTA 2200</b>			
Intro. to American Foreign Policy	.....	3-0-3	.....
<b>CS 1501</b>			
Intro. to Computing	3-3-4	.....	.....
<b>CS 1502</b>			
Intro. to Programming	.....	3-6-5	.....
<b>ENGL 2110, 2201, 2210, or 2401</b>			
Intro. to Literature or Drama and Film	.....	.....	3-0-3
<b>Nonspecified Electives</b>	.....	.....	3-0-3
<b>TOTALS</b>	X-X-17	X-X-18	X-X-16

### Junior Year

Course	1st Q.	2nd Q.	3rd Q.
<b>ECON 4300</b>			
International Economics	3-0-3	.....	.....
<b>MSCI 2100</b>			
Survey of Statistics	3-0-3	.....	.....
<b>INTA 3000</b>			
International Relations Theory I	3-0-3	.....	.....
<b>INTA 3100</b>			
Quantitative and Analytical Methods in Int'l. Affairs	.....	3-0-3	.....
<b>INTA 3200</b>			
International Political Economy	.....	3-0-3	.....
<b>INTA 3300</b>			
U.S. Foreign Policy	.....	.....	3-0-3
<b>INTA 3400</b>			
Comparative Political Philosophies and Ideologies	.....	3-0-3	.....
<b>Nonmajor Cluster Electives</b>	.....	3-0-3	3-0-3
<b>INTA Electives</b>	3-0-3	3-0-3	3-0-3
<b>Nonspecified Electives</b>	3-0-3	.....	6-0-6
<b>TOTALS</b>	15-0-15	15-0-15	15-0-15

### Senior Year

Course	1st Q.	2nd Q.	3rd Q.
<b>INTA 4100</b>			
Science, Technology, & World Politics	3-0-3	.....	.....
<b>INTA 4581</b>			
Senior Seminar: International Strategy & Policy I	.....	3-0-3	.....
<b>INTA 4582</b>			
Senior Seminar: International Strategy & Policy II	.....	.....	3-0-3
<b>Nonmajor Cluster Electives</b>	3-0-3	3-0-3	3-0-3
<b>INTA Electives</b>	3-0-3	3-0-3	3-0-3
<b>Nonspecified Electives</b>	6-0-6	6-0-6	6-0-6
<b>TOTALS</b>	15-0-15	15-0-15	15-0-15

Total Credit Hours Required for Graduation = 186

## Courses of Instruction

### INTA 1000. Introduction to International Relations 3-0-3.

An analysis of the theory and structure of the international system and their application to contemporary international affairs.

### INTA 1100. Comparative Politics 3-0-3.

Analyzes the similarities and differences between and among the political and governmental systems of nation-states.

**INTA 2000. International Relations of the Great Powers**  
3-0-3.

This course explores the development of foreign relations between and among the Great Powers of Europe and Asia during the nineteenth and early twentieth centuries.

**INTA 2200. Introduction to American Foreign Policy**  
3-0-3.

Study of United States foreign policy before 1945, stressing economic, political, and strategic factors.

**INTA 3000. International Relations Theory I**

3-0-3. Prerequisites: INTA 1000 and INTA 2000, or consent of the School.

This course examines the more prominent theories of how and why the international system and the nation-states and other actors within it function as they do.

**INTA 3100. Quantitative and Analytical Methods in International Affairs**

3-0-3. Prerequisites: INTA 1000 and MSCI 2100.

This course explores methods of analysis in international relations, including the use of quantitative techniques, levels of analysis, and basic simulation and computer methodologies.

**INTA 3200. International Political Economy**

3-0-3. Prerequisites: INTA 1100 and ECON 4300, or consent of the School.

Analyzes the relationship between political and economic issues in contemporary international affairs.

**INTA 3210. The Politics of European Integration**

3-0-3. Prerequisites: INTA 1000 and INTA 1100, or consent of the School.

This course examines the processes and problems of economic and political integration in the European Community, the world's largest trading bloc.

**INTA 3300. U.S. Foreign Policy**

3-0-3. Prerequisite: POL 1251, or consent of the School.

Study of the formulation and implementation of United States foreign policy since 1945, stressing economic, political, and strategic factors.

**INTA 3310. Soviet Foreign Policy**

3-0-3.

A study of the formulation and conduct of the foreign policy of the Soviet Union and its successor states. Consideration of ideological and geopolitical influences and the development of relations with the Western world and the Third World.

**INTA 3320. Chinese Foreign Policy**

3-0-3.

After examining Chinese foreign policy before the 1949 revolutions, this course focuses on Chinese foreign policy under Mao and the post-Mao Chinese leadership.

**INTA 3400. Comparative Political Philosophies and Ideologies**

3-0-3.

This course examines the political philosophies and ideologies of Aristotle, Aquinas, Machiavelli, Locke, Hobbes, Mill, Marx, and other major political philosophers and theorists.

**INTA 3410. Soviet Government and Politics**

3-0-3.

An examination of government and politics in the former Soviet Union and its successor states from 1917 to the present.

**INTA 3420. Chinese Government and Politics**

3-0-3.

This course provides an understanding of both past and present Chinese government practices, policies, and structures.

**INTA 3430. Western European Government and Politics**

3-0-3.

Comparative analysis of governmental and political processes in the nations of Western Europe.

**INTA 3440. Eastern European Government and Politics**

3-0-3.

Comparative analyses of governmental and political processes of the nations of Eastern Europe both before and after the revolutions of 1989.

**INTA 3450. Japanese Government and Politics**

3-0-3.

This course examines the changes taking place in contemporary Japanese government and politics, including social and cultural issues.

**INTA 3460. The Developing Nations**

3-0-3.

A study of selected underdeveloped nations, including economic and political development.

**INTA 3470. Latin American Governments and Politics**

3-0-3.

A survey of governmental and political processes in Latin American countries.

**INTA 3480. African Government and Politics**

3-0-3.

A survey of the history, cultures, social systems, governments, economics, and international roles of Africa south of the Sahara.

**INTA 3510. U.S. Defense Policy**

3-0-3. Prerequisite: POL 1251, or consent of the School.

Analysis of recent and current United States defense policy, including an examination of defense decision making.

**INTA 3520. U. S. Military Policy**

3-0-3. Prerequisite: POL 1251, or consent of the School.

Examination of the armed forces' relationship to society including the development of the military-industrial complex.

**INTA 3540. Defense Economics**

3-0-3. Prerequisite: INTA 3510, or consent of the School.

This course examines the impact of politics on defense planning, budgeting and procurement, and the interaction between defense spending and the economic and political structure of the U.S.

**INTA 3550. Nuclear Weapons and Nuclear Policy**

3-0-3.

This course examines the evolution of deterrence from 1945 to the present. Special emphasis is placed on understanding and analyzing current debates over the modernization of American strategic and theater nuclear forces.

**INTA 3560. Pacific Security Issues**

3-0-3. Prerequisite: INTA 1000, or consent of the School.

This course examines current and future security problems in the Pacific, including Korean issues, Japanese defense, forward basing, and Southeast Asia and the Philippines.

**INTA 3570. European Security Issues**

3-0-3. Prerequisite: INTA 1000, or consent of the School.

After providing background on the development of the present European security environment, this course focuses on contemporary European security issues including the future of NATO, economic integration, the unification of Germany, and the environment.

**INTA 3580. Insurgency and Counter Insurgency**

3-0-3. Prerequisite: INTA 1000, or consent of the School

This course examines the roots and methods of revolutions, as well as the methods that have been undertaken to counter revolution.

**INTA 3590. The Challenge of Terrorism**

3-0-3.

This course examines the ideologies, strategies, and structures of terrorist organizations and analyzes alternative approaches to combating terrorism in terms of moral, ethical, and practical issues.

**INTA 3600. Political Geography**

3-0-3. Prerequisite: INTA 1000, or consent of the School.

This course examines the ways in which geography works through economics, politics, and society to influence international affairs.

**INTA 3750. International Language Policies**

3-0-3. Prerequisite: INTA 1000, or consent of the School.

An introduction to the politics, problems, and alternative solutions in national language choices, including a comparative analysis of industrialized and developing nations.

**INTA 4100. Science, Technology, and World Politics**

3-0-3. Prerequisites: INTA 1000 and INTA 2000, or consent of the School.

An analysis of the impact of science and technology on the international system, including the role of science and technology in the foreign policy process.

**INTA 4110. International Technology Transfer**

3-0-3. Prerequisite: INTA 1000, or consent of the School.

This course examines how technology is transferred from one country to others and is both historical and policy relevant.

**INTA 4120. Technology Transfer and Economic Development**

3-0-3. Prerequisite: INTA 1000, or consent of the School.

This course examines the impact of technology transfer on economic development in both developed and developing countries.

**INTA 4130. Technology Transfer and Arms Sales**

3-0-3. Prerequisite: junior standing or INTA 1000 and INTA 3300.

This course explores the international arms market and the manner in which defense production knowledge and technology are diffused worldwide.

**INTA 4140. The Political Economy of France**

3-0-3. Prerequisites: INTA 1100 and INTA 3200, or consent of the School.

This course examines the political economy of France, Europe's second largest economy and one of America's principal trading partners.

**INTA 4150. Domestic Sources of International Decisionmaking**

3-0-3. Prerequisites: INTA 1000 and INTA 1100, or consent of the School.

This course uses the case method to examine the dynamics of decisionmaking in international negotiations and disputes, with an emphasis on domestic influences.

**INTA 4210. International Negotiations**

3-0-3. Prerequisite: INTA 1000, or consent of the School.

Examination of theories of bargaining and negotiation, with an emphasis on explaining success and failure in U.S. foreign policy and national security negotiations.

**INTA 4220. Arms Control and Technology**

3-0-3. Prerequisite: INTA 1000, or consent of the School.

This course examines the impact of technology on the process and outcome of arms control negotiations, focusing on nuclear, chemical, biological, and advanced conventional weapons.

**INTA 4310. The Vietnam War**

3-0-3. Prerequisite: INTA 1000, or consent of the School.

This course studies political, military, economic, social, and other aspects of the longest war in U.S. history—Vietnam.

**INTA 4581. Senior Seminar—International Strategy and Policy I**

3-0-3. Prerequisites: Senior standing and completion of INTA core courses; enrollment limited to international affairs majors.

Places students in an international problem setting. Students must formulate strategies and policies to cope with given problems. Themes examined vary from seminar to seminar.

**INTA 4582. Senior Seminar—International Strategy and Policy II**

3-0-3. Prerequisite: INTA 4581.

Students will continue and complete work begun in INTA 4581, formulating strategies and policies to cope with international problems within the seminar's theme.



**INTA 4610. Seminar in Europe: European Security**  
3-0-3. Prerequisite: INTA 1000 or INTA 1100, or consent of the School.

This course examines the history, institutional structure and functions, and current policy challenges facing the North Atlantic Treaty Organization (NATO) and other European security institutions.

**INTA 4620. Seminar in Europe: European Community**  
3-0-3. Prerequisite: INTA 1000 or INTA 1100, or consent of the School.

This course explores the history and processes of economic and political integration within the framework of the European Community.

**INTA 4875-6-7-8. Special Topics in International Affairs**  
3-0-3.

Examines a variety of social, economic, political, cultural, and military issues in the international arena. Topics change on a quarter-by-quarter basis.

**INTA 4953-4-5-6. Special Problems in International Affairs**  
Credit to be arranged.

**POL 3276. International Organizations**  
3-0-3. Prerequisite: INTA 1000, or consent of the School  
Study of evolution, impact, and future of international organizations.

## School of Literature, Communication, and Culture

**Established in 1990**

**Location: Skiles Building**

**Telephone: 404-894-2730/2731**

*Director and Associate Professor*—Kenneth J. Knoespel; *Associate Director*—James J. Bynum; *Director of Graduate Studies and Associate Professor*—Peter McGuire; *Director of Undergraduate Studies and Associate Professor*—Richard Grusin; *Professors*—Jay Bolter, Irving F. Foote, Nancy Nersessian, Larry J. Rubin, Jay P. Telotte, Maxine T. Turner; *Associate Professors*—Philip Auslander, Edith H. Blicksilver, Wister J. Cook, Sandra Corse, Sarah E. Jackson, Matthew C. O'Brien, Sara Putzell-Shoemaker, Carol Senf, Robert E. Wood; *Assistant Professors*—Anne Balsamo, Carol Colatrella, Richard J. Corbin, William Evans, Blake Leland, Rebecca Merrens, Joseph Petraglia-Bahri, Alan Rauch; *Visiting Assistant Professors*—Matthew Causey, Terry Harpold, Daryl Ogden; *Brittain*

*Fellows*—Martha Henn, Lissa Holloway-Attaway, Juliana M. Kubala, Ryan Lankford, Don Latham, Mark Ledden, Kim Loudermilk, Adrienne L. McLean, Carole Meyers, Dean Rader, Michael Saunders, Donna J. Smith, John P. Stewart, Alice Weber, Kim Whitehead, Patricia Worrall; *Director of DramaTech*—Greg Abbott; *Coordinator of Continuing Education*—Dennis Backus.

## General Information

The School of Literature, Communication, and Culture provides a challenging setting to study and practice writing in a range of scientific, technological, and cultural environments. Besides offering courses that satisfy the Institute humanities requirement, LCC has five certificate programs that allow students to cluster courses and earn the equivalent of a minor. For students who wish to pursue an undergraduate major, the School offers an undergraduate Bachelor of Science degree in Science, Technology, and Culture (STAC).

The School embodies Tech's commitment to provide students with a broad education for a multicultural world that has been shaped by science and technology. The study of literature encompasses not only written achievement recognized by a special community but an array of social, scientific, and technical literature necessary for the critical study of communication and culture in a national and world setting. Communication not only is concerned with the strategies of oral and written presentation, but also involves its psychological, cultural, and visual aspects. Culture embraces both objects that have come to merit special study within civilization and the conventions and practices of different social linguistic groups. Through a faculty committed to integrating teaching and research, the School contributes to the research environment of the Ivan Allen College and the Institute and contributes to the multidisciplinary resources within and beyond the Institute.

## Certificates

The School offers five certificate programs: American Literature; Drama and Film; Science, Technology, and Culture; Technical and Business Communication; and Western Traditions.

The American Literature certificate courses investigate how American cultural events,

historical movements, and philosophies were influenced by the national literature.

Drama and Film offers courses on specific periods, authors, social issues, and techniques in the history of these two related media.

STAC courses examine the structure of understanding within engineering, science, and the humanities. From historical and theoretical perspectives, the courses ask what relations have existed between prevailing scientific theories, literary forms, and intellectual perspectives that constitute a society's way of knowing the world.

Technical and Business Communication offers courses that teach the principles of effective communication and give practice in applying them in the practical form of briefings, speeches, memoranda, technical reports, and other standard forms of technical communication.

Western Traditions offers courses in Western world literature including historical surveys and the study of specific literary and cultural traditions.

## Bachelor of Science in Science, Technology, and Culture (STAC)

The B.S. in Science, Technology, and Culture offers students an opportunity to study the ways science and technology have participated in the constitution of both western and nonwestern cultures. The program has three primary objectives: 1) to provide students with the critical and analytical skills to negotiate their way among the overlapping domains of science, technology, and culture; 2) to provide students with the communication skills necessary to bridge the gap between the increasingly specialized discourse of science and technology and the needs and demands of the public; and 3) to provide students with a broadly based understanding of the common heritage of literature, science, and technology within the history of western and nonwestern civilization.

## Requirements for the Bachelor of Science in STAC

Basic Distribution	89 - 91 hours
Major Hours	54 hours
Non-major Cluster	15 hours
Free Electives	at least 30 hours
<b>TOTAL</b>	<b>190 hours</b>
<b>Basic Distribution:</b>	<b>91 hours</b>
Mathematics	15 hours
Science and Engineering	
— Two sequences in the biological or physical sciences	20-22 hours
— Engineering-oriented course(s) selected from an approved list	6 hours
Humanities and Fine Arts	
— Includes English 1001-1002 plus other English courses from approved list	18 hours
Social Sciences	
— Includes POL 1251 or 3200 and HIST 1001 or 1002 plus other courses from approved list	18 hours
Other requirements	
— An internationally oriented course selected from an approved list	3 hours
— Physical education	3 hours
— PST 1126-7	6 hours
<b>TOTAL</b>	<b>89-91 hours</b>

### Mathematics

The mathematics requirement may be satisfied by one of the following sequences: MATH 1507-8-9; MATH 1711-12-13; MATH 1507-8, and 1711. Students will not receive credit for both MATH 1712 and 1507 or MATH 1713 and 1508.

### Science and Engineering

Students must complete two sequences in the biological or physical sciences, for a total of 20-22 hours. At least one sequence (10-12 hours) must be a laboratory science (typically BIOL 1110-1-2; CHEM 1101 and 1102 or 1112; or

PHYS 2021-2). Students who take the biology or chemistry lab sequence can take PHYS 2011-2-3 for their second sequence. Additionally, all students will take a minimum of six hours in engineering electives selected from an approved list.

### **Humanities**

Students are required to complete 18 hours of course work in the humanities, including ENGL 1001 and 1002 plus 12 hours of English courses in excess of those STAC courses designated for the major.

### **Social Sciences**

Students are required to complete 18 hours of course work in the social sciences, including POL 1251 or 3200, HIST 1001 or 1002, and 12 additional hours of social science electives. Neither the 12 hours of non- LCC STAC electives nor PST 1126-7 can be used to fulfill the social sciences requirement.

### **International Course**

Each student must take a minimum of one three-hour course that is internationally oriented. This requirement can be satisfied by either an INTA course or a foreign language course.

### **Health and Performance Sciences**

No student may receive credit for more than three hours of physical education towards the degree. See "Department of Health and Performance Sciences" in this catalog for physical education requirements and approved courses.

### **Other Lower Division Courses**

All STAC majors must take PST 1126 and 1127.

### **Non-major Cluster**

All students must take a 15-hour concentration from a unit other than Literature, Communication, and Culture. This requirement may be met by an existing certificate program or by a 15-hour concentration approved by the School and meeting the following requirements: 1) 12 hours must be over and above the required courses and distribution requirements in the course curriculum; 2) all courses must either be in one discipline or be part of an interdisciplinary cluster grouped around a particular topic; and 3) the

cumulative average for the concentration must be at least 2.0.

### **Designated Courses in the Major**

All students must take 27 hours of STAC courses: English 2301 plus 24 hours chosen from the following 3-hour courses, with at least nine hours both at the 3000- and the 4000-level: ENGL 3340, 3341, 3342, 3343, 3344, 3345, 4301, 4302, 4303, 4304, 4305, 4310. Students can, with School approval, use up to 6 hours of Special Topics courses towards these 24 hours. In addition, students must take 9 hours of communication courses chosen from the following: ENGL 3010, 3015, 3020, 4020, or approved alternatives.

### **Senior Thesis**

All students must take 6 hours of senior thesis courses (ENGL 4380 and 4390). Normally these courses are taken in the student's final two quarters. A student must have a contract signed by the thesis adviser to receive permission to register for ENGL 4380 and 4390.

### **Science- and Technology-related Electives Outside LCC**

Students must take 12 hours STAC electives in Ivan Allen units outside of LCC. These electives should be chosen from an approved list of relevant courses.

### **Free Electives**

Each student must have accumulated at least 190 hours of credit toward the Bachelor of Science degree in Science, Technology, and Culture. Therefore, in addition to the requirements listed above, the student must take a sufficient number of elective courses either within or outside LCC to reach 190 hours. Typically, this will be in the range of 30 hours.

## Bachelor of Science in Science, Technology, and Culture Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Math</b>	5-0-5	5-0-5	5-0-5
<b>Lab Science</b>	X-X-4	X-X-4	X-X-4
<b>ENGL 1001-2</b>			
Analysis of Literature and Language	3-0-3	3-0-3	.....
<b>Humanities Elective</b>	.....	.....	3-0-3
<b>HIST 1001/1002</b>			
History of U.S. I, II	3-0-3	.....	.....
<b>POL 1251/3200</b>			
Government of U.S./ American Constitution	.....	3-0-3	.....
<b>Social Sciences Course</b>	.....	.....	3-0-3
<b>Health and Performance Sciences</b>			
<b>Course Requirements</b>	X-X-3	.....	.....
<b>TOTALS</b>	X-X-18	X-X-15	X-X-15

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Lab Science</b>	X-X-5	X-X-5	.....
<b>Engineering Electives</b>			
<b>Approved List</b>	.....	X-X-3	X-X-3
<b>ENGL 2301</b>			
Introduction to Literature and Science	3-0-3	.....	.....
<b>Humanities Electives</b>	3-0-3	3-0-3	3-0-3
<b>ENGL 33XX</b>			
STAC Period Course	.....	.....	3-0-3
<b>International Course</b>			
<b>Approved List</b>	.....	.....	3-0-3
<b>PST 1126-7</b>			
Science, Technology, and Human Value	3-0-3	3-0-3	.....
<b>Social Science Electives</b>	3-0-3	3-0-3	3-0-3
<b>TOTALS</b>	X-X-17	X-X-17	X-X-15

### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Non-major Cluster</b>	X-X-3	X-X-3	X-X-3
<b>LCC Communication Courses</b>	3-0-3	3-0-3	.....
<b>ENGL 33XX</b>			
STAC Period Courses	3-0-3	.....	3-0-3
<b>ENGL 43XX</b>			
STAC Issue Courses	.....	3-0-3	3-0-3
<b>STAC Electives</b>			
<b>Approved List</b>	3-0-3	3-0-3	.....
<b>Free Electives</b>	X-X-6	X-X-3	X-X-6
<b>TOTALS</b>	X-X-18	X-X-15	X-X-15

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Non-major Cluster</b>	X-X-3	.....	X-X-3
<b>ENGL 33XX</b>			
STAC Period Course	3-0-3	.....	.....
<b>ENGL 43XX</b>			
STAC			
Issues Course	3-0-3	3-0-3	.....
<b>LCC Communication Course</b>	.....	.....	3-0-3
<b>ENGL 4380-90</b>			
Senior Thesis	.....	3-0-3	3-0-3
<b>STAC Electives</b>			
<b>Approved List</b>	3-0-3	3-0-3	.....
<b>Free Electives</b>	X-X-3	X-X-6	X-X-6
<b>TOTALS</b>	X-X-15	X-X-15	X-X-15

Total Credit Hours Required for Graduation=190

## Advanced Placement

Students with a score of 4 on the CEEB Advanced Placement Examination in Composition and Literature or Language and Composition receive credit for English 1001.

Students with a score of 5 on the CEEB Advanced Placement Examination in Composition and Literature or Language and Composition receive credit for English 1001 and 1002.

Students with a score of 700 (or higher) on the English Achievement Test receive credit for English 1001.

## Regents' Examination

This exam measures proficiency in reading and English composition. A passing score is required by the Board of Regents for graduation. Students who have not passed the exam by the time they have completed 50 hours of degree credit must schedule ENGL 0020 in their following quarter in residence. In addition to ENGL 0020, the School offers short workshops in preparation for the exam, consultation with those who have failed, and an appeal system for those who fail.

## Master of Science in Information Design and Technology

The M.S. in Information Design and Technology educates specialists in electronically mediated communication. Its graduates are employed as multimedia and hypermedia specialists and project managers in educational and not-for-profit institutions, government, corporations, and

multimedia production firms.

The program is physically located in LCC's Center for New Media Education and Research which provides extensive computer and video facilities. IDT students also participate in Georgia Tech's Center for Graphics, Visualization, and Usability which provides high-end computer laboratories and Usability laboratories.

The IDT program is open to students with undergraduate backgrounds in the humanities, social sciences, management, physical and computer science, and engineering. The program offers:

- extensive course work in the cultural, cognitive, social, and rhetorical aspects of communication
- laboratory work in video production and computer applications
- development of a sub-specialty in either a communications application, such as marketing, management, or education, or a body of related knowledge such as cognitive science, networking or Usability testing
- an internship or co-op for students without professional communications experience in electronic communication
- the option of completing either a traditional academic thesis or a practical communications project.

## Courses of Instruction

**ENGL 0020. Writing the Impromptu Essay**  
3-0-3.

Special attention given to developing basic skills in writing for students who need additional preparation for college-level English. Lectures, exercises. Cannot be counted for credit toward graduation.

**ENGL 1001-2. Analysis of Literature and Language I, II**  
3-0-3 each. Freshman year. Courses must be taken in numerical sequence and are prerequisite to all other English courses.

A study of literary and expository texts to determine rhetorical strategies. Intensive writing practice in these strategies, with emphasis on organizing ideas, evidence, and readership in paragraph sequences and then on forecasting and monitoring paragraph sequences.

**ENGL 2004. Survey of English Literature**  
3-0-3. Prerequisites: ENGL 1001-2.

A study of English literature since Shakespeare, with emphasis on significant figures and their works. Lectures, reports, papers, quizzes.

**ENGL 2101. Introduction to Drama and Film**  
3-0-3. Prerequisites: ENGL 1001, 1002.

A study of dominant themes and concerns of world literature through the analysis of selected plays, screenplays, and films.

**ENGL 2201. Introduction to American Literature**  
3-0-3. Prerequisites: ENGL 1001-2.

Major themes of optimism, guilt and doubt, and nature in the development of American literature.

**ENGL 2301. Introduction to Literature and Science**  
3-0-3. Prerequisites: ENGL 1001-2.

Challenges the assumptions in conventional understandings of the relations among science, technology, and literature.

**ENGL 2401. Introduction to the Western Tradition in Literature and Art**  
3-0-3. Prerequisites: ENGL 1001-2.

Explores major ideas of the Western humanities as revealed in ancient and modern literary masterpieces.

**ENGL 3006. The English Language**  
3-0-3. Prerequisites: ENGL 1001-2.

Study of the origin of the English language, its relation to other languages, and its differentiation and development into modern English and American.

**ENGL 3010. Issues in Professional Communication**  
3-0-3. Prerequisites: ENGL 1001-2. Does not carry humanities credit.

Introduces major issues in technical communication, including readability theory, audience analysis, documentation techniques, and the principles of document design through examples of professional writing. Taught as lecture/workshop.

**ENGL 3015. Public Speaking**  
3-0-3. Prerequisites: ENGL 1001-2. Normally taken by juniors and seniors. Does not carry humanities credit.

Instruction in the basic principles of effective public speaking, with emphasis on practice and criticism. The course is conducted as a laboratory.

**ENGL 3020. Technical Writing**  
3-0-3. Prerequisites: ENGL 1001-2. Does not carry humanities credit. Junior or senior year.

Focuses on the technical report. Includes preliminary instruction in letter and memoranda writing.

**ENGL 3037-8-9. Acting and Producing the Play I, II, III**  
0-3-1 each.

Participation in DramaTech production through acting or crew work: set design, publicity, lighting, make up, etc.

**ENGL 3051. Chaucer I**  
3-0-3. Prerequisites: ENGL 1001-2.

Introduction to the poetry of Chaucer in Middle English. Major emphasis on the study of *The Canterbury Tales*.

**ENGL 3056. Joyce**  
3-0-3. Prerequisites: ENGL 1001-2.

A study of the works of James Joyce, with particular emphasis on Joycean techniques of fiction as developed in *Ulysses* and other selected works.

**ENGL 3058. Contemporary Drama**  
3-0-3. Prerequisites: ENGL 1001-2.

An analytic survey of prominent playwrights and trends in contemporary drama. Lectures, reports, collateral reading, quizzes.

**ENGL 3059. Contemporary Fiction**

3-0-3. Prerequisites: ENGL 1001-2.

An analytic study of prominent writers and trends in contemporary fiction. Lectures, reports, collateral reading, quizzes.

**ENGL 3072. The Civil War in Literature**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

A study of selected works of literature dealing with the American Civil War, with emphasis on the relation of history and literature.

**ENGL 3076. Faulkner**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

A study of selected works of William Faulkner, with particular emphasis on major themes and the nature of his narrative art.

**ENGL 3081-2-3-4-5-6. Seminars in Literature**

3-0-3 each. Prerequisites: ENGL 1001-2.

Intensive study of individual writers, movements, periods or themes in literature, with the purpose of developing knowledge in depth, critical independence, and expository skill.

**ENGL 3103. Greek and Roman Drama**

3-0-3. Prerequisites: ENGL 1001-2, 2101.

Greek and Roman drama in context. The shift from epic to tragic world view and the separation of comic from heroic through study of Homer, Aeschylus, Sophocles, Euripides, Aristophanes, Terence, Plautus, Seneca.

**ENGL 3131. The Narrative Art of Film**

3-0-3. Prerequisites: ENGL 1001-2, 2101.

Introduction to major forms of film narrative and to principles used in analyzing and understanding cinematic storytelling.

**ENGL 3132. Film Genres**

3-0-3. Prerequisite: ENGL 2101.

Students examine specific film genres, such as the Western and the Musical to establish the concept of "genre" and principles of analysis.

**ENGL 3133. Film History I**

3-0-3. Prerequisite: ENGL 2101.

Introduces students to film history from its origins to the World War II era, examining major film movements, figures, and technological developments.

**ENGL 3134. Film History II**

3-0-3. Prerequisite: ENGL 2101.

Studies modern post World War II cinema, examining major directors, foreign film movements, changes within Hollywood, and new technologies.

**ENGL 3151. Shakespeare: Comedy and History**

3-0-3. Prerequisites: ENGL 1001-2, 2101.

Focuses on Shakespeare's methods and on the concern comedy and history plays have for society as a whole. Major works of Shakespeare's contemporaries are studied as appropriate.

**ENGL 3152. Shakespeare: Tragedy and Romance**

3-0-3. Prerequisites: ENGL 1001-2, 2101.

Focuses on Shakespeare's methods and on the theme of the suffering individual, sacrificed and triumphant. Major works of Shakespeare's contemporaries are studied as appropriate.

**ENGL 3161. Science Fiction**

3-0-3. Prerequisites: ENGL 1001-2.

Study of selected works of science fiction, with special emphasis on the relationship of their ideas to those of mainstream fiction, science, politics, and history. Seminars, reports, papers.

**ENGL 3162. Television Narrative**

3-0-3. Prerequisite: ENGL 2101.

Introduces various methods for close analysis of television programs as social, narrative, and non-narrative texts.

**ENGL 3165. Interpretation of Performance**

3-0-3. Prerequisite: ENGL 2101.

Focuses on the interpretation of diverse contemporary performances, including theatre, stand-up comedy, and performance art.

**ENGL 3181. Social Issues in Drama**

3-0-3. Prerequisites: ENGL 1001-2, 2101.

Brings a concern with theme or issue to bear on a collection of plays chosen for their social context as well as their aesthetic achievement.

**ENGL 3201. American Fiction**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

Focuses on novels that reflect American reactions to materialism and idealism, to individual freedom and social responsibility, and to the continuing struggle for the American Dream.

**ENGL 3203. American Drama**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

Treats a wide range of typically American themes and motifs in the work of America's major dramatists. Themes range from the moral consequences of Puritan repression to the conflict between materialism and idealism.

**ENGL 3205. American Poetry**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

Treats theses such as the Puritan outlook, American optimism, and the American response to nature as these themes are presented by nineteenth- and twentieth-century poets.

**ENGL 3221. Major Figures in 19th-century American Literature**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

Concentrates on the works of Poe, Emerson, Hawthorne, Melville, and other writers in the American Renaissance.

**ENGL 3225. The Southern Renaissance**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

Investigates this major 20th-century literary movement, which treated the history of the South in poetry, essays, and novels.

**ENGL 3227. Contemporary Southern Literature**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

Examines the ways contemporary Southern writers such as Eudora Welty and Alice Walker view the South, its people, changing values, and social issues.

**ENGL 3251. Hemingway and His Contemporaries**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

Examines the works of Ernest Hemingway and other major writers of the 1920s as they dramatize the shattering effect of World War I and offer perspectives on the modern world that emerges in the postwar years.

**ENGL 3340. Writers in the Age of Ptolemy**

3-0-3. Prerequisite: ENGL 2301.

Examines seminal works in the definition and transmission of science and technology within Greek, Arab, and Latin settings from Presocratics to Renaissance Humanists.

**ENGL 3341. Writers in the Age of Galileo**

3-0-3. Prerequisite: ENGL 2301.

Examines the changing views of nature and language in the literature, science, and philosophy of the 16th and 17th centuries.

**ENGL 3342. Writers in the Age of Newton**

3-0-3. Prerequisite: ENGL 2310.

Considers the imaginative reformulation of the internal and external world urged by Newton's natural philosophy.

**ENGL 3343. Writers in the Age of Darwin**

3-0-3. Prerequisite: ENGL 2310.

Studies the cultural and scientific forces that gave rise to and that follow from Darwin's evolutionary paradigm.

**ENGL 3344. Writers in the Age of Freud and Einstein**

3-0-3. Prerequisite: ENGL 2310.

Pursues the roles of uncertainty and identity in scientific and literary modernism.

**ENGL 3345. Writers in the Age of Postmodern Science**

3-0-3. Prerequisite: ENGL 2301.

Explores the relations between information technology, nonlinear physics, and the art, literature, and culture of postmodernism.

**ENGL 3401-2. The Western Traditions I, II**

3-0-3. Prerequisite: ENGL 1001-2.

Great works of ancient and modern literature representing the dominant traditions of Western civilization, the classical and the Judeo-Christian. Courses need not be taken in sequence.

**ENGL 3411-2. Arts and Ideas I, II**

3-0-3. Prerequisite: ENGL 1001-2.

Major ideas of Western culture expressed in literature and other art forms—painting, sculpture, architecture, and music. Courses need not be taken in sequence.

**ENGL 3461. The Old Testament in the Western Tradition**

3-0-3. Prerequisites: ENGL 1001-2.

Examines selected Old Testament literature, with special emphasis on the continuing efforts to define deity, society, and self.

**ENGL 3462. The New Testament in the Western Tradition**

3-0-3. Prerequisites: ENGL 1001-2.

Examines selected New Testament literature, with special emphasis on the continuing efforts to define deity, society, and self.

**ENGL 3483. The Concept of Humanism**

3-0-3. Prerequisites: ENGL 1001-2.

Examines the celebration of the place of the individual in the cosmic order in representative literary and visual artists from the Renaissance to the 20th century.

**ENGL 3501. Poetry Writing**

3-0-3. Prerequisites: ENGL 1001-2.

Intensive work in the composition of poetry. Conducted as a seminar/tutorial.

**ENGL 3502. Fiction Writing**

3-0-3. Prerequisites: ENGL 1001-2.

Intensive work in composition of fiction. Conducted as a seminar/tutorial.

**ENGL 3786. The Immigrant Experience**

3-0-3. Prerequisites: ENGL 1001-2, HIST 1001 or 1002.

The history and literature of immigrant/ethnic groups such as English, Blacks, Irish, Germans, Asians, southern and eastern Europeans, and Hispanics; exploring Old World reasons for emigrating, New World reactions, assimilation, bigotry, restrictive immigration policies, the Second World War relocation camp experience, alienation, the American Dream fulfilled. Lectures and papers.

**ENGL 3881-2-3. Special Topics in the Western Tradition**

3-0-3 each. Prerequisites: ENGL 1001-2, 2401.

Study of special topics of current interest in Western literature, art, culture, and ideas.

**ENGL 4015. Advanced Public Speaking in Business and Industry**

3-0-3. Prerequisites: ENGL 3015, 3020. Does not carry humanities credit.

Focuses on oral technical briefings and the dynamics of panel and committee leadership. Practice in the use of visual aids in oral presentation.

**ENGL 4020. Advanced Technical Writing**

3-0-3. Prerequisites: ENGL 1001-2, 3020. Does not carry humanities credit.

Applies principles of document design, of readability, and of audience analysis to the writing of longer technical documents, such as proposals, feasibility studies, and scientific articles. Seminar.

**ENGL 4037-8-9. Acting and Producing the Play IV, V, VI**  
0-3-1 each. Prerequisites: ENGL 3037-8-9.

Participation in DramaTech productions through acting or crew work: set design, publicity, lighting, make-up, etc.

**ENGL 4083. Current Issues**

3-0-3. Prerequisites: ENGL 1001-2.

Intensive study of works of modern literature that treat selected issues of concern.

**ENGL 4301. Metaphor and Narrative**

3-0-3. Prerequisite: ENGL 2310.

Stresses the analysis and interpretation of narrative and figurative language in literary and scientific texts.

**ENGL 4302. Topics in Science, Technology, and Values**

3-0-3. Prerequisites: ENGL 2310.

Analyzes the rhetorical and logical structures of verbal and visual representations of our environment through close study of texts, paintings, photographs, and maps.

**ENGL 4303. Analysis of Scientific Discourse**

3-0-3. Prerequisite: ENGL 2310.

Analyzes written and oral discourse in research and development, proposals, laboratory notes, marketing articles, and journal articles. Stresses cognitive and social aspects of team research. Does not carry humanities credit. Counts toward Technical Communications Certificate.

**ENGL 4304. Science, Technology, and Ideology**

3-0-3. Prerequisite: ENGL 2301.

Takes up recent work in theories of ideology to explore the ways in which questions of ideology are both concealed and made manifest in the discourse and practices of science, technology, and culture.

**ENGL 4305. Science, Technology, and Gender**

3-0-3. Prerequisite: ENGL 2301.

Considers recent work in theories of gender to explore the ways in which questions of gender are both concealed and made manifest in the discourse and practices of science, technology, and culture.

**ENGL 4310. Science, Technology, and Communication**

3-0-3. Prerequisite: ENGL 2301.

Treats both current and historical relations among science, technology, and communication as manifested in particular thematic, disciplinary, or topical issues.

**ENGL 4380. Senior Thesis Research**

Prepares students for writing senior thesis through faculty-directed independent research.

**ENGL 4390. Senior Thesis**

Allows students to complete and be examined on their required senior thesis.

**ENGL 4755. Sex Roles: Their Development and Cultural Influence**

3-0-3. Prerequisites: ENGL 1001-2.

Psychological principles, legal facts, and literary explanations are integrated in an examination of the roles of

men and women from three time perspectives: historical, current, and future. Readings, lectures, discussions, and invited panelists will be utilized.

**ENGL 4801-11-21. Special Topics**

1-0-1. Prerequisite: consent of the School.

Study of special topics of current interest in the humanities.

**ENGL 4803-13-23. Special Topics**

3-0-3. Prerequisites: ENGL 1001-2.

Study of special topics of current interest as reflected in selected literary works.

**ENGL 4832. Special Topics in Film**

3-0-3. Prerequisites: ENGL 1001-2, 2101.

Examines in depth a theoretical issue in film criticism.

**ENGL 4833. Special Topics in American Literature**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

Study of special topics of current interest.

**ENGL 4842. Special Topics in Drama**

3-0-3. Prerequisites: ENGL 1001-2.

Intensive analysis of selected plays, with emphasis on the artistic excellence and significance of the works in the development of modern scientific and philosophical attitudes.

**ENGL 4843. Special Topics in Southern Literature**

3-0-3. Prerequisites: ENGL 1001-2, 2201.

Study of special topics of current interest.

**ENGL 4901-2-3-4. Special Problems**

Credit to be arranged. Prerequisite: consent of the School. Does not carry humanities credit.

Study of specialized aspects of literature and language selected on basis of current interest.

**ENGL 6023. Seminar in Technical Communication**

3-0-3. Prerequisite: graduate standing or consent of School.

Series of intensive writing and editing projects for graduate students who need to communicate technical information effectively.

**LCC 6000. Computer Software Workshop**

0-3-1.

Introduction to and practice with the basic software required in a communications program, including word processing, document design, graphics, and bibliographic data base of software.

**LCC 6001. Communications from a Rhetorical Perspective**

3-0-3.

An introduction to concepts of rhetorical theory and their application to technical and organizational settings.

**LCC 6002. Communication from a Social and Organizational Perspective**

3-0-3.

An introduction to applications of social and organizational research and theory to practical problems of communication.



**LCC 6003. Communications from a Cognitive****Perspective**

3-0-3.

Introduction to the role of cognitive science in the study of communication. The course will follow selected problems along several lines of argument.

**LCC 6004. Communication from a Historical and Cultural Perspective**

3-0-3.

An introduction to how technical communication is part of specific cultural and historical contexts and helps define and structure those contexts.

**LCC 6101. Document Design**

3-0-3.

An introduction to the design of technical and organizational documents with special concern for the functional rhetoric of document design.

**LCC 6102. Graphic Design**

3-0-3.

An introduction to the principles of graphic design and the practice of integrating graphic elements into documents.

**LCC 6103. Multimedia Design**

3-0-3.

Demonstrate how to integrate text, sound, and graphics to inform and persuade. Provides methods for determining and resolving rhetorical, technical problems in multimedia production.

**LCC 6104. Video Production**

3-0-3.

This course teaches video scripting, shooting, and editing. Each student produces a video project related to his/her own area of research.

**LCC 6105. Collaboration and Groupware**

3-0-3.

An investigation of the collaborative processes of production in institutional and corporate settings in light of research and theory of group interaction.

**LCC 6106. Interviewing and Information Gathering**

3-0-3.

An examination of electronic and interpersonal tools of data gathering and information location; the processes by which that information is integrated into writing.

**LCC 6107. Quantitative Research Methods**

3-0-3.

Introduction to quantitative methods in communication research. Basic research design issues, basic statistical concepts and techniques, and computer packages for statistical analysis.

**LCC 6201. Policy Manuals**

3-0-3.

Provides student with practice in designing documents commonly used in industry.

**LCC 6202. Project Proposals and Reports**

3-0-3.

Provides student with practice in designing documents commonly used in industry.

**LCC 6203. Documentation**

3-0-3.

Provides student with practice in documenting communications commonly used in industry.

**LCC 6204. Risk Communication**

3-0-3.

Focuses on the role of communication in risk assessments. Explores theoretical and practical issues in designing risk communication strategies.

**LCC 6205. Science, Technology, and the Public**

3-0-3.

Explores the role of mass communication in cultivating public conceptions of science and technology, with special attention to science journalism.

**LCC 6206. Communication within Engineering Organizations**

3-0-3.

Study of communication theory and theory of organizational behavior as they apply to engineering organizations. Practice in applying these skills in the design of reports.

**LCC 6207. Communication in Government Settings**

3-0-3.

Discussion of and practice in dealings with the special rhetorical problems that arise in the social/political context of government settings.

**LCC 6208. International Communication**

3-0-3.

Considers socio-cultural differences, differences in communication systems and situation-specific conditions that influence the dynamics of international communication.

**LCC 6301. Social Organization in Communication**

3-0-3.

Seminar topics include: cognition and communication, legal and corporate constraints, text evaluation, international and intercultural communication, and social organization.

**LCC 6302. Cultural Theory of Communication**

3-0-3.

Applies 20th century theories of culture and history to problems of technical communication.

**LCC 6303. Gender Issues in Communication**

3-0-3.

A seminar that enables students to address the ways that gender concerns impact on organizations and their communication strategies.

**LCC 6304. Topics in Rhetorical Theory**

3-0-3.

Exploration of specific rhetorical theories or theories with rhetorical implications.

**LCC 6305. Evaluating Text Effectiveness**

3-0-3.

An examination and critique of standard usability measures and suggestions for their use in comprehensive document testing plans.

**LCC 6306. Discourse Structures**

3-0-3.

A study of major contemporary theories of discourse structure.

**LCC 6307. Language Theory**

3-0-3.

A study of major contemporary theories of language and discourse from the Saurruean revolution to the present.

**LCC 6800. Project Paper**

6-0-6. Prerequisite: consent of School.

Permits credit for project paper completed as part of the non-thesis option for the M.S.

**LCC 7000. Master's Thesis**

To be arranged. Prerequisite: consent of School.

Permits credit for the thesis paper completed as part of the thesis option for the M.S.

**LCC 8100-10-20-30-40. Special Topics**

1-0-1 to 5-0-5 respectively.

Special topics designed to permit students and professor to pursue a specialized interest not treated in the offerings of the School.

**LCC 8600-10-20-30-40. Special Projects**

1-0-1 to 4-0-4 respectively.

Study of specialized aspects of communication.

**LCC 8997. Teaching Assistantship**

To be arranged.

For graduate students holding teaching assistantships.

**LCC 8998. Research Assistantship**

To be arranged.

For graduate students holding research assistantships.

*Professor*—Naresh K. Malhotra; *Director of International Center for Continuous Quality Improvement and Associate Professor*—Soumen Ghosh; *Hal and John Smith Chair of Entrepreneurship and Small Business Management and Associate Professor*—Jeffrey G. Covin; *Director of the DuFree Center for Entrepreneurship and New Venture Development and Assistant Professor*—Scott Shane; *Thomas R. Williams Chair in Finance and Professor*—Cheol Eun; *Regents' Professors Emeritus*—Sherman F. Dallas, Robert E. Green; *Professors*—Philip Adler, Jr., Terry C. Blum, Fred C. Allvine, Robert W. Carney (retired), Cheryl Gaimon, Charles E. Gearing (retired), Robert G. Hawkins, David M. Herold, Ferdinand K. Levy, Roderick F. O'Connor (retired), Leonard J. Parsons, Richard D. Teach; *Associate Professors*—Yih-Long Chang, Andrew J. Cooper III, Richard L. Daniels, Donald B. Fedor, Narayanan Jayaraman, Jackie Kleiner, Patricia P. McDougall, John R. McIntyre, Dennis H. Nagao, Sridhar Narasimhan, Arnold Schneider, Deborahah Turner; *Assistant Professors*—Daniel Cable, Judith Carlisle, Goutam Challagalla, Jim-Wan Cho, Kenneth Kahn, Ajay Khorana, Sabyasachi Mitra, Jennifer Myatt, Edward Nelling, Robert J. Ramsay, Sue Rhee, Christina Shalley, Milind Shrikhande, Vinod R. Singhal, Krishnamurthy Surysekar, Francis M. Ulgado, Z. Kevin Weng.

**General Information**

The School of Management provides education of the highest quality to prepare students for careers as managers or for additional study at the graduate level. The increasing number of organizations and the growing complexity of modern industrial and governmental operations have resulted in an increased need for college graduates with formal preparation in management and economics.

The School of Management offers two undergraduate programs leading to the Bachelor of Science in Management and the Bachelor of Science in Management Science. Both degree programs follow a common core curriculum with only minor exceptions. However, each program allows sufficient flexibility for the student to develop and follow his or her own educational goals. Both programs are accredited by the American Assembly of Collegiate Schools of Business.

**School of Management**

**Established in 1913 as**

**School of Commerce**

**Location: School of Management**

**755 Ferst Drive**

**Telephone: 404-894-2600/2624**

*Dean*—Arthur Kraft; *Director of Ph.D. Programs and Professor*—Charles K. Parsons; *Director of MSM Program*—Ann Johnston Scott; *Director of Career Services*—Catherine Neiner; *Director of Undergraduate Programs and Professor*—Lloyd L. Byars; *Director of MOT Program and Associate Professor*—William M. Riggs; *Fuller E. Callaway Chair*—Eugene E. Comiskey; *Regents'*

Problem solving takes place in a complex technical, social, and political environment. Students can sharpen the basic tools of management by understanding the natural, life, and social sciences, exploring the environment of the business enterprise, and gaining knowledge of the internal activities of the enterprise itself. Thus, every student is required to take course work in laboratory science, humanities, and the social sciences. Students become familiar with the fundamental activities of management by taking courses such as accounting, economics, information technology, marketing, operations management, finance, and strategic management. The use of computers is an integral part of the School program. Ownership of a personal computer is encouraged, though not required. Graduate work in the School leads to the Master of Science in Management and the Doctor of Philosophy in Management.

The Master of Science in Management (M.S.M.) is an innovative and rigorous two-year, full-time business program with a quantitative, microcomputer base of instruction. Highly qualified candidates from all academic backgrounds enter the program, which is small, intentionally designed to foster teamwork and a closely knit class. To receive the greatest exposure to current management developments, first year M.S.M. students complete a series of core courses that provide the basis of subsequent management education. In the second year, each student chooses electives related to his or her own career objectives. The electives selected may be used to build a concentration area from courses offered within the School of Management or to explore other areas of graduate study at Tech. Courses may be interdisciplinary rather than segmented along traditional departmental lines.

In the summer quarter between the first and second academic years, M.S.M. students work as interns in companies such as Coca-Cola, UPS, and Southern Bell. The internship program provides an opportunity to apply managerial skills in an actual business environment.

The Ph.D. in management is designed to produce graduates who can make scholarly contributions to their chosen fields. Most graduates undertake careers as teachers, scholars, and researchers in academic environments. The doctoral degree also can lead to careers in industry and government.

## **Certificate Programs**

In addition to its degree programs, the School of Management offers students in good standing an opportunity to broaden their areas of expertise or acquire skills or information beyond their major degree requirements. Students who satisfactorily complete this special program will receive a certificate of recognition.

## **Accounting**

One of the certificates offered by the School of Management is in accounting. Students not enrolled in the School of Management are required to pass a minimum of six accounting courses with a grade of *C* or better in each. These courses should include

MGT 2000	Accounting I
or	
MGT 2010	Honors Financial Accounting
MGT 2001	Accounting II
or	
MGT 2011	Honors Cost Accounting
or	
MGT 3020	Accounting Theory and the Analysis and Interpretation of Financial Statements

and three or more electives from the following:

MGT 3010	Taxation
MGT 3021	Topics in Managerial Accounting and Control
MGT 4020	Auditing and Accounting Systems
MGT 4022	Problems in Financial Reporting
MGT 4024	Seminar in Financial Reporting and Control
MGT 4040	Auditing Concepts
MGT 4814	Special Topics in Management

Students in the School of Management may receive a certificate in accounting by earning a grade of *C* or better in eight of the above courses. These should include all three of the first group and any five of the second set.

## **Marketing**

The School of Management also offers a certificate in marketing. Students not enrolled in the School of Management must earn a *C* or better in each marketing course taken and have a grade average

of at least 3.0 for all marketing courses taken. The student must take

MGT 3300	Marketing I
MGT 3301	Marketing II
MGT 3310	Marketing Research

and three additional marketing courses selected from

MGT 3315	Marketing Analysis
MGT 3320	Management Science Models in Marketing
MGT 3325	Product Planning
MGT 3330	Contemporary Issues in Marketing
MGT 4306	Industrial Marketing
MGT 4331	Consumer Behavior
MGT 4335	International Marketing
MGT 4803	Special Topics - taught by one of the marketing faculty
MGT 4901, 2, or 3	Individual Research - under the direction of one of the marketing faculty and designated by the faculty member as a marketing course

In addition, the student will be required to participate in a marketing research project by either providing data or collecting data for a project. This requirement may be waived by a majority opinion of the marketing faculty if no project is available.

For other majors whose degree programs require one course in marketing, six courses (from the list above) including MGT 3301 and MGT 3310, must be completed in addition to the one required course.

For management and management science majors, six courses (from the list above), including MGT 3301 and 3310, must be completed in addition to the two required courses.

The grade requirement and participation requirement are the same for all students.

## Operations Management

The School of Management offers a certificate in operations management. For students **not enrolled** in the School of Management, the certificate will require a minimum of six operations management courses in which a grade

of C or better is earned in each. These courses should include the following:

MGT 3501	Operations Management I
MGT 4352	Operations Management II
MGT 4353	Manufacturing Strategy
MGT 4354	Manufacturing Information Systems

In addition, two or more electives from the following should be taken:

MGT 4355	Measuring Performance in Manufacturing
MGT 4356	Artificial Intelligent Approaches to Operations Management
MGT 4803	Approved Special Topics in Operations Management
ISYE 4035	Project Management Systems Design
ISYE 4039	Quality Control
ISYE 4073	Storage and Distribution Systems Design
ISYE 4756	Technological Forecasting
ISYE 4757	Technology Assessment

Students **enrolled** in the School of Management may receive a certificate in operations management by earning a grade of C or better in seven of the above courses. These courses should include all four in the first set and any three in the second set. (Note that MGT 3501 is required for management majors.)

## Information Systems

The Information Systems Certificate is offered jointly by the College of Computing and the School of Management. (Management students are eligible to obtain this certificate, but computer science students are not.) The focus of the certificate is in data base and data base management applications, but additional course work dealing with the management of software projects and data communications is included as outlined below. Management students must take a minimum of 20 hours of courses from the following set to obtain this certificate. At least nine of these hours must be taken in the School of Management, and at least 11 of these hours must be computer science courses.

1. Students must take the following two courses:  
 CS 2430 Control and Concurrency (3-3-4)  
 CS 3431 Operating Systems and Data Base Management (3-3-4)

2. Students must take one of the following:  
 CS 4351 MIS Methodology (3-0-3)  
 or  
 MGT 3050 Computer-based Management Systems (3-0-3)

3. Students must take at least one of the following:  
 CS 3302 Intro. to Software Engineering (3-3-4)  
 or  
 MGT 3052 Systems Analysis and Design (3-0-3)

4. Students must take at least one of the following:  
 CS 4450 Introduction to Data Base Design (3-0-3)  
 or  
 ISYE 4750 Data Base and Information Systems Development (3-0-3)  
 or  
 MGT 4750 Data Base and Information Systems Development (3-0-3)

5. Students must take one of the following:  
 CS 4301 Software Engineering Project Management (3-3-4)  
 CS 4380 Data Communications (3-0-3)  
 CS/PSY 4753 Human Factors in Software Development (3-3-4)  
 MGT 4051 Expert Systems for Business Applications (3-0-3)  
 MGT 4053 Data Communications for Management (3-0-3)  
 MGT4054 Data Base Applications in Management (3-0-3)  
 MGT 4354 Manufacturing Information Systems (3-0-3)  
 TOTAL: Minimum of 20 hours

It should be noted that several of these courses have prerequisites that are not included in the certificate program. Specifically, CS 1501 and 1502 are prerequisites to the computer science courses. MGT 3501 is a prerequisite to MGT 4354. MGT 2050 is a prerequisite to MGT 3050. CS 4375 is a prerequisite to CS 4380. PSY 3304 is a prerequisite to CS 4753.

### Applying for the Certificate

Students must petition either the College of Computing or the School of Management to obtain the Information Systems Certificate. The certificate application is available in SOM 103 or COC 164. It should be submitted to Ms. Jenny Harris, SOM Room 330. The certificate will be awarded once it has been verified that the requirements for the certificate have been satisfied. Both the dean of the College of Computing and the dean of the School of Management must approve the Information Systems Certificate.

### Finance

The School of Management offers a certificate in finance. This certificate program provides a sound grounding in the area of finance and should be especially useful to students considering careers in finance or business administration as well as to those considering graduate work in finance, law, or business administration. It should also be attractive to students who wish to broaden their education and to understand the business world.

For students enrolled in the School of Management and the School of Economics, the following three courses are required.

MGT 3060	Finance I
MGT 3061	Finance II
MGT 3080	Investments I

The student must then choose four from the following list:

MGT 3065	Topics in Financial Analysis
MGT 3081	Investments II: Options and Futures
MGT 3090	Commercial Bank Management
MGT 4070	International Finance
MGT 4071	Multinational Financial Management
MGT 4803	Special Topics (as taught by the Finance faculty)
MGT 4903	Individual Research (in the area of finance)

A grade of C or higher earned in each of the seven selected courses is required for the student to qualify for the certificate.

For students enrolled in degree programs other

than those for the B.S. in MGT, the B.S. in MSCI, and the B.S. in ECON, the following six courses must be taken.

ECON 2000	Principles of Economics I
MGT 2000	Accounting I
MSCI 3100	Survey of Statistics (ISYE 3028 may be substituted)
MGT 3060	Finance I
MGT 3061	Finance II
MGT 3080	Investments I

The student must then choose three courses from the following list:

MGT 3065	Topics in Financial Analysis
MGT 3081	Investments II: Options and Futures
MGT 3090	Commercial Bank Management
MGT 4070	International Finance
MGT 4071	Multinational Finance Management
MGT 4803	Special Topics (as taught by the Finance faculty)
MGT 4903	Individual Research (in the area of finance)

A grade of C or higher must be earned in each of the nine selected courses in order for the student to qualify for the certificate.

## International Management

The School of Management offers a certificate in international management. The certificate in international management is designed to give Georgia Tech undergraduate students foundational exposure to the concepts and methodologies relating to (a) the current international business patterns and their history, (b) the evolving social, political, legal, and economic environments in home and host countries as they impact on international business operations and strategy, (c) the major economic constructs relating to international flows, (d) the financial/monetary forms and institutions that measure and facilitate international transactions, and (e) the selection of optimal strategies for firms facing international opportunities and constraints.

Course requirements from three areas must be met:

1. Language Requirement. Two years of foreign language at the college level or passing an equivalency test administered by the Modern Language Department.
2. School of Management Core Requirements. Completion of the following courses in the School of Economics and the School of Management is essential:

ECON 2000	Principles of Economics, (Micro), 3-0-3
ECON 2001	Principles of Economics (Macro), 3-0-3
MGT 3150	Management Theory, 3-0-3
MGT 4155	Management of World Business, 3-0-3

3. Certificate Specific Requirements. Completion of the following courses will be required for the certificate:

### A. Economics and Management

ECON 4300	International Economics, 3-0-3
MGT 4070	International Finance, 3-0-3
MGT 4335	International Marketing, 3-0-3
MGT 4160	Management Concepts and Issues in World Business, 3-0-3

### B. International Affairs

1. INTA 3200 International Political Economy, 3-0-3
2. One elective selected from the following set of International Affairs courses:
 

INTA 3410	Soviet Government and Politics, 3-0-3
INTA 3420	Chinese Government and Politics, 3-0-3
INTA 3430	Western European Government and Politics, 3-0-3
INTA 3440	Eastern European Government and Politics, 3-0-3

INTA 3450	Japanese Government and Politics, 3-0-3
INTA 3460	The Developing Nations, 3-0-3
INTA 3470	Latin American Government and Politics, 3-0-3
INTA 4100	Science, Technology, and World Politics, 3-0-3
INTA 4110	International Technology Transfer, 3-0-3
INTA 4120	Technology Transfer and Economic Development, 3-0-3
INTA 4210	International Negotiations, 3-0-3

### Recommended Experiences

- Membership in AIESEC
- Summer overseas or business internship overseas

### Grade Requirements

Students working to receive a Certificate in International Management must earn a C or better in all of the above named courses.

### Process

Students may apply for a Certificate in International Management by submitting a petition (available in SOM 103) to Professor John McIntyre. The petition must include a listing of the courses taken or equivalency tests satisfactorily completed (languages), the grades earned toward satisfying the certificate requirements, and a response to the recommended experience requirements.

### Transfer Credit Policy for Undergraduate Students

Students may transfer courses taken at another accredited institution if the courses are passed with a grade of C or better and are deemed by a School of Management area coordinator to be equivalent to a Georgia Tech course. Such courses will be transferred for the same number of credits as the corresponding School of Management courses provided they are equal to three or more quarter hours of credit.

For institutions within the University System of Georgia, the total number of credit hours transferred for courses within the core

curriculum\* will match the number of credit hours granted by the originating institution. Hours of credit in excess of the corresponding Georgia Tech courses may be transferred only as free electives. For courses taken outside the core curriculum, the rules in the previous paragraph will apply.

Junior- or senior-level courses with three or more quarter hours of credit that have no corresponding School of Management course may transfer as electives in management if they are approved by a School of Management coordinator and the Undergraduate Curriculum Committee.

Because of the difference in the intellectual level of various courses, freshman- or sophomore-level courses taken at other institutions may only be transferred for equivalent freshman- or sophomore-level courses offered at Georgia Tech. (Exception: University System of Georgia schools may transfer the equivalent of MGT 2260, Business Law I, if taught at the freshman or sophomore level. Business Law I has been designated as a core course.)

\* Core curriculum for this purpose may be defined as 2000-level management and management science courses plus Business Law I.

### Pass/Fail Courses

Up to 12 credit hours in the named category of Free Electives may be taken on a pass/fail basis if no nonresident credit has been awarded. (See the table of pass/fail credit hours on p. 30 for more information.)

### Prerequisites

Management and Management Science majors should complete all required 2000 level Management and Management Science courses prior to registering for 3000 and 4000 level Management and Management Science courses.

### Bachelor of Science in Management

Students with a broad interest in all management activities and operating problems should profit from the management degree program. The program builds upon knowledge of the functional, environmental, behavioral, economic, and legal aspects of business and provides analytic and conceptual tools for analyzing complicated

problems. It prepares the student for managerial responsibilities and decision making. The large number of elective hours allows the student to tailor a program to his or her individual educational objectives. Students may take a concentration of electives in areas such as organizational behavior, finance, accounting, computer applications, marketing, industrial relations, and general management.

## Bachelor of Science in Management Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Science Electives</b>	X-X-4	X-X-4	X-X-4
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>ENGL 2101, 2201, 2301, or 2401</b>			
Introduction to Literature or Drama and Film	.....	.....	3-0-3
<b>Social Sciences Electives</b>	3-0-3	3-0-3	3-0-3
<b>Mathematics</b>	5-0-5	5-0-5	5-0-5
<b>Health and Performance Sciences</b>			
(requirements, p. 311)	....	.....	X-X-3
<b>TOTALS</b>	X-X-15	X-X-15	X-X-18

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MSCI 2100</b>			
Survey of Statistics	.....	3-0-3	.....
<b>MGT 2260 or 2261</b>			
Law I or Law II	.....	.....	3-0-3
<b>MGT 2030</b>			
Management Forum	1-0-1	.....	.....
<b>Humanities Electives</b>	3-0-3	3-0-3	3-0-3
<b>ECON 2000-1</b>			
Principles of Economics I, II	.....	3-0-3	3-0-3
<b>MGT 2000-1</b>			
Accounting I, II	3-0-3	3-0-3	.....
<b>MGT 2050</b>			
Management Applications of Information Technology	2-3-3	.....	.....
<b>Non SOM Electives</b>	6-0-6	3-0-3	3-0-3
<b>MSCI 2400</b>			
Analytical Methods in Management I	.....	.....	3-0-3
<b>TOTALS</b>	X-X-16	X-X-15	X-X-15

### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MGT 4101</b>			
Social and Regulatory Environment for Managing Human Resources	.....	.....	3-0-3
<b>MGT 3501</b>			
Operations Management I	.....	3-0-3	.....
<b>MGT 3060</b>			
Finance I	3-0-3	.....	.....
<b>MGT 3300</b>			
Marketing I	3-0-3	.....	.....
<b>Marketing Elective</b>	.....	3-0-3	.....
<b>ENGL 3015</b>			
Public Speaking	.....	.....	3-0-3
<b>MGT 3150</b>			
Management Theory	3-0-3	.....	.....
<b>SOM Electives</b>	.....	3-0-3	6-0-6
<b>MGT 3050</b>			
Computer-based Management Systems	.....	3-0-3	.....
<b>MGT 3061</b>			
Finance II	.....	3-0-3	.....
<b>Non-SOM Elective</b>	6-0-6	.....	.....
<b>Free Elective</b>	.....	.....	3-0-3
<b>TOTALS</b>	15-0-15	15-0-15	15-0-15

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MGT 4100</b>			
Organizational Analysis	3-0-3	.....	.....
<b>Social Sciences Electives</b>	3-0-3	3-0-3	.....
<b>SOM Electives</b>	3-0-3	6-0-6	6-0-6
<b>MGT 4155</b>			
Fundamentals of World Business	3-0-3	.....	.....
<b>Free Electives</b>	3-0-3	6-0-6	6-0-6
<b>MGT 4195</b>			
Integrated Management Problems	.....	.....	3-0-3
<b>TOTALS</b>	15-0-15	15-0-15	15-0-15

**Total Credit Hours Required for Graduation = 184**

### Requirements

#### Mathematics

The mathematics requirement may be satisfied by one of the following sequences: MATH 1711-2-3; MATH 1307-8 and 1711; MATH 1507-8 and 1711; or MATH 1307-8-9 and 2307-8; MATH 1507-8-9 and 2507-8. Students may not receive credit for MATH 1307 and 1712 or 1507 and 1712. Credit may not be received for MATH 1308 and 1713 or 1508 and 1713. Courses must be taken and passed in sequence; concurrent registration for



two or more of these courses is not permitted. Transfer students into the School must consult with the School of Management undergraduate program office to determine their mathematics requirement at the time of transfer.

## **Electives**

### **Science Electives**

A science sequence is required to be selected and completed from among chemistry (10 hours), biology (12 hours), or physics (10 hours).

### **Social Sciences Electives**

Students must complete 18 hours in the social sciences (see p. 33). All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement and part of the total 18-hour requirement.

Psychology courses may be used to fulfill part of the 18 hours in the social sciences (see p. 33 for the allowed psychology courses).

### **Modern Languages Electives**

Students interested in international business are encouraged to take courses in modern languages.

### **Physical Education Elective**

See "Health Sciences Requirement," Department of Health and Performance Sciences p. 311, for freshman physical education requirements. The three-hour requirement can be fulfilled during any quarter of the freshman year.

### **Humanities Electives**

Students are required to complete nine hours of humanities selected from the list of approved humanities courses listed on p. 33 of this catalog. A student electing to use a 1000-level sequence in a modern language must complete the three quarter sequence in the same language in order to receive humanities credit. (Free elective credit granted on the basis of high school study may not be used for humanities credit.) Humanities electives transferred from other institutions may be used to fulfill this nine hour humanities requirement.

### **Non-School of Management Electives**

Students are required to complete 18 hours of non-SOM electives, defined to include any course not taught by the School of Management and Economics or otherwise required by this curriculum. (No more than 12 hours of economics courses may be used in this category.)

### **Marketing Elective**

Students must select an additional marketing course taught by the School of Management.

### **School of Management Electives**

Management or management science courses, not otherwise required, will satisfy this requirement. School of Management electives are required to be either junior or senior 3000- or 4000-level courses and may not be taken on a pass/fail basis. MGT 2260 or 2261 may satisfy School of Management electives.

## **Bachelor of Science in Management Science**

Rigorous analytic and technical decision-making skills are combined with a solid background in management, economics, and policy to respond to challenges organizations face to establish and maintain their competitive position in an international marketplace. In addition to courses in management and economics, the curriculum contains a broad and rigorous set of courses in basic mathematics, mathematical modeling and analysis of application solutions. The program's mathematical underpinnings provide the student with the ability to systematically attack complex problems with the aid of analytic and computer-generated decision-making tools.

First, the fundamentals of management and economics are covered in a broad set of courses. Second, students complete a concentration of courses in the Management of Technology area. These courses focus on problems faced by firms operating in industries characterized by rapid changes in technology (both product and process) and international competition. Third, students complete a specialization of courses chosen to further examine a particular dimension of management theory and application.

Graduates of this program typically obtain employment as staff analysts in industry

(particularly high-tech firms) and government, or in a wide variety of positions where a high degree of analytic ability is required. The program also provides an excellent base for graduate study in management or economics (especially operations management, information systems, management science, and operations research).

## Bachelor of Science in Management Science Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Science Electives</b>	X-X-4	X-X-4	X-X-4
ENGL 1001-2			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
ENGL 2101, 2201, 2301, or 2401			
Introduction to Literature or Drama and Film	.....	.....	3-0-3
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>Social Sciences Electives</b>	3-0-3	3-0-3	3-0-3
<b>Health and Performance Sciences</b>			
(requirements, p. 311)	.....	.....	X-X-3
<b>TOTALS</b>	X-X-15	X-X-15	X-X-18

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 4215/ISYE 3027</b>			
Introduction to Probability	.....	.....	3-0-3
<b>Humanities Electives</b>	3-0-3	3-0-3	3-0-3
<b>MATH 2501, 2, 3</b>			
Calculus w/Linear Algebra, Difference & Differential Equations, Algorithms	3-0-3	3-0-3	3-0-3
<b>ECON 2000-1</b>			
Principles of Economics I, II	3-0-3	3-0-3	.....
<b>MGT 2260 or 2261</b>			
Law I or Law II	.....	.....	3-0-3
<b>MGT 2050</b>			
Management Applications of Information Technology	2-3-3	.....	.....
<b>MGT 2000-1</b>			
Accounting I, II	3-0-3	3-0-3	.....
<b>Social Sciences Electives</b>	.....	.....	3-0-3

### CS 1501

Introduction to Computing	.....	3-3-4	.....
<b>MGT 2030</b>			
Management Forum	1-0-1	.....	.....
<b>TOTALS</b>	15-3-16	15-3-16	15-0-15

### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MSCI 3200-1 or ISYE 3231-32</b>			
Management Science I, II	3-0-3	3-0-3	.....
<b>MGT 3611</b>			
MOT I: External Environment	3-0-3	.....	.....
<b>MGT 3612</b>			
MOT II: Resources Management	.....	3-0-3	.....
<b>MGT 3613</b>			
MOT III: Strategic Management	.....	.....	3-0-3
<b>MATH 4216/ISYE 3028</b>			
Introduction to Statistics	3-0-3	.....	.....
<b>MGT 3050</b>			
Computer-based Management Systems	3-0-3	.....	.....
<b>MGT 4100</b>			
Organizational Analysis	.....	3-0-3	.....
<b>MGT 3060</b>			
Finance	.....	.....	3-0-3
<b>MGT 3300</b>			
Marketing I	.....	3-0-3	.....
<b>MGT 3150</b>			
Management Theory	3-0-3	.....	.....
<b>Free Elective</b>	.....	.....	3-0-3
<b>ENGL 3015</b>			
Public Speaking	.....	.....	3-0-3
<b>MGT 3501</b>			
Operations Management I	.....	3-0-3	.....
<b>ISYE 4044</b>			
Simulation	.....	.....	2-3-3
<b>TOTALS</b>	15-0-15	15-0-15	14-3-15

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MGT 3061</b>			
Finance II	3-0-3	.....	.....
<b>Specialization</b>	3-0-3	6-0-6	6-0-6
<b>MGT 3674</b>			
MOT Seminar I	1-0-1	.....	.....
<b>MGT 3675</b>			
MOT Seminar II	.....	1-0-1	.....
<b>MGT 4352</b>			
Operations Management II	3-0-3	.....	.....
<b>Marketing Elective</b>	3-0-3	.....	.....
<b>MGT 4155</b>			
Fundamentals of World Business	3-0-3	.....	.....
<b>School of Management</b>			

Electives	.....	3-0-3	3-0-3
<b>MGT 4195</b>			
Integrated			
Management Problems	.....	.....	3-0-3
<b>Free Electives</b>	.....	3-0-3	3-0-3
<b>TOTALS</b>	16-0-16	13-0-13	15-0-15

**Total Credit Hours Required for Graduation = 184**

## Requirements

MSCI 3200-1 and ECON 3100 are offered once a year only in quarters listed; thus they are to be taken as listed.

**Prerequisites:** MATH 4216 satisfies the prerequisite for ECON 3100.

## Electives

### Science Electives

A science sequence is required to be selected and completed from among chemistry (10 hours), biology (12 hours), or physics (10 hours).

### Social Sciences Electives

Eighteen hours of electives in the social sciences are required of all students (see p. 33). All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia; HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement and part of the total 18-hour requirement.

Psychology courses may be used to fulfill part of the 18 hours in the social sciences (see p. 33 for allowed courses).

### Physical Education Electives

See "Curricula and Courses of Instruction," Department of Health and Performance Sciences, p. 311, for freshman physical education requirements. The three-hour requirement can be fulfilled during any quarter of the freshman year.

### Marketing Elective

Students must select any marketing course taught by the School of Management.

### Humanities Electives

Students are required to complete nine hours of humanities selected from the list of approved humanities courses on p. 33 of this catalog. A student electing to use a 1000-level sequence in a modern language must complete the three quarter

sequence in the same language in order to receive humanities credit. (Free elective credit granted on the basis of high school study may not be used for humanities credit.) Humanities electives transferred from other institutions may be used to fulfill this nine hour humanities requirement.

### School of Management Electives

Six hours are to be selected from courses taught by the School of Management and not used for other requirements of the MSCI curriculum. School of Management electives are required to be either junior or senior 3000- or 4000-level courses and may not be taken on a pass/fail basis. MGT 2260 or 2261 may satisfy School of Management electives.

### Specialization Electives

For the specialization, the student selects an area of study and courses within that area. Areas of study include economics, finance, marketing, organizational behavior, psychology, accounting, management information systems, production/operations management, computer science, and other areas representing a consistent program of study in a minor area, as approved by your MSCI adviser. Related areas may be combined to yield programs such as economics/finance, finance/accounting, psychology/organizational behavior, marketing/finance, and management information systems/computer science.

## Graduate Programs

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

The M.S.M. program, which is accredited by the American Assembly of Collegiate Schools of Business, provides a professional management education for students with baccalaureate degrees in any discipline. Calculus is the only prerequisite. For students who want to review and sharpen their quantitative and computer knowledge, two-week intensive review courses are offered in calculus, probability, and computer skills prior to the fall quarter.

The M.S.M. program is full time and comprises 27 courses (normally 81 hours), 16 of which are required. These 16 courses form a common core

of knowledge required of all M.S.M. students. The remaining 11 elective courses provide flexibility for students to build competence in one or more concentration areas. This freedom permits each student to fashion a curriculum directed toward individual educational and career goals.

Concentration areas may include accounting, economics, finance, human resource management, information technology for management, international business, marketing, operations management and strategic management, or other graduate courses offered at Georgia Tech.

Entry is in the fall quarter only, and enrollment is strictly full time. The typical course load for first year students is five courses per quarter. Second year students take four classes per quarter. The core is completed in the first academic year. Students with appropriate backgrounds are encouraged to substitute suitable advanced courses for some basic core requirements. Since no graduate courses are offered during the summer, students are encouraged to participate in the School's internship program during the summer between the first and second years of the program. Only one required course is scheduled in the second year so that students can devote most of the year to concentration area(s) and electives.

Applicants to the M.S.M. program should note that supplementary application materials are required by the School of Management in addition to those requested by Georgia Tech's Office of Graduate Studies. Incomplete applications will not be reviewed. M.S.M. application forms, as well as program description materials, may be obtained by writing to the Director of Graduate Admissions, School of Management, Room 212, Georgia Institute of Technology, Atlanta, Georgia 30332, or by calling (404) 894-2604.

The undesigned Master of Science degree program serves students whose educational and career goals may not be best served by the M.S.M. program. Under these circumstances, the student can pursue a specially tailored master's level curriculum that satisfies the American Assembly of Collegiate Schools of Business (AACSB) common body of knowledge requirements and provides a coherent concentration of elective courses chosen

in consultation with an academic adviser. This specialized degree program is designed primarily for students who are admitted to Georgia Tech on approved foreign education programs. Admission to this program must be approved by the Master's Committee of the School of Management prior to enrollment.

The doctoral program in the School of Management is intended for full-time students who will complete their entire doctoral program prior to leaving the campus. Full-time residence in or near Atlanta is expected. The doctoral program is strongly research oriented and emphasizes early and effective involvement in research, with students experiencing considerable personal attention and close interaction with faculty. The Ph.D. program complements and reflects the technological emphasis of the Institute and places considerable weight on learning outside the classroom. The tutorial model is the basic educational model employed throughout the program.

All doctoral students take comprehensive examinations, which include both a general and a special examination. The student becomes a candidate for the degree after successful completion of both exams and the approval of the prospectus of his or her dissertation. On completion of the dissertation, the student must take a final oral examination as prescribed in the general regulations of the graduate division.

Applicants to the doctoral program in management should note that supplementary application materials are required by the School of Management in addition to those required by Georgia Tech's Office of Graduate Studies. Incomplete applications will not be reviewed. Ph.D. application forms, as well as program description materials, may be obtained by writing to the Director of Graduate Admissions, School of Management, Room 212, Georgia Institute of Technology, Atlanta, Georgia 30332, or by calling (404) 894-2604.

## Multidisciplinary Programs

Faculty and graduate students in the School of Management are quite active in two multidisciplinary programs. Some faculty and many students are involved in the Computer Integrated Manufacturing Systems Program (CIMS) see p. 101. This is an opportunity for

graduate study in the integration of design, information and material processing, and management in manufacturing systems. The Management of Technology program (MOT) is a new and developing program which is administered by the School of Management. This program provides an opportunity for students to study the relationship of technology management to the external environment of the firm, resource management in the technological firm, and the technology/strategic management interface.

## Management of Technology Certificate

The MOT Certificate Program is designed for graduate students enrolled in any discipline; however, students entering the program must have a "technical background." This generally will be satisfied by either bachelor's or graduate-level study in engineering, physical sciences, or computer science. In some unusual cases, this requirement may be satisfied by industrial experience of a specifically technical nature. In the design of the program, including the core courses, the project, and the seminars, major emphasis has been placed on the interdisciplinary nature of managing technology in any institutional setting.

Required Courses:		Hours
MOT I	Mgt, ISyE, PubP 6771	3
MOT II	Mgt, ISyE, 6772	3
MOT III	Mgt 6773	3
MOT Project	Mgt, ISyE 6774	3
MOT Seminars(3)	Mgt, ISyE 6775	3
Total Hours		15
Electives*		6
<b>Total Hours for Certificate</b>		<b>21</b>

\* Students in the Ivan Allen College must take their six hours of electives outside their home academic units; other students also are encouraged to take electives outside their home academic units.

MOT I, II, and III comprise a three course sequence which encompasses most of the major topics relevant to the management of technology, organized as follows:

MOT I	Managing Technology: The External Environment
MOT II	Managing Resources of the Technological Firm
MOT III	Strategic Issues in the Management of Technology

The sequence can begin with any one of the three courses, though each course needs to be taken in conjunction with the MOT seminar offered concurrently. The seminar presentations will be coordinated with the topics of the MOT course to provide applications of classroom concepts, to amplify important issues, and to broaden the students' experience with different but relevant topics.

## Program in Statistics

For information concerning the graduate program in statistics, refer to page 157.

### MANAGEMENT

#### MGT 1051. Introduction to Microcomputers I 0-3-1.

Introduction to microcomputers. Covers word processing, office productivity tools, presentation systems, hypertext software, and communications.

#### MGT 1052. Introduction to Microcomputers II 0-3-1.

Introduction to microcomputers is analogous to Microcomputers I, but for a different operating system. Emphasis is on spreadsheets, data base management systems, and communications using the microcomputer.

#### MGT 2000. Accounting I

3-0-3. Prerequisite: sophomore standing.

Provides a general understanding of financial accounting systems and an interpretation of financial reports.

#### MGT 2001. Accounting II

3-0-3. Prerequisite: MGT 2000.

Provides a general understanding of cost accounting systems, with emphasis on the manufacturing situation.

#### MGT 2010. Honors Financial Accounting

3-0-3.

A more intensive and rigorous treatment of topics covered in MGT 2000. Credit is not allowed for both MGT 2000 and MGT 2010.

#### MGT 2011. Honors Cost Accounting

3-0-3.

A more intensive and rigorous treatment of topics covered in MGT 2001. Credit is not allowed for both MGT 2001 and MGT 2011.

#### MGT 2030. Management Forum

I-0-1.

The course covers orientation topics as well as specific management development issues such as ethics, leadership, strategic planning, time management, and enhancement of written and oral communication skills.

**MGT 2050. Management Applications of Information Technology**

2-3-3.

An introduction to management computing, with a focus on the capabilities required for management information systems/decision support systems. Also, students are introduced to spreadsheet and data base applications.

**MGT 2260. Business Law I**

3-0-3.

Development and function of the law, court organization, procedure, and substantive law in contracts, business organizations, and agencies.

**MGT 2261. Business Law II**

3-0-3.

Legal problems encountered in an urban environment with a socioeconomic and political atmosphere, specifically in the areas of consumer problems, bankruptcy, and constitutional law.

**MGT 3010. Taxation**

3-0-3. Prerequisite: MGT 2000.

Business income tax requirements for individuals and the management planning necessitated by various tax alternatives.

**MGT 3020. Accounting Theory and the Analysis and Interpretation of Financial Statements**

4-0-4. Prerequisite: MGT 2001.

Accounting techniques and principles for measuring assets, equities, and earnings of manufacturing and financial corporations. Includes revenue recognition, inventory valuation, accounting theory, etc.

**MGT 3021. Topics in Managerial Accounting and Control**

3-0-3. Prerequisites: MGT 2001 and MSCI 2100.

Advanced topics in managerial reporting and analysis, such as divisional performance measurement, activity-based costing, quality management, budgeting, control, and other issues in internal resource allocation.

**MGT 3050. Computer-based Management Systems**

3-0-3. Prerequisite: MGT 2050.

An introduction to concepts used in the design of management systems relying on computers and information technology.

**MGT 3052. Systems Analysis and Design**

3-0-3. Prerequisite: MGT 3050.

An introduction to the tools, techniques, and methodologies for structured analysis, design, development, and implementation of business systems.

**MGT 3060. Finance I**

3-0-3. Prerequisites: ECON 2000, MGT 2001, and MSCI 2100 or an equivalent statistics course.

Introduction to financial analysis, financial planning, and working capital management.

**MGT 3061. Finance II**

3-0-3. Prerequisite: MGT 3060.

Analysis of firm investment and financing decisions, including capital budgeting, cost of capital, capital structure, and dividend policy.

**MGT 3065. Topics in Financial Analysis**

3-0-3. Prerequisites: MGT 3060 and 3061, MSCI 2100.

Subjects covered include cross sectional and time series, analysis of financial statements, advanced topics in capital asset pricing, predicting systematic risk, predicting and analyzing bankruptcies, mergers, and acquisitions.

**MGT 3080. Investments I**

3-0-3. Prerequisite: MGT 3060.

The theory and practice of security analysis and portfolio management as applied to stocks and bonds.

**MGT 3081. Investments II: Options and Futures**

3-0-3. Prerequisite: MGT 3080.

The second course in a two-part investment sequence. An introduction to options and futures is provided. Concepts of arbitrage and index trading are introduced.

**MGT 3090. Commercial Bank Management**

3-0-3. Prerequisite: MGT 3060 or permission of the instructor.

Contemporary problems and practices of managing banks and related institutions, including asset and liability management, loan and liquidity management, and aspects of regulation.

**MGT 3100. Organizational Development**

3-0-3.

Analysis of the structural development of the organization. Particular emphasis is given to organization-environment interfaces, effectiveness, and efficiency. Managing technology and change.

**MGT 3150. Management Theory**

3-0-3. Prerequisite: ECON 2000.

Provides students with a fundamental management theory matrix essential to the understanding of management, process, and role.

**MGT 3300. Marketing I**

3-0-3. Prerequisite: ECON 2000.

Marketing's role in productive process, basic buyer behavior, market segmentation concepts, the management of marketing activities, environmental influences on marketing management.

**MGT 3301. Marketing Management**

3-0-3. Prerequisite: MGT 3300.

Emphasis on marketing management problems through the process of analysis, planning and control, case analysis, and readings.

**MGT 3310. Marketing Research**

3-0-3. Prerequisites: MGT 3300, MSCI 2100.

Focuses on marketing research principles in defining the problem, developing an approach, and formulating a research design.

**MGT 3315. Marketing Analysis**

3-0-3. Prerequisite: MGT 3300.

The course covers various marketing data analysis techniques. Major marketing implications are drawn through the proper interpretation of data analysis outputs.

**MGT 3320. Management Science Models in Marketing**

3-0-3. Prerequisites: MGT 2050, 3300 and MSCI 2100, 2400.

The use of management science models to solve marketing management problems; application rather than theory is stressed.

**MGT 3325. Product Planning**

3-0-3. Prerequisites: MSCI 2100 and MGT 3300.

Study of the new product development process. Use of market research data and marketing models for product design, test marketing, product positioning, market segmentation, market share estimation, and product portfolio management.

**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 3401. Microcomputer Applications for Management**

0-3-1. Prerequisite: MGT 1051 or equivalent.

Use of spreadsheets for management applications. Covers such spreadsheet capabilities as user-defined functions, graphical comparisons, limitations of the spreadsheet as a data base, advanced macros, and methodologies for modeling financial activities. Credit may not be received for both MGT 3501 and MGT 4350.

**MGT 3501. Operations Management I**

3-0-3. Prerequisites: MGT 3150, MSCI 2400.

Analysis of an organization's resources and processes in its efforts to create products or services. The set of resources planned and managed includes the work force, equipment, information, and materials. Special emphasis on long-term methods to improve productivity and quality of production processes. Credit may not be received for both MGT 3501 and MGT 4350.

**MGT 3611. MOT I: Management of Technology: The External Environment**

3-0-3. Prerequisites: junior standing and MSCI majors only.

Examines factors in the firm's external environment essential to managing technology. Topics include: 1) industrial competitiveness and technology innovation, 2) roles of government, and 3) developing information about the environment.

**MGT 3612. MOT II: Managing Resources of the Technological Firm**

3-0-3. Prerequisites: junior standing and MSCI majors only.

Focuses on the resources management for a technology-based firm. Emphasis given to planning under conditions of rapid process and product innovation and international competition.

**MGT 3613. MOT III: Strategic Issues in the Management of Technology**

3-0-3. Prerequisites: junior standing and MSCI majors only.

Explores the technology and strategic management interface from an internal as well as an external perspective. Particular focus on the strategic implications of competing in technologically sophisticated industries.

**MGT 3674. MOT Seminar - I**

1-0-1. Prerequisites: junior standing and MSCI majors only.

Designed to 1) introduce the student to the technological frontiers of some key technologies; 2) provide a forum for visiting speakers from the corporate world; 3) supplement the topics of the MOT I, II, and III (MGT 3611, 3612, 3613) courses.

**MGT 3675. MOT Seminar - II**

1-0-1. Prerequisites: junior standing and MSCI majors only.

Designed to 1) introduce the student to the technological frontiers of some key technologies; 2) provide a forum for visiting speakers from the corporate world; 3) supplement the topics of the MOT I, II, and III (MGT 3611, 3612, 3613) courses.

**MGT 4020. Auditing and Accounting Systems**

3-0-3. Prerequisites: MGT 2001, 3060.

Emphasizes both the design of accounting systems and external and internal auditing and control procedures.

**MGT 4022. Problems in Financial Reporting**

4-0-4. Prerequisite: MGT 3020.

Consolidations, funds statements, earnings per share, results of operations, mergers and poolings, general price level adjustments, foreign exchange transactions, and not-for-profit organizations.

**MGT 4024. Seminar in Financial Reporting and Control**

4-0-4. Prerequisite: MGT 4022.

In-depth study of one or two major current issues in accounting involving controversy and a significant possibility of substantial impact on theory and practice.

**MGT 4040. Auditing Concepts**

4-0-4. Prerequisites: MSCI 2100 and MGT 3020.

Problems in certifying financial statements, including audit objectives, statistical approaches to audit scope, and auditing complex computerized data systems.

**MGT 4051. Expert Systems for Business Applications**

3-0-3. Prerequisite: MGT 3050.

The course covers expert systems development including knowledge acquisition, knowledge structuring, knowledge representation, and applications for business.

**MGT 4053. Data Communications for Management**

3-0-3. Prerequisite: MGT 3050.

An introduction to data communications for those undergraduates in management or a similar curriculum. Concepts of network design, management, and security are introduced.

**MGT 4054. Data Base Applications in Management**

3-0-3. Prerequisite: MGT 4750.

Development of business data base applications. Covers both command-language and menu use of data base management system with an emphasis on relational functions. Includes development of menus.

**MGT 4070. International Finance**

3-0-3. Prerequisite: MGT 3061.

This course covers the behavior of exchange rates, international financial markets, and the management of international financial risks. The course focuses on understanding the markets for spot and forward foreign exchange, currency futures, options eurocurrencies, bonds and swaps in an international environment.

**MGT 4071. Multinational Financial Management**

3-0-3. Prerequisite: MGT 4070.

This course addresses the problems faced by an international banker or a financial officer of a multinational firm. The first part of the course examines the workings of the

foreign exchange risk market and the empirical behavior of exchange rates. The focus of the second part of the course is on exchange risk management and financing decisions. This will include the measurement of exposure, accounting for exposure, and various techniques for hedging exposure. Multinational capital budgeting decisions and foreign direct investment will also be discussed.

**MGT 4100. Organizational Analysis**

3-0-3.

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 4101. Social and Regulatory Environment for Managing Human Resources**

3-0-3.

Analysis of various frameworks for understanding the social and regulatory environments of human resources management and how they influence management decision-making.

**MGT 4110. The Management of Organized Effort**

3-0-3. Open only to seniors.

Management as a process of developing and controlling situations toward which people act and respond, both individually and as members of groups.

**MGT 4115. Contemporary Management Thought**

3-0-3. Prerequisite: MGT 3150 or consent of the School.

This course emphasizes the impact of changing social values on management thought and practices. Guest speakers make important contributions to the course.

**MGT 4120. Contemporary Research in Management**

3-0-3. Prerequisite: either MGT 4100 or consent of the School.

Investigations, analyses, 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 the School.

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 4145. Institutional Public Relations**

3-0-3. Prerequisite: MGT 3150.

A study of the managerial concepts and methodologies that underlie the development and implementation of institutional public relations programs, with emphasis on a managerial rather than a journalistic perspective.

**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 4152. Management of High-technology Institutions**

3-0-3. Prerequisite: senior or graduate standing.

General management issues involved with the production of

high-tech products are analyzed with special emphasis directed to the integration of research and development, manufacturing, and marketing.

**MGT 4155. Fundamentals of World Business**

3-0-3. Prerequisites: MGT 2001, 3150.

Covers the broad aspects of international business, position of the United States in world markets, various types of international business transactions, and the relationship of business to economics, politics, culture, and government interaction.

**MGT 4160. Management Concepts and Issues in World Business**

3-0-3. Prerequisite: MGT 4155; normally taken by seniors.

Covers significant aspects of international business, changing patterns of world industry, emergence of common markets, role of United States industry overseas.

**MGT 4165. Seminar**

1-0-1. Prerequisite: junior standing.

Lectures and discussions with prominent business, government, labor, and educational leaders. Offered winter quarter only.

**MGT 4170. Career Analysis**

3-0-3. Prerequisite: senior standing.

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. Prerequisites: senior standing and MGT 3150, 3300, a marketing elective, MGT 3061 and 3501.

Comprehensive cases are used to integrate knowledge at the policy level of management and to relate managerial decisions to the economic and competitive forces affecting business.

**MGT 4200. Industrial Relations**

3-0-3.

Theories of the labor movement, union-management relationship, including the legal setting, contract negotiations, contract administration, and the roles and nature of third parties.

**MGT 4201. Contemporary Unionism and Collective Bargaining**

3-0-3. Prerequisite: MGT 4200.

A study of union structure, collective bargaining procedures, and the analysis of union-management contracts.

**MGT 4202. Cases in Labor-Management Relations**

3-0-3. Prerequisite: MGT 4200.

A case study of problem areas in union-management relations. The cases used will be actual (NLRB) and labor arbitration decisions.

**MGT 4306. Industrial Marketing**

3-0-3. Prerequisite: MGT 3300.

This course explores the points of departure between business to business marketing and consumer marketing. The



course will integrate the body of literature into an operational treatment of industrial marketing.

**MGT 4331. Consumer Behavior**

3-0-3. Prerequisite: MGT 3300.

Provides a basic understanding of the behavior of consumers in the market place.

**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 4352. Operations Management II**

3-0-3. Prerequisite: MGT 3501.

This course is a continuation of MGT 3501 with a focus on comparative manufacturing systems. The course analyzes modern production systems (job shops, FMSs, etc.) and control/operating policies (push versus pull, JIT, Kanban, etc.) and discusses their applicability to various competitive environments.

**MGT 4353. Manufacturing Strategy**

3-0-3. Prerequisite: MGT 3501.

This course provides an introductory exposure to the major concepts of manufacturing strategy. The course stresses relationships between manufacturing strategy and (1) factors such as a firm's competitive position, competitor actions, and government regulations; (2) corporate strategies; and (3) other areas such as finance, accounting, marketing, economics, and organizational behavior.

**MGT 4354. Manufacturing Information Systems**

3-0-3. Prerequisite: MGT 3501.

The main objective of this course is to investigate the contribution of information systems in the integrated manufacturing environment. This course will analyze how manufacturers can improve productivity using better information systems. Furthermore, it will explore concepts of information simplification such as JIT systems that are evolving as integral parts of manufacturing information systems.

**MGT 4355. Measuring Performance in Manufacturing**

3-0-3. Prerequisite: MGT 3501.

This course discusses performance measurement systems in the context of environments characterized by changing technology, intense competition, and changing customer needs. The shortcomings of currently used performance measurement systems and possible improvements will be described. The impact of the improved systems will be discussed from the strategic to the operational level including the effect of improving quality, productivity, and a firm's competitive position.

**MGT 4356. Artificial Intelligence Approaches to Operations Management**

3-0-3. Prerequisite: MGT 3501.

This course demonstrates the use of artificial intelligence (AI) approaches to improve manufacturing productivity, quality, and a firm's overall competitive position. Students will develop an understanding of the most recent AI developments in manufacturing applications. Specific topics include expert systems, knowledge-based systems for operations, intelligent automation, and AI systems used in design, production planning and control, quality management, and strategic planning.

**MGT 4444. Simulation and Gaming**

3-0-3. Prerequisites: ECON 3000, MGT 3301, 2050, and permission of the instructor.

Students will participate in and partially design a total enterprise business simulation.

**MGT 4750. Data Base and Information Systems Development**

3-0-3. Cross listed with ISyE 4750. Prerequisite: junior or senior standing.

Development of data bases and information systems. The course covers systems development life cycle, structured analysis/design tools, the relational data model, and information query processing.

**MGT 4801-2-3. Special Topics in Industrial Management**

3-0-3 each.

Permits groups of students and a professor to pursue areas of management not extensively treated in other courses.

**MGT 4811-2-3-4-5. Special Topics in Management**

1-0-1 through 5-0-5 respectively.

Permits a group of students and a professor to pursue areas of management not extensively treated in other courses of the college.

**MGT 4901-2-3. Individual Research in Management**  
Credit to be arranged.

Designed to permit independent study with a faculty member. To register, the student must obtain the written approval of the dean's representative and of the sponsoring professor.

**MGT 4990. Georgia Internship Program**

Credit to be arranged. Prerequisite: consent of the School.

Broadens the scope of the School curriculum by offering students a community-based learning experience that stresses the completion of a specific task.

**MGT 6000. Financial Accounting**

3-0-3. Prerequisite: consent of the School.

A foundation course in measuring and reporting the financial performance and status of the firm. Emphasizes underlying theoretical concepts, reporting requirements, and financial analysis implications of modern financial accounting.

**MGT 6001. Managerial Accounting**

3-0-3. Prerequisites: MGT 6000 and consent of the School.

Introduction to cost and managerial accounting. Topics include basic cost concepts, costing systems, cost-volume-profit analysis, and the general role of accounting data in planning, control, and decision making.

**MGT 6010. Individual Taxation: Analysis and Planning**  
3-0-3.

An overview of the federal income tax system as it relates to individuals. Special emphasis is placed on developing tax analysis and research skills.

**MGT 6020. Accounting Theory and the Analysis and Interpretation of Financial Statements**

4-0-4. Prerequisite: MGT 6000.

Accounting techniques and principles of measuring assets, equities, and earnings of manufacturing and financial corporations. Includes revenue recognition, inventory valuation, accounting theory, etc.

**MGT 6021. Topics in Managerial Accounting and Control**

3-0-3. Prerequisites: MGT 6001, MSCI 6021, and consent of the School.

Advanced topics in managerial reporting and analysis, such as divisional performance measurement, activity-based costing, quality management, budgeting, control, and other issues in internal resource allocation.

**MGT 6022. Financial Reporting**

4-0-4. Prerequisite: MGT 6020.

Consolidations, funds statements, earnings per share, results of operations, mergers and poolings, general price level adjustments, foreign exchange transactions, and not-for-profit organizations.

**MGT 6024. Financial Reporting and Control**

4-0-4. Prerequisite: MGT 6022.

In-depth study of one or two major current issues in accounting, involving controversy and a significant possibility of substantial impact on theory and practice.

**MGT 6030. International Accounting**

3-0-3. Prerequisite: MGT 6000

The course provides an overview of accounting issues arising from the increased internationalization of business. Topics include comparative financial reporting among countries and accounting treatments of international transactions.

**MGT 6040. Auditing Concepts**

4-0-4. Prerequisites: MGT 6001, 6020.

Problems in certifying financial statements, including audit objectives, statistical approaches to audit scope, and auditing complex computerized data systems.

**MGT 6041. Taxation and Decisions**

4-0-4. Prerequisites: MGT 6000 and 6010 or consent of the School.

A comprehensive examination of the major provisions of the Internal Revenue Code as they relate to corporations and partnerships. Emphasis is placed upon the impact of taxes on business decisions.

**MGT 6050. Management Information Systems**

3-0-3.

This course provides an introduction to computer-based information systems technology and its application to support managerial decisions.

**MGT 6051. Introduction to Data Base Management Systems**

3-0-3. Prerequisite: MSCI 6055.

An introduction to data base management systems, with emphasis on design principles, implementation issues, data base administration, and organizational implications.

**MGT 6052. Systems Analysis and Design**

3-0-3. Prerequisite: MSCI 6055

An introduction to tools, techniques, and methodologies for structured analysis, design, development, and implementation of business systems.

**MGT 6053. Data Communications for Management**

3-0-3. Prerequisite: MSCI 6055.

An introduction to data communications for graduate

students in management or a similar curriculum. Concepts of network design, management, and security are introduced.

**MGT 6055. Management Applications of Artificial Intelligence**

3-0-3. Prerequisite: MSCI 6055.

A study of artificial intelligence methods and systems in management, with emphasis on the integration of knowledge-based methods with other types of decision support.

**MGT 6060. Financial Management I**

3-0-3. Prerequisite: MGT 6000.

The objective of this course is to introduce the student to the basic concepts used for valuation in finance and their applications. The course concentrates on the time value of money and relation between risk and return. These concepts are applied to valuation of stocks and bonds and to the investment decisions of the modern corporation. Financial analysis and concepts of sustainable growth are also discussed.

**MGT 6061. Financial Management II**

3-0-3. Prerequisite: MGT 6060.

The objective of this course is to analyze the short-term and long-term financing decisions of a corporation. Topics covered include dynamic capital budgeting, leasing, risk management, market efficiency, capital structure, cost of capital, dividend policy, and working capital management.

**MGT 6062. Theory of Financial Management**

3-0-3. Prerequisite: MGT 6061.

Financial policy, theory, and cases dealing with a variety of topics in corporate finance.

**MGT 6063. Corporate Cash Management and Banking Relations**

3-0-3. Prerequisites: MGT 6061, MSCI 6022.

Daily cash management, short-term securities, cash planning, cash forecasting, credit lines, short-term financing, banking relations, collection systems, credit policy, and other aspects of the corporate treasurer's job.

**MGT 6064. Financial Planning Systems**

3-0-3. Prerequisites: MGT 6063, MSCI 6055.

Computer-based financial statement generators and budgeting systems, short- and long-term financial models, computer-based capital budgeting systems, and a variety of other financial planning models.

**MGT 6065. Seminar in Financial Management**

3-0-3. Prerequisite: MGT 6061.

Topics of current interest in the field of financial management.

**MGT 6070. International Finance**

3-0-3. Prerequisite: MGT 6061.

This course covers the behavior of exchange rates, international financial markets, and the management of international financial risks. The course focuses on understanding the markets for spot and forward foreign exchange, currency futures, options eurocurrencies, bonds and swaps in an international environment.

**MGT 6071. Multinational Financial Management**

3-0-3. Prerequisite: MGT 6070.

This course addresses the problems faced by an international banker or a financial officer of a multinational firm. The first part of the course examines the working of the

foreign exchange risk market and the empirical behavior of exchange rates. The focus of the second part of the course is on exchange risk management and financing decisions. This will include the measurement of exposure, accounting for exposure, and various techniques for hedging exposure. Multinational capital budgeting decisions and foreign direct investment will also be discussed.

**MGT 6080. Investments I**

3-0-3. Prerequisite: MGT 6060.

The theory and practice of security analysis and portfolio management as applied to stocks and bonds.

**MGT 6081. Investments II**

3-0-3. Prerequisite: MGT 6080.

A continuation of MGT 6080. Includes advanced topics in portfolio theory and detailed study of bonds, options, and futures contracts.

**MGT 6090. Commercial Bank Management**

3-0-3. Prerequisite: MGT 6060 or permission of the instructor.

The analysis of management problems of commercial banks, including the loan, investment, deposit, and capital functions and the interrelationships between them.

**MGT 6100. Organization Processes**

3-0-3. Prerequisite: consent of the School.

Introduction to behavioral issues in individual, group, and organizational performance.

**MGT 6101. Contemporary Issues in Human Resource Management**

3-0-3. Prerequisite: consent of the School.

Survey of the manager's role in understanding and implementing an organization's human resource policy.

**MGT 6102. Methodology in Human Resource Management**

3-0-3. Prerequisite: MGT 6101.

The use of statistics and methodology in making data-based decisions about human resources.

**MGT 6103. Compensation and Jobs**

3-0-3. Prerequisite: MGT 6101.

Concepts and procedures used for compensating managerial and nonmanagerial personnel.

**MGT 6104. Attraction, Selection, and Development of Human Resources**

3-0-3. Prerequisite: MGT 6101.

Advanced study of legal, statistical, and theoretical issues in the development of effective human resource policies.

**MGT 6105. Individuals in Organizations**

3-0-3. Prerequisite: MGT 6100.

Discussion and application of theories involving individual behavior in organizations.

**MGT 6106. Group Processes in Organizations**

3-0-3. Prerequisite: MGT 6100.

Problems in understanding and managing the performance of work groups.

**MGT 6107. Organization Theory**

3-0-3. Prerequisite: MGT 6100.

A treatment of factors affecting the design of effective complex organizations.

**MGT 6108. Human Resource Management Practicum**

3-0-3. Prerequisite: MGT 6101.

Experiences in dealing with and solving various human resource management problems.

**MGT 6140. Management Systems Analysis**

3-0-3.

An analysis of the environmental factors and forces that interact to form systems and their resultant impact upon the practice of management.

**MGT 6155. Development of Management Thought**

3-0-3.

A survey of the development of management thought based upon a critical examination of classic works in management literature.

**MGT 6160. Management Theory**

3-0-3. Prerequisite: consent of the School.

Provides resources essential to the development of a matrix of management theory at the professional level.

**MGT 6175. Entrepreneurial Management**

3-0-3. Prerequisite: MGT 6000.

The manager's role in building or restructuring enterprises. Students interact with entrepreneurs in and out of class and write a report on a growing firm.

**MGT 6180. Multinational Business**

3-0-3. Prerequisite: consent of the School.

Critical examination of business concepts, organizational structures, and control processes of the multinational corporation in different political and economic environments.

**MGT 6185. International Business Environments**

3-0-3.

The course is a survey of the macro-environmental perspective (socio-cultural, economic, ethical, political, and legal) of the international manager's world.

**MGT 6195. Managerial Policy I**

3-0-3. Prerequisites: MGT 6000, 6100, ECON 6000, and two of MGT 6001, 6060, 6300, 6350 and consent of the School.

Economic, competitive, and governmental forces affecting the formulation of corporate strategy, managerial policies, and decision-making.

**MGT 6196. Managerial Policy II**

3-0-3. Prerequisite: MGT 6195.

An examination of selected strategic issues, problems, and competitive strategies in particular industries and types of organizations, combined with field projects and guest lectures.

**MGT 6200. Labor Problems**

3-0-3.

An examination of the union-management relationship. Includes analysis of labor agreement, grievance procedures and arbitration, and the legal environment of labor relations.

**MGT 6260. The Legal Environment**

3-0-3.

The role of law in society, legal philosophy, and basic legal concepts.

**MGT 6300. Marketing Management I**

3-0-3. Prerequisite: consent of the School.

Critical analysis of the marketing functions of an industrial enterprise; organizing and control of marketing programs is emphasized.

**MGT 6301. Marketing Management II**

3-0-3. Prerequisite: MGT 6300 and consent of the School.

Advanced course in marketing analysis and strategy formulation. Particular emphasis will be given to application of materials from MGT 6300.

**MGT 6302. Buyer Behavior**

3-0-3. Prerequisite: MGT 6300.

This course exposes students to behavioral science concepts and approaches of relevance in describing, understanding, and predicting the behavior of consumers.

**MGT 6303. Sales and Promotion Management**

3-0-3. Prerequisites: MGT 6300, 6301.

Advertising, personal selling, sales promotion aids, channel (resellers) stimulation, and other communication tools as variables in the overall promotional mix.

**MGT 6305. Strategic Market Planning**

3-0-3. Prerequisites: MGT 6300, 6301.

Integrates marketing planning into the strategic planning process. Focuses on new concepts and techniques that facilitate market analysis and the development of strategic plans.

**MGT 6306. Industrial Marketing**

3-0-3.

The purpose of this course is to provide the student with insights into the nature of industrial marketing. The course will cover the unique dimensions and problems of the marketing of industrial and high-tech products.

**MGT 6310. Marketing Research and Analysis**

3-0-3. Prerequisite: MGT 6300.

Theory and techniques of marketing research and their applications in real life situations.

**MGT 6315. Marketing Analysis**

3-0-3. Prerequisites: MGT 6300, 6310.

This course seeks to impart an understanding of the various techniques useful for analyzing and interpreting marketing research data.

**MGT 6320. Marketing Models**

3-0-3. Prerequisites: MGT 6300 and a knowledge of probability and statistics.

Marketing models utilizing probability and statistics as well as behavioral techniques.

**MGT 6325. Product Planning**

3-0-3.

Study of new product development process. Use of market research data and marketing models for product design, test marketing, product positioning, market segmentation, market share estimation, and product portfolio management.

**MGT 6335. International Marketing**

3-0-3. Prerequisites: MGT 6300, 6301.

Provides the student with insight into the dynamic environment of international marketing and examines the unique dimensions and issues that multinational firms and international marketers face.

**MGT 6350. Production and Operations Management I**

3-0-3. Prerequisites: MSCI 6020 or equivalent and consent of the School.

Analysis of an organization's resources and processes in its

efforts to create products or services. The set of resources planned and managed includes the work force, equipment, information, and materials. Special emphasis on long-term methods to improve productivity and quality of production processes in both manufacturing and service environments.

**MGT 6351. Production and Operations Management II**

3-0-3. Prerequisite: MGT 6350.

This course is a continuation of MGT 6350 with a focus on comparative manufacturing systems. The course analyzes modern production systems (job shops, FMSs, etc.) and control/operating policies (push versus pull, JIT, Kanban, etc.) and discusses their applicability to various competitive environments.

**MGT 6353. Manufacturing Strategy**

3-0-3. Prerequisite: MGT 6350.

This course provides exposure to the major concepts of manufacturing strategy. The course stresses analysis of the relationships between manufacturing strategy and (1) factors such as a firm's competitive position, competitor actions, and government regulations; (2) corporate strategies; and (3) other areas such as finance, accounting, marketing, economics, and organizational behavior.

**MGT 6354. Manufacturing Information Systems**

3-0-3. Prerequisite: MGT 6350.

The main objective of this course is to investigate the contribution of information systems in the integrated manufacturing environment. This course analyzes how manufacturers can improve productivity, reduce costs, and reduce lead times through the use of information systems. Furthermore, the course explores concepts of information simplification such as JIT systems that are evolving as integral parts of manufacturing information systems.

**MGT 6355. Measuring Performance in Manufacturing**

3-0-3. Prerequisite: MGT 6350.

This course discusses performance measurement systems in the context of environments characterized by changing technology, intense competition, and changing customer needs. The shortcomings of currently used performance measurement systems and possible improvements will be described. The impact of the improved systems will be discussed from the strategic to the operational level including the effect on improving quality, productivity, lead time, and a firm's competitive position.

**MGT 6356. Artificial Intelligence Approaches to Operations Management**

3-0-3. Prerequisite: MGT 6350.

This course demonstrates the use of artificial intelligence (AI) approaches to improve manufacturing productivity, quality, and a firm's overall competitive position. Students will develop an understanding of the most recent AI developments in manufacturing applications. Specific topics include expert systems, knowledge-based systems for operations, intelligent automation and AI systems used in design, production planning and control, quality management, and strategic planning.

**MGT 6410. Introduction to Microcomputers I**

0-3-1. Prerequisite: consent of the School.

Introduction to microcomputers using a graphics interface. Covers word processing, office productivity tools, presentation systems, data base management systems, and communications.

**MGT 6411. Introduction to Microcomputers II**

0-3-1. Prerequisite: consent of the School.

Introduction to microcomputers using a conventional user interface. Covers word processing, office productivity tools, presentation systems, data base management systems, and communications.

**MGT 6412. Advanced Financial Microcomputer Applications**

0-3-1. Prerequisite: MGT 6411.

Use of spreadsheets for management applications. Covers such spreadsheet capabilities as user-defined functions, graphical comparisons, limitations of the spreadsheet as a data base, advanced macros, and financial applications.

**MGT 6445. Data Base Applications in Management I**  
3-0-3.

Development of dBase business applications. Covers both command language and menu use of dBase, with an emphasis on relational functions. Includes development of menus.

**MGT 6600. Applied Managerial Statistics**  
3-0-3.

This course uses statistics probability in business decision making. It defines data, ethical issues dealing with data, how to present data, and instills a discipline for performing the appropriate analysis.

**MGT 6601. Analytical Tools for Decision Support**  
3-0-3.

Topics include linear and integer programming, network analysis, queuing/waiting line models and computer simulation. The student will formulate and model the problem to analyze data while considering ethics in the cases.

**MGT 6750. The Changing Economy**  
3-0-3.

This course examines the long-run forces within the economy that support economic growth and rising standards of living. Studies the changes in these sources of growth due to the recent performance of the economy.

**MGT 6770. MOT Project Initiation**

1-0-1. Prerequisite: Enrollment in MOT certificate program and planning to take MGT/ISYE 6774 the following quarter.

Under faculty supervision, students work in a multidisciplinary team to develop a viable proposal for their MOT project (MGT/ISYE 6774).

**MGT 6771. MOT I: Management of Technology: The External Environment**

3-0-3. Cross listed with ISYE 6771 and POL 6771.

Examines factors in the firm's external environment essential to managing technology. It develops skills in acquiring and interpreting information about the environment to facilitate technology management. Topics are arranged in three groups (1) industrial competitiveness and technological innovation (2) roles of government, and (3) developing information about the environment.

**MGT 6772. MOT II: Managing Resources of the Technological Firm**

3-0-3. Cross listed with ISYE 6772.

In the setting of a technology-based firm, this course will

study the management of resources such as manufacturing technologies, information technologies, work force, and materials. Specific topic groupings are: (1) characteristics and potentials of new technologies, (2) impetus for new technologies, (3) technological innovation, (4) strategic implications of new technology, (5) managing productivity and quality, (6) justification of new technology, and (7) managing change.

**MGT 6773. MOT III: Strategic Issues in the Management of Technology**  
3-0-3.

Explores the interconnectedness of technology and strategic management. Specific topics will include: (1) integrating technological and business strategies, (2) strategy formation in technology-based firms, (3) new product development, (4) implementation of technological change, (5) organizational structures for technology-based firms, (6) management of innovation and entrepreneurship, and (7) managing technology in global firms and markets.

**MGT 6774. MOT Project**

0-9-3. Cross listed with ISYE 6774. Prerequisites: MGT or ISYE 6770 in the prior quarter. Successful completion of MGT 6771, 6772, and 6773 preferred with completion of at least one of these and concurrent enrollment in a second required.

This course is designed to provide the student with an experience of working in a multidisciplinary team devoted to solving a real problem of a technology-based firm. Weekly progress reports will be required and a formal presentation of the results will be given to a group of corporate representatives, faculty, and fellow students.

**MGT 6775. MOT Seminar I**  
1-0-1.

This seminar series is offered fall quarter and is designed to accomplish three things: (1) to introduce the MOT students to the technological frontiers of some key technologies, (2) to provide a forum for visiting speakers from the corporate world, and (3) to supplement the topics of the MOT I, II, and III courses. The seminar series will meet weekly. Student grades (SU ONLY) will be determined by attendance and participation.

**MGT 6776. MOT Seminar II**  
1-0-1.

This seminar series is offered each quarter and is designed to accomplish three things: (1) to introduce the MOT students to the technological frontiers of some key technologies, (2) to provide a forum for visiting speakers from the corporate world, and (3) to supplement the topics of the MOT I, II, and III courses. The seminar series will meet weekly. Student grades (SU ONLY) will be determined by attendance and participation.

**MGT 6777. Analysis of Emerging Technologies**  
4-0-4.

Effective management of technology begins with "intelligence" information on likely changes in technology and their implications. This course provides a framework and analytical tools to develop such technological foresight. It covers technology monitoring, forecasting, and assessment in the context of three prominent emerging technologies.

**MGT 6790. Computer Integrated Manufacturing Systems I**

3-0-3. Priority to CIMS students.

A broad overview of the functions, processes, and disciplines of computer integrated manufacturing.

**MGT 6791. Computer Integrated Manufacturing Systems II**

3-0-3. Prerequisite: CIMS I.

An in-depth study of current issues, emerging technologies, and future developments in computer integrated manufacturing.

**MGT 6792. Computer Integrated Manufacturing Systems Seminar**

1-0-1. (Same as MGT 6775)

Guest speakers on a broad range of CIMS related topics: research, applications, and technology.

**MGT 6798. Cooperative Internship**

1-0-1.

This course will allow students to matriculate and be on graduate standing for co-op program participation prior to beginning normal graduate course work. (Audit grading basis only.)

**MGT 6800. Managerial Communication Skills**

3-0-3.

The course focuses on skill building. Cases and reading will be assigned to develop written and oral communication skills along with team problem solving skills. Some cases will focus on ethical considerations.

**MGT 6810. Integrative Simulation Project**

3-0-3.

Industry dynamics are analyzed to develop strategic planning to assist in problem solving. Teams of students develop tactics to implement a solution taking into account ethical considerations.

**MGT 6811. Integrative Management Analysis**

3-0-3.

This course provides students with the opportunity to gain expertise in a particular industry or firm. Students are organized into teams to perform a comprehensive analysis of an integrative management problem, including the ethical considerations among other issues.

**MGT 6812. Integrative Field Study**

3-0-3.

Students are grouped in teams to analyze a firm and to develop a strategic plan covering all the functions of the firm, as well as the ethics of its operating policies and procedures.

**MGT 6901. Management Consulting**

3-0-3.

This course is a project course in which the students form teams and take on consulting roles with actual firms. These students work closely with executives of client firms and with individuals representing various consulting agencies in the Atlanta metro area.

**MGT 7000. Master's Thesis****MGT 7750. Seminar on Psychology and Management**

3-0-3. Prerequisites: PSY 6601 or 6609, MGT 6150 or 6105,

and consent of the School.

Selected management problems involving psychological complexities, individual behavior in an organizational setting. Also listed as PSY 7750.

**MGT 8401-2-3-4-5-6. Special Topics**

1-0-1 through 6-0-6 respectively. Prerequisite: consent of the School.

Topics of current interest in the field of management.

**MGT 8501-2-3-4. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

Provides project work experience in the field of management.

**MGT 8801-2-3-4. Management Research**

Credit to be arranged.

Credit given for the presentation of a satisfactory written report embodying the results of intensive research and study of a management problem. Conferences will be arranged.

**MGT 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**MGT 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**MGT 9000. Doctoral Thesis****MANAGEMENT SCIENCE****MSCI 2100. Survey of Statistics**

3-0-3. Prerequisite: MATH 1711.

A survey of discrete probability and statistics with emphasis on economic and business applications. Serves as core requirement for MGT degree. Credit cannot be obtained for MSCI 2100 and either or both MSCI 3110 and 3111.

**MSCI 2400. Analytical Methods in Management I**

3-0-3. Prerequisite: MATH 1711.

Introduction to linear programming. Emphasis on formulation of problems encountered in professional practice and on interpretation of solutions.

**MSCI 3200. Management Science I**

3-0-3. Prerequisite: matrix algebra.

Applications of linear programming to the analysis of managerial problems. Topics include duality, transportation problems, and post-optimality analysis.

**MSCI 3201. Management Science II**

3-0-3. Prerequisite: MATH 4215 or ISYE 3027.

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.

**MSCI 3300. Decision Analysis in Management**

3-0-3. Prerequisite: MATH 1711.

An introduction to decision models for management situations under risk and uncertainty, including fundamental economic concepts of a theory of rational choice.

**MSCI 3401. Analytical Methods in Management II**

3-0-3. Prerequisite: MSCI 3400 or 3200.

Additional applications of linear programming to analysis of management decision problems. Topics include alternatives to the simplex algorithm and special applications.

**MSCI 3402. Analytical Methods in Management III**

3-0-3. Prerequisite: MSCI 3400 or 3200.

Introduction to the theory and applications of dynamic, integer, and nonlinear programming in the analysis of management decision problems.

**MSCI 3403. Analytical Methods in Management IV**

3-0-3. Prerequisite: MSCI 3100 or 3110.

Analytical and simulation approaches to the analysis of queueing and inventory systems.

**MSCI 4801-2-3. Special Topics in Management Science**

3-0-3 each. Normally taken by seniors.

Designed to permit students and a professor to pursue a specialized interest in an area of management science not extensively treated in the offerings of the College.

**MSCI 4811-2-3-4-5. Special Topics in Management Science**

1-0-1 through 5-0-5 respectively.

Designed to permit students and a professor to pursue a specialized interest in an area of management science not extensively treated in the offerings of the College.

**MSCI 4990. Georgia Internship Program**

Credit to be arranged. Prerequisite: consent of the School.

Broadens the scope of the School curriculum by offering students a community-based learning experience that stresses the completion of a specific task.

**MSCI 4991-2-3. Special Problems**

Credit to be arranged.

The special project is designed to provide the student an opportunity to apply his or her full training to the analysis of an applied or theoretical problem. To register, the student must obtain the written approval of the dean's representative and of the sponsoring professor.

**MSCI 6010. Analytical Methods in Management**

3-0-3.

Introduction to matrix algebra and calculus. Emphasis on formulating and solving problems in management and economics.

**MSCI 6023. Cases and Applications in Management Science**

3-0-3. Prerequisites: MSCI 6021, MSCI 6022.

Application of management science in varied functional and organizational contexts. Actual cases are analyzed, and the results are communicated in oral and written reports.

**MSCI 6051. Computer Simulation of Management Problems**

3-0-3. Prerequisite: MSCI 6021 or equivalent.

Techniques of simulating general management decisions utilizing information from the areas of marketing, production, finance, and industrial relations.

**MSCI 6101. Applications of Statistical Methods to Management Decision Making**

3-0-3. Prerequisite: MSCI 6021 or equivalent.

Theory and applications of elementary multiple regression analysis in a management framework.

**MSCI 6102. Applications of Regression Analysis for Management**

3-0-3. Prerequisite: MSCI 6101.

Multivariate statistical analysis with applications in business economics.

**MSCI 6105. General Decision Theory**

3-0-3. Prerequisite: MSCI 6020.

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.

**MSCI 6106. Applications of General Decision Theory in Management and Economics**

3-0-3. Prerequisite: MSCI 6020.

Risk games, statistical games, Bayes and min-max strategies, principle of choice problem, no data and data variants. Applications in management and economics.

**MSCI 6201. Stochastic Optimization**

3-0-3. Prerequisite: MATH 4221 or MSCI/MATH 6750.

Optimization of sequential decision models for production, congestion, inventory, fisheries, and other contexts. Myopic policies, Markov decision processes, and monotone policies.

**MSCI 6300. Risk Management**

3-0-3. Prerequisites: probability and statistics at the level of MSCI 6020 and 6021.

Scope and methods of risk management. Protecting the firm against losses from pure risks. Loss prevention, risk retention, and optimal insurance coverage are considered.

**MSCI 6410. Mathematical Programming**

3-0-3. Prerequisites: MSCI 6010 and consent of the School.

Survey of major results in linear programming, goal programming, and integer programming. Includes cases that illustrate issues of practical implementation.

**MSCI 6411. Seminar in Mathematical Programming**

3-0-3. Prerequisite: MSCI 6410.

Student research and/or in-depth study of recent literature on theory and application of mathematical programming in management and economics.

**MSCI 6750. Stochastic Models in Management Science**

3-0-3. Prerequisites: introductory probability (MATH 4215) and calculus (MATH 2308).

Stochastic process models for managerial contexts including production, congestion, cash flow, fisheries, and passenger reservations. Processes include birth and death, renewal and Markov. Also listed as MATH 6750.

**MSCI 8401-2-3-4-5-6. Special Topics**

1-0-1 through 6-0-6 respectively. Prerequisite: consent of the School.

Topics of current interest in the field of management science.

**MSCI 8501-2-3-4. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

Provides project work experience in the field of management science.

**MSCI 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**MSCI 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

## Department of Military Science

**Established in 1917**

**Location: Building 23 A, Bobby Dodd Way**  
**Telephone: 404-894-4760**

*Professor and Head*—Lieutenant Colonel Jeffrey Kern; *Assistant Professors*—Major Thomas Holt, Captain John McDonald, Captain William C. Werling.

### General Information

The purpose of the Army ROTC is to prepare students for commissioning as officers in the Active Army, Army Reserve, or National Guard Forces. Concurrently, the overall program is designed to aid students in developing the abilities and attitudes that will make them academically successful and to develop well-educated junior officers.

The curriculum is divided into two courses: a Basic Course open to all freshmen and sophomores, and an Advanced Course for qualified juniors, seniors, and graduate students. The student who is undecided about pursuing a commission has the option of participating in the Basic Course without incurring a military obligation. Successful completion of the Basic Course (or commensurate training), a minimum 2.0 cumulative grade point average, and the appropriate medical and physical qualifications are prerequisites for enrollment in the Advanced Course. Successful completion of both courses and the award of a bachelor's degree constitute the normal progression to gaining a commission as a Second Lieutenant. Courses are available to both men and women.

The overall Army ROTC curriculum prepares students to become effective leaders and managers in a variety of responsible and challenging commissioned officer fields, thus facilitating early middle management career development and progression. A description of the course requirements and associated programs is covered in the following paragraphs.

### The Basic Course Curriculum

The basic program consists of a six-quarter block of instruction taken during the freshman and sophomore years. Successful completion of all six quarters satisfies the military science requirements for progression to the Advanced Course. These courses provide a foundation in basic military subjects such as customs and traditions, history, leadership, and map reading. They round out a student's academic life, provide a challenge, foster confidence, and facilitate personal growth and development. Courses are offered fall, winter, and spring quarters with two credit hours awarded for each course. Six hours of basic ROTC courses may be applied as elective credits toward degree requirements at the school. Courses normally meet two hours a week. A one-hour leadership laboratory and participation in physical conditioning training is also required. Students in the Basic Course do not incur any military obligation unless they are on an ROTC scholarship. They are issued uniforms and may participate in the other ROTC related events and training, such as Airborne School, Air Assault School, and Northern Warfare Training. The Basic Course consists of the following:

<i>Course</i>	<i>Credit Hours</i>
<b>MS 1021</b>	
The Army of Today .....	2-1-2
<b>MS 1022</b>	
Army Operational Systems .....	2-1-2
<b>MS 1023</b>	
Basic Military Navigation and Techniques .....	2-1-2
<b>MS 2021</b>	
Introduction to Leadership .....	2-1-2
<b>MS 2012</b>	
Analysis of Command and Leadership ...	2-1-2
<b>MS 2023</b>	
Military Training of the Individual .....	2-1-2
<b>TOTAL</b> .....	<b>12-6-12</b>



## **Optional Basic Camp**

Those academically qualified students who are unable to fulfill the requirements of the Basic Program during their freshman and sophomore years may qualify for admission to the Advanced Course by successfully completing basic camp preparatory training. This option is primarily designed to meet the needs of transfer students, those completing the sophomore year, and others, including graduate students, who have six quarters remaining at the Institute. This option provides a two-year program in lieu of the standard four-year curriculum.

The basic camp option consists of a six-week training period conducted at an active Army post during the summer months. During each summer, various cycles will be available to meet student needs. Students choosing this option are required to submit a formal application and pass a general physical.

Students electing the basic camp training program will receive approximately \$700 in addition to travel expenses to and from the camp. Uniforms, housing, medical care, and meals are furnished by the government during the camp. Interested students should contact the Military Science Department.

## **The Advanced Course Curriculum**

The Advanced Course is designed to fully develop a cadet's leadership and management potential, physical stamina, and self-confidence, as well as those personal characteristics desired in an Army officer. The objective is to produce the highest caliber junior officer fully capable of discharging a wide spectrum of command and management responsibilities in the modern Army and in the business world.

The Advanced Course consists of six quarters of instruction normally taken during the junior and senior years. Successful completion of the six courses fulfills the military science academic requirements for award of an officer's commission. Each student must also participate in

a regular physical conditioning program and successfully pass the Army Physical Fitness Test. Eleven credit hours are earned, nine of which may be applied as elective credits toward any degree at the Institute. Advanced Course students receive a subsistence allowance of \$150 a month, not to exceed \$1,500 per academic year. Service veterans and service academy cadets may qualify for direct entry into the Advanced Course. Advanced Course students are eligible to participate in the Simultaneous Membership Program with the Army Reserve and National Guard. Students in this program affiliate with an Army unit as an officer trainee and receive an additional \$150 per month.

Students enrolled in the Advanced Course are also required to complete a six-week advanced camp to become eligible for commissioning. Attendance at advanced camp normally occurs during the summer between the junior and senior years. Students can also participate in additional voluntary training, such as Airborne School or Cadet Troop Leader Training. In addition to completing the military science academic requirements of both the Basic and Advanced Courses, the student must complete at least one undergraduate course from each of five designated fields of study:

*Written Communications:* select any course offered by the institution in English composition or creative writing.

*Human Behavior:* select any course offered by the institution in psychology, sociology, anthropology, or ethics.

*Military History/National Security Studies:* select INTA 3520, INTA 3510, or other similar course approved by the professor of military science.

*Computer Literacy:* select any course offered by the College of Computing except CS 1000 (Information and Society).

*Mathematics Reasoning:* select any course offered by the School of Mathematics.

Students who successfully complete the Army ROTC curriculum and earn a bachelor's degree can be commissioned Second Lieutenants. Subsequent military service may be on active duty or with the Army Reserve or National Guard. The following courses constitute the Advanced Course:

<i>Course</i>	<i>Credit Hours</i>
<b>MS 3011</b>	
Advanced Military Navigation .....	2-1-2
<b>MS 3012</b>	
Tactical Decision Making I .....	2-1-2
<b>MS 3023</b>	
Tactical Decision Making II .....	2-1-2
<b>MS 4011</b>	
The Military Team and the Junior Officer .....	2-1-2
<b>MS 4012</b>	
Military Justice .....	2-1-2
<b>MS 4023</b>	
Professional Army Ethics .....	1-1-1
<b>TOTAL</b> .....	<b>11-6-11</b>

## Scholarship Programs

Each year the Army offers a variety of full scholarship programs to those young men and women who have demonstrated outstanding academic scholarship and leadership potential. Four-year scholarships are awarded to incoming freshmen through national merit competition. Three-year and two-year scholarships are available on either a national competitive basis or directly through the professor of military science. Scholarships provide full tuition to both resident and out-of-state students, a stipend for textbooks and supplies, and laboratory fees in addition to a \$150-a-month tax-free allowance. Scholarship students will serve either on active duty or in the reserves.

## Options

Those students who wish to obtain a commission as an officer but do not want to serve on active duty can request guaranteed reserve forces duty. In this program, students are guaranteed in writing that they will not be placed on active duty and can fulfill their entire commitment in the Army Reserve or National Guard.

The Department of Military Science allows students to participate in the co-op program. Co-op students are monitored and advised quarterly so that they meet requirements for commissioning.

## Student Advisory Services

Faculty members are available throughout the academic year and during each summer orientation session in the Department of Military Science for academic counseling, schedule planning, and career guidance. Students and their parents are encouraged to seek advice on the overall Army ROTC program, scholarship opportunities, and officer career development. Appointments may be made personally or by collect call to (404) 894-4760/4761.

## Courses of Instruction

### **MS 1500. Ranger Company (Optional)**

1-1-1. Audit only.

An organization designed to train and prepare the small-unit leader with patrolling, military mountaineering, and stream crossing operations in a demanding physical environment.

### **MS 1021. The Army of Today**

2-1-2.

An introduction to the organization, mission, customs, and traditions of the U.S. Army. Students are also exposed to a variety of life skills, such as leadership, time management, stress management, total fitness, and speed reading.

### **MS 1022. Army Operational Systems**

2-1-2.

A study of the basic operational systems and individual skills essential to the effective functioning of a military organization.

### **MS 1023. Basic Military Land Navigation and Techniques**

2-1-2.

Military map reading and basic land navigation, and orienteering techniques.

### **MS 2012. Analysis of Command and Leadership**

2-1-2.

Analysis and development of fundamental leadership skills required to lead individuals and small units in a military environment; includes use of case studies to develop organizational and leadership techniques. [Leadership Assessment Program (LAP)]

**MS 2021. Introduction to Leadership**

2-1-2.

Introduction to fundamental leadership principles through the study of small unit tactics. Students apply the processes of problem analysis, decision-making, planning, organizing, delegation, and control.

**MS 2023. Military Training of the Individual**

2-1-2.

Introduction to military training management. Includes evaluating the training status of individuals, developing training objectives and standards, and planning and conducting military training.

**MS 3011. Advanced Military Navigation**

2-1-2. Prerequisite: advanced course standing or consent of the Department.

Military map reading, land navigation, and terrain analysis. Practical exercises require students to navigate cross country using terrain association and azimuths.

**MS 3012. Tactical Decision Making I**

2-1-2. Prerequisite: advanced course standing or consent of the Department.

Tactical decision-making process within small military units. Includes introduction to squad- and platoon-level tactics, with emphasis on troop leading procedures in a defensive setting.

**MS 3023. Tactical Decision Making II**

2-1-2. Prerequisite: advanced course standing or consent of the Department.

Continued study and application of the decision-making process at small-unit level. Emphasis is placed on planning and executing tactical operations in an offensive setting.

**MS 4011. Military Team and the Junior Officer**

2-1-2. Prerequisite: advanced course standing or consent of the Department.

A course organized to allow the potential officer to learn concepts and ease the transition from civilian to military officer.

**MS 4012. Military Justice**

2-1-2. Prerequisite: advanced course standing or consent of the Department.

This course is a study of military law and the Uniform Code of Military Justice.

**MS 4023. Professional Ethics and the Army Officer**

1-1-1. Prerequisite: advanced course standing or consent of the Department.

A study of pressures and influences imposed by contemporary society on the military professional and the standards of conduct and special trust by which the military professional must function.

**MS 4901-3. Special Problems**

1-1-1. Prerequisite: advanced course standing and consent of the department head.

## Department of Modern Languages

**Established in 1904**

**Location: Swann Building**

**Telephone: 404-894-7327**

*Professor and Head*—Heidi M. Rockwood;

*Professors*—Vicki B. Galloway, Angela Labarca, Edmun B. Richmond, Louis J. Zahn (emeritus);

*Associate Professors*—Barbara L. Blackburn, Jerry Carroll Brooks, Bettina Cothran, William W. Johnson;

*Assistant Professors*—Masato Kikuchi, Catherine C. F. Marin, Rumiko Shinzato-Simonds, David J. Shook;

*Instructors*—Frederic Castellan, Zhesheng Cheng, Robin Huff, Natalia Myshkin, Deepika Petraglia-Bahri, Maria A. Ribero.

## General Information

The diverse course offerings of the Department of Modern Languages provide students with opportunities for achieving reasonable fluency in understanding, speaking, reading, and writing several foreign languages (including English for nonnative speakers). Furthermore, they instruct students in the civilizations and literatures of the countries in which those languages are spoken.

Although the Department does not offer a degree or "major," certificates, or "minors," are available in French, German, linguistics, and Spanish. To receive a certificate in one of these options, students must take 18 credit hours, 15 hours of which must be on the 3000-level or above. Students should consult the Department for additional details.

Students may take any courses for which they have the prerequisites as specified in the catalog descriptions. Students who have had two years of a language in high school may not enroll for credit in the first 1000-level course in that language. Counseling and placement examinations are available on request. Usually, two years in high school equal one year at Tech. Each course is essentially a unit in itself, but beginning students are encouraged to pursue at least the elementary three-quarter sequence in order to achieve a minimum level of proficiency. Students may not enroll in or receive advanced standing for 1000-level courses after the successful completion of any 2000-, 3000- or 4000-level course. Students may, however, enroll simultaneously in a 1003-

and a 2000-level course in the same language without special permission. Students who take courses in their native language must schedule courses no lower in number than 3001. Co-ops who are beginning a foreign language should limit themselves to French, German, and Spanish.

Courses at the 2000-, 3000-, and 4000-level do not have to be taken in chronological order, provided prerequisites are fulfilled.

With minor exceptions, students can fulfill their 36-hour humanities requirement for graduation by taking courses, including linguistics courses, in the Department of Modern Languages. Students should consult the catalog course descriptions and the section of this catalog titled "Humanities and Social Sciences Requirements," p. 33, in order to determine which courses are classified as humanities and which are classified as social sciences in their respective colleges. With the approval of their major schools, students may take any courses offered by the Department of Modern Languages on a pass/fail basis.

### **College Credit for High School Study**

The Department will grant nine hours of elective credit in French, German, Spanish, Chinese, Japanese, or Russian for high school study in a foreign language, provided the student has two or more years of high school credit (or the equivalent) in the language in question and has completed nine quarter hours at the 2000-, 3000-, or 4000-level with an average grade of C or higher. Transfer students must complete at least three of the nine hours at Georgia Tech.

Students submitting a score of 4 or 5 on the College Entrance Examination Board Advanced Placement Examination in French, German, or Spanish "Language Level III" or "Literature Level III" may receive free elective credit for courses numbered 1001-2-3 in the respective language. Students who submit language scores of 5 or above from a certified high school International Baccalaureate Program may also receive free elective credit for courses numbered 1001-2-3 in the respective language.

The Department will not grant credit for high school study in a foreign language to students who speak the language in question as their native language or to students who have taken 1000-level courses or the equivalent at Georgia Tech or at

other college-level institutions for which they have received transfer credit.

To have this free elective credit entered on their records, students must request that the appropriate form be submitted by the Department of Modern Languages to the registrar. This elective credit is not applicable toward fulfillment of the 36-hour humanities requirement for graduation. No grade is attached to this credit.

### **Doctoral Degree Language Requirements**

See page 42.

### **English for Foreign Students**

All nonnative speakers of English must fulfill requirements in English for graduation either by taking the same courses required of native speakers, offered by the School of Literature, Communication, and Culture, or by taking the special series (FL 0031; FL 1032-33) offered by the Department of Modern Languages.

Nonnative speakers of English may take FL 1032-33 in lieu of the regular ENGL 1001-2 series with the following exceptions:

- 1) International students who have completed three years of study in an American high school and who have earned an American high school diploma must register for the regular ENGL 1001-2 series. These students must pass the Regents' Test.
- 2) Those international students who fail to meet the criteria for entrance into FL 1032 will be asked to first complete FL 0031.

The FL 1032-33 courses must be taken for a letter grade and must be taken in sequence.

Nonnative speakers of English who do not fit into category (1) above can fulfill the requirements of the Regents' Testing Program on competence in English by (1) passing the Regents' Test; (2) by completing the FL 1032-33 series and receiving a course grade of at least 80 in FL 1033, as well as receiving a grade of 85 or higher on the composition portion of the FL 1033 final examination; or (3) by taking the official Michigan English Language Assessment Battery (MELAB) and receiving an overall score of 80 or higher, with a grade of 85 or higher on the composition portion of the test.

## Courses of Instruction

### CHINESE

#### CHIN 1101. Elementary Mandarin Chinese I

3-0-3.

Intensive study of patterns of expression in spoken Chinese. Emphasis on pinyin writing system. (Hum.)

#### CHIN 1102. Elementary Mandarin Chinese II

3-0-3. Prerequisite: CHIN 1101 or equivalent.

Continuation of CHIN 1101; introduction to the Chinese writing system. (Hum.)

#### CHIN 1103. Elementary Mandarin Chinese III

3-0-3. Prerequisite: CHIN 1102 or equivalent.

Continuation of CHIN 1102; more emphasis on written Chinese. (Hum.)

#### CHIN 2101. Intermediate Mandarin Chinese I

3-0-3. Prerequisites: CHIN 1101-2-3 or equivalent.

Intensive study of advanced patterns of expressions in spoken Chinese. Limited introduction to written Chinese (Hum.)

#### CHIN 2102. Intermediate Mandarin Chinese II

3-0-3. Prerequisites: CHIN 2101 or equivalent.

Continuation of CHIN 2101. (Hum.)

#### CHIN 2103. Intermediate Mandarin Chinese III

3-0-3. Prerequisites: CHIN 2102 or equivalent.

Continuation of CHIN 2102. (Hum.)

### FOREIGN LANGUAGE

#### FL 1011-12-13. Elementary Brazilian-Portuguese I, II, III

3-0-3 each course. Prerequisites: 1011-none; 1012-1011 or equivalent; 1013-1012 or equivalent.

Pronunciation, conversation, reading, composition, grammar. Audio-lingual methodology and materials. (Hum.)

#### FL 1021-22-23. Elementary Italian I, II, III

3-0-3 each course. Prerequisites: 1021-none; 1022-1021 or equivalent; 1023-1022 or equivalent.

Pronunciation, conversation, reading, composition, grammar. Audio-lingual methodology and materials. (Hum.)

#### FL 0031. Remedial English as a Foreign Language I

5-0-5.

Special attention given to developing basic listening, vocabulary, and writing skills for nonnative speakers of English who need additional preparation for FL 1032-33. Cannot be counted for credit toward graduation.

#### FL 1032. English as a Foreign Language II

5-0-5. Prerequisite: FL 0031 or equivalent.

Stresses writing, reading, vocabulary. (Hum.)

#### FL 1033. English as a Foreign Language III

5-0-5. Prerequisite: FL 1032.

Stresses composition, readings on life in the United States. (Hum.)

#### FL 2011. Colonial Brazil and the Portuguese Empire, 1500 to 1808

3-0-3. Prerequisite: FL 1013 or equivalent.

Cultural history of Portuguese America from conquest and settlement to the end of the colonial period. Includes grammar review. Conducted in Portuguese. (Hum.)

#### FL 2012. Development of Independent Brazil, 1808 to 1930

3-0-3. Prerequisite: FL 1013 or equivalent.

Cultural history of Brazil from independence through the Empire and the Old Republic. Includes grammar review. Conducted in Portuguese. (Hum.)

#### FL 2013. Brazil since 1930: The Giant Emerges

3-0-3. Prerequisite: FL 1013 or equivalent.

Cultural history of contemporary Brazil from the rise of Vargas to the present day. Conducted in Portuguese. (Hum.)

#### FL 2021. Cultural History of Florence 1300 to 1500

3-0-3. Prerequisite: FL 1023 or equivalent.

Dante, Boccaccio, and the Medicis. Grammar review. Conducted in Italian. (Hum.)

#### FL 2022. Cultural History of Rome 1500 to 1700

3-0-3. Prerequisite: FL 1023 or equivalent.

Emphasis on Michelangelo, Bernini, Borromini. Grammar review. Conducted in Italian. (Hum.)

#### FL 2023. Cultural History of Italy since 1848

3-0-3. Prerequisite: FL 1023 or equivalent.

Unification, Fascism, resistance, postwar boom, current unrest. Conducted in Italian. (Hum.)

#### FL 3801-2-3-4. Special Topics in Modern Languages

3-0-3. Prerequisite: consent of head of the Department.

Permits students to do work in languages not treated in other courses and/or to engage in special research and/or experimental studies.

### FRENCH

#### FREN 1001. Elementary French I

3-0-3.

Essential principles of French grammar and phonetics, acquisition of vocabulary through simple conversational exercises and the reading of simple selections. (Hum.)

#### FREN 1002. Elementary French II

3-0-3. Prerequisite: FREN 1001 or equivalent.

Continuation of FREN 1001, extension of the survey of French grammar, acquisition of a general vocabulary through conversation and reading. (Hum.)

#### FREN 1003. Elementary French III

3-0-3. Prerequisite: FREN 1002 or equivalent.

Reading of selected texts, composition, completion of the survey of French grammar. (Hum.)

#### FREN 2021-2-3. Intermediate Conversation I, II, III

1-3-2 each. Prerequisite: FREN 1003, two years in high school, or equivalent.

A conversational approach to topics of current interest in the humanities in France. (Hum.)

**FREN 2101-2-3. Patterns of French Culture I, II, III**

3-0-3. Prerequisite: FREN 1003 or consent of the instructor.

Proficiency-based introduction to selected sociocultural aspects of France: geography, demography, social institutions, history, art, socioeconomic problems, and current events; incorporates grammar review. Conducted in French. (Hum.)

**FREN 3001. French Literature from 1800 to 1850**

3-0-3. Prerequisite: FREN 2103 or equivalent.

Romanticism, the reappearance of lyric poetry, the importance of the individual as opposed to classical anonymity. Conducted in French. (Hum.)

**FREN 3002. French Literature from 1850 to 1900**

3-0-3. Prerequisite: FREN 2103 or equivalent.

Parnassianism and symbolism, developments in poetry, realism, and naturalism, trends in prose, with emphasis on the development of the novel. Conducted in French. (Hum.)

**FREN 3003. French Literature since 1900**

3-0-3. Prerequisite: FREN 2103 or equivalent.

Exploration of currents in modern prose, poetry, and drama. Conducted in French. (Hum.)

**FREN 3007-8-9. Survey of Literature I, II, III**

3-0-3 each. Prerequisite: FREN 2103 or equivalent. (Hum.)

**FREN 3011. France Today I**

3-0-3. Prerequisite: FREN 2103 or equivalent.

Culture, history, and geography of modern France in lectures and class discussions, short papers on assigned topics; conducted in French. (Hum.)

**FREN 3012. France Today II**

3-0-3. Prerequisite: FREN 2103 or equivalent.

Continuation of FREN 3011. (Hum.)

**FREN 3013. France Today III**

3-0-3. Prerequisite: FREN 2103 or equivalent.

Continuation of FREN 3012. (Hum.)

**FREN 3021-2-3. Advanced Conversation I, II, III**

1-3-2 each. Prerequisite: FREN 2023, or three years in high school or equivalent.

A conversational approach to topics of current interest in the social sciences in France. (Hum.)

**FREN 3030. French Phonetics**

3-0-3. Prerequisite: FREN 2103 or three years of high school French.

A detailed analysis of the significant features of the French sound system, intonation curves, and graphic representation of individual sounds. Taught in French. (Hum.)

**FREN 3061-62-63. France: Culture, Economy, Commerce I, II, III**

3-0-3 ea. Prerequisites: French 2021-22-23 sequence or equivalent.

Introduction to business French. Overview of French government, politics, commerce, communications, publicity, various social milieux, and the work place. (Hum.)

**FREN 3691. Business Communication and Correspondence in France**

3-6-5. Prerequisite: One year of college French or equivalent.

Corequisites: FREN 3692 and FREN 3693.

Refinement of accuracy and flexibility in oral/written expression. Focus on appropriate use of strategies, business negotiation protocols, lexical precision. Incorporates grammar review. Part of the French intensive summer language program. See catalog p. 24. Admission by application only. (Hum.)

**FREN 3692. French Business and Technology**

3-6-5. Prerequisite: One year of college French or equivalent. Corequisites: FREN 3691 and FREN 3693.

Study of business, technological, and cultural issues, tendencies and patterns of behavior among French speaking people. Value systems and their manifestations. Part of the French intensive summer language program. See catalog p. 24. Admission by application only. (Hum.)

**FREN 3693. French Business and Technology II**

3-6-5. Prerequisite: One year of college French or equivalent. Corequisites: FREN 3691 and FREN 3692.

Business organizations and use of technology in France. Specialized vocabularies of economics, engineering and computer science. Attention to geographical and anthropological aspects of selected social and political situations. Part of the French intensive summer language program. See catalog p. 24. Admission by application only. (Hum.)

**FREN 3694. French Business and Technology Abroad**

1-6-3. Prerequisite: Intermediate proficiency level or above.

Two-week tour of France. Field study of technology, economic trends, business institutions and cultural protocols. Journals and papers assigned. Admission by application only.

**FREN 4001. French Stylistics**

3-0-3. Prerequisite: FREN 3003 or equivalent.

Advanced study of syntax and semantics, aimed at development of stylistic sensitivity. Compositions in French. (Hum.)

**FREN 4061-2-3. French Science and Technology I, II, III**

3-0-3 each. Prerequisites: FREN 2103 or three years in high school. Background in chemistry, physics, or biology strongly recommended.

Introduction to scientific and technical French. Analysis and discussion of scientific and technical material pertaining to current issues in the scientific and technical communities. (Hum.)

**FREN 4901-2. Special Problems in French**

Credit to be arranged.

Provides the special instruction required under special programs. (Hum.)

**GERMAN**

**GER 1001. Elementary German I**

3-0-3.

Pronunciation, essential principles of German grammar, rapid acquisition of vocabulary by the reading of simple selections; elementary composition. (Hum.)

## **GER 1002. Elementary German II**

3-0-3. Prerequisite: GER 1001 or equivalent.

Continuation of GER 1001. (Hum.)

## **GER 1003. Elementary German III**

3-0-3. Prerequisite: GER 1002 or equivalent.

Reading and the acquisition of a large vocabulary; continued study of German grammar, composition. (Hum.)

## **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. (Hum.)

## **GER 2002. Introduction to Modern German Culture II**

3-0-3. Prerequisite: GER 1003 or equivalent.

Continuation of GER 2001. (Hum.)

## **GER 2003. Introduction to Modern German Culture III**

3-0-3. Prerequisite: GER 1003 or equivalent.

Continuation of GER 2002. (Hum.)

## **GER 2061-2-3. Issues in Business, Science, and Technology I, II, III**

3-0-3 ea. Prerequisites: GER 1003 or equivalent.

Analysis and discussion of German materials (texts, videos, cassettes) pertaining to issues in the current business world and the scientific and technological communities. (Hum.)

## **GER 3001. Introduction to German Literature I**

3-0-3. Prerequisite: GER 2003 or equivalent.

Literary masterpieces in German. Period: Medieval times to 1750. (Hum.)

## **GER 3002. Introduction to German Literature II**

3-0-3. Prerequisite: GER 2003 or equivalent.

Literary masterpieces in German. Period: 1750 to 1840. (Hum.)

## **GER 3003. Introduction to German Literature III**

3-0-3. Prerequisite: GER 2003 or equivalent.

Literary masterpieces in German. Period: 1840 to the present. (Hum.)

## **GER 3011. Germany Today I**

3-0-3. Prerequisite: GER 2003 or equivalent.

Lectures, papers, and class discussions on German history, urban and rural morphology, postwar social and economic development in East and West Germany. (Hum.)

## **GER 3012. Germany Today II**

3-0-3. Prerequisite: GER 2003 or equivalent.

Continuation of GER 3011; treatment of additional topics: German family life, educational system, church and religion, development of the arts, the Hitler era. (Hum.)

## **GER 3013. Germany Today III**

3-0-3. Prerequisite: GER 2003 or equivalent.

Continuation of GER 3011 and 3012; in-depth treatment of contemporary issues. Supplementary instructional media: slides, recordings, journals, and panel discussions. (Hum.)

## **GER 3031. The German Novelle I**

3-0-3. Prerequisite: GER 2003 or equivalent.

Period: 1795-1840. Goethe, Kleist, Tieck, Arnim, E. T. A. Hoffmann, Eichendorff. Conducted in German. (Hum.)

## **GER 3032. The German Novelle II**

3-0-3. Prerequisite: GER 2003 or equivalent.

Period: 1840 to 1885. Stifter, Keller, Storm, Ebner-Eschenbach, Meyer. Conducted in German. (Hum.)

## **GER 3033. The German Novelle III**

3-0-3. Prerequisite: GER 2003 or equivalent.

Period: 1885 to the present. Hofmannsthal, Mann, Kafka, Musil, Wiechert, Borchert, Gaiser, Piontek. Conducted in German. (Hum.)

## **GER 3041. German Radio Drama I**

3-0-3. Prerequisite: GER 2003 or equivalent.

German radio drama as a literary genre. Study of works of representative dramatists. (Hum.)

## **GER 3042. German Radio Drama II**

3-0-3. Prerequisite: GER 2003 or equivalent.

An in-depth study of the works of Gunter Eich. (Hum.)

## **GER 3061. Advanced Conversation**

3-0-3. Prerequisite: GER 2003 or equivalent.

Practice of speaking and listening proficiency; vocabulary buildup. (Hum.)

## **GER 3062. Advanced Composition**

3-0-3. Prerequisite: GER 3061 or equivalent.

In-depth study of advanced grammar patterns as used in written expression, including business correspondence. (Hum.)

## **GER 3063. Advanced Stylistics**

3-0-3. Prerequisite: GER 3062 or equivalent.

Advanced study of syntax and semantics aimed at the development of stylistic sensitivity. Analysis of representative literary and current interest texts for practice in conversation and composition. (Hum.)

## **GER 3691. Business Communication and Correspondence in Germany**

3-6-5. Prerequisite: one year of college German or equivalent.

Corequisites: GER 3692 and GER 3693.

Refinement of accuracy and flexibility in oral/written expression. Focus on appropriate use of strategies, business negotiation protocols, lexical precision. Incorporates grammar review. Part of the German intensive summer language program. See catalog p. 24. Admission by application only. (Hum.)

## **GER 3692. German Business Culture**

3-6-5. Prerequisite: One year of college German or equivalent.

Corequisites: GER 3691 and GER 3693.

Study of German business structure and issues. Business etiquette, comparative aspects Germany-USA. Part of the German intensive summer language program. See catalog p. 24. Admission by application only. (Hum.)

## **GER 3693. German Science and Technology**

3-6-5. Prerequisite: One year college German or equivalent.

Corequisites: GER 3691 and GER 3692.

Uses of science and technology in the German speaking world. Study of firms and organizations in the energy and

high-tech sector. Specialized vocabulary of engineering, computer science, alternative energy sources. Part of the German intensive summer language program. See catalog p. 24. Admission by application only. (Hum.)

**GER 3694. German Business and Technology Abroad**  
1-0-3.

Two-week tour of German industry, government and technological institutions. Journals and papers assigned. Admission by application only.

**GER 4023. Selected Readings in German Literature**

3-0-3. Prerequisite: GER 2003 or equivalent.

Study of selected authors, movements, genres, and forms in German literature. Selections vary from year to year. Parallel readings, reports, and papers. (Hum.)

**GER 4061-62-63. Advanced Business German I, II, III**  
3-0-3 each. Prerequisite: GERM 2061-62-63, or equivalent.

Advanced principles of German business organization and language. Taught through the use of reading, audio, and video materials. (Hum.)

**GER 4901-2. Special Problems in German**

Credit to be arranged.

Provides the special instruction required under special programs. (Hum.)

**ITALIAN**

See FL 1021 and 2021.

**JAPANESE**

**JAPN 1001. Elementary Japanese I**

4-0-4.

Essential principles of Japanese grammar and phonetics, acquisition of vocabulary through conversational exercises, video, and tape material. (Hum.)

**JAPN 1002. Elementary Japanese II**

4-0-4. Prerequisite: JAPN 1001 or equivalent

Continuation of JAPN 1001. (Hum.)

**JAPN 1003. Elementary Japanese III**

4-0-4. Prerequisite: JAPN 1002 or equivalent.

Continuation of JAPN 1002. (Hum.)

**JAPN 2010. Intermediate Japanese I**

4-0-4. Prerequisite: JAPN 1001-2-3, or equivalent.

Further principles of Japanese grammar and vocabulary. Introduction to different style levels and the writing system. (Hum.)

**JAPN 2020. Intermediate Japanese II**

4-0-4. Prerequisite: JAPN 2010, or equivalent.

Continuation of JAPN 2010. (Hum.)

**JAPN 2030. Intermediate Japanese III**

4-0-4. Prerequisite: JAPN 2020, or equivalent.

Continuation of JAPN 2020. (Hum.)

**JAPN 3001. Advanced Japanese I**

3-0-3. Prerequisite: JAPN 2010-20-30.

Completion of the basic, necessary structures of spoken Japanese. Practice of Kanji characters. (Hum.)

**JAPN 3002. Advanced Japanese II**

3-0-3. Prerequisite: JAPN 3001.

Continuation of JAPN 3001. (Hum.)

**JAPN 3003. Advanced Japanese III**

3-0-3. Prerequisite: JAPN 3002.

Introduction of short, unedited Japanese materials. Composition in the language. (Hum.)

**JAPN 4801-02. Special Topics in Japanese**

3-0-3 each.

**LINGUISTICS**

**LING 2001. Introduction to Language I**

3-0-3.

Study of the design of natural language with emphasis on the traditional description of its phonological and grammatical systems. (Hum.)

**LING 2002. Introduction to Language II**

3-0-3. Prerequisite: LING 2001 or consent of the Department.

Introduction to modern grammatical and semantic theories of language. (Hum.)

**LING 2003. Introduction to Language III**

3-0-3. Prerequisite: LING 2002 or consent of the Department.

Survey of the types of linguistic change and development, comparison of generic and genetic linguistic relationships, linguistic borrowing. (Hum.)

**LING 3001. Introduction to Articulatory Phonetics**

3-0-3. Prerequisite: LING 2003 or consent of the Department.

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. (Hum.)

**LING 3004. Natural Language Processing**

3-0-3.

Primarily for CS students; study of selected topics from grammar and semantics that are important in the understanding and processing of natural language in human and computer contexts. (Hum.)

**LING 3006. Black English I**

3-0-3. Prerequisite: LING 2001 or equivalent.

Origins and development of American Black English from the 1600s to the present. Includes analysis of its structure and its relationship to African languages and cultures. (Hum.)

**LING 3007. Black English II**

3-0-3. Prerequisite: LING 3006 or equivalent.

Continuation of LING 3006 with emphasis on specific area studies relevant to linguistic and cultural typologies of the Black Diaspora. (Hum.)

**LING 3750. International Language Policies**

Cross-listed as INTA 3750.

3-0-3. Prerequisite: LING 2001 or permission of instructor.

An introduction to the politics, problems, and alternative solutions in national language choices. A comparative analysis of several industrialized and developing nations is included. (Hum.)



**LING 4002. Current Developments in Linguistics**

3-0-3. Prerequisite: prior study of linguistics or consent of the Department.

Live issues in the field and approaches favored by various contemporary schools. (Hum.)

**LING 4003. Semantics and Linguistic Structure**

3-0-3. Prerequisite: prior study of linguistics or consent of the Department.

Various approaches to the problem of dealing with meaning in linguistic analysis. (Hum.)

**LING 4901-2. Special Problems in Linguistics**

Credit to be arranged.

Provides the special instruction required under special programs. (Hum.)

**PORTUGUESE**

See FL 1011 and 2021.

**RUSSIAN**

**RUSS 1101. Elementary Russian I**

3-0-3.

Pronunciation, essential principles of Russian grammar, acquisition of vocabulary through illustrative conversations and readings, intensive familiarization with recorded material. (Hum.)

**RUSS 1102. Elementary Russian II**

3-0-3.

Continuation of RUSS 1101. (Hum.)

**RUSS 1103. Elementary Russian III**

3-0-3.

Continuation of RUSS 1102. (Hum.)

**RUSS 2001. History and Culture of Russia I**

3-0-3. Prerequisite: RUSS 1003 or equivalent.

Period: Ninth century to eighteenth century. Review of grammar and oral practice. (Hum.)

**RUSS 2002. History and Culture of Russia II**

3-0-3. Prerequisite: RUSS 1003 or equivalent.

Period: Eighteenth century to 1917. Review of grammar and oral practice. (Hum.)

**RUSS 2003. History and Culture of Russia III**

3-0-3. Prerequisite: RUSS 1003 or equivalent.

Period: 1917 to the present. Review of grammar and oral practice. (Hum.)

**RUSS 4901-2. Special Problems in Russian**

Credit to be arranged.

Provides the special instruction required under special programs. (Hum.)

**SPANISH**

**SPAN 1001. Elementary Spanish I**

3-0-3.

The beginning course. Pronunciation, grammar, reading, composition. Conversations with student assistants who are native speakers of Spanish. (Hum.)

**SPAN 1002. Elementary Spanish II**

3-0-3. Prerequisite: SPAN 1001 or equivalent.

Continuation of SPAN 1001. (Hum.)

**SPAN 1003. Elementary Spanish III**

3-0-3. Prerequisite: SPAN 1002 or equivalent.

Continuation of SPAN 1002. (Hum.)

**SPAN 2021-2-3. Contemporary Hispanic Culture I, II, III**

3-0-3. Prerequisite: SPAN 1003 or consent of the instructor.

Introduction to selected sociocultural aspects of the contemporary Hispanic world. Conducted in Spanish. (Hum.)

**SPAN 3001. Spanish-American Literature before 1895**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Conducted in Spanish. (Hum.)

**SPAN 3003. Introduction to Spanish Literature**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

The cultural heritage of Spain in the Americas as reflected in representative European and Spanish-American literary works. Conducted in Spanish. (Hum.)

**SPAN 3004. Cultural History of Mexico**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Readings from representative authors. Vocabulary building, lectures, discussions, conversation, and composition. (Hum.)

**SPAN 3012. The Latin American Short Story**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

The short story in Latin America both as a literary genre and as an instrument of social revolution, includes authors such as Echeverria, Dario, Lillo, and Borges. (Hum.)

**SPAN 3061. Business Spanish I**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Introduction to fundamentals of business and government institutions and practices in the Spanish-speaking world. Focus on specialized vocabulary. (Hum.)

**SPAN 3062. Business Spanish II**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Focus on oral and written language and cultural context of Hispanic business protocols. Banking and finance, marketing and advertising structures and practices. (Hum.)

**SPAN 3063. Business Spanish III**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Development of linguistic and cultural strategies for conducting successful negotiations with Spanish as the medium of communication. Conducted in Spanish. (Hum.)

**SPAN 3101. Spanish Conversation I**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

A thematic and transactional approach to oral communication, focusing on culturally appropriate use of the language in problem solving and conflict resolution. Conducted in Spanish. (Hum.)

**SPAN 3102. Spanish Conversation II**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Development of communicative ability and cross-cultural awareness through discussion of contemporary issues in the Hispanic world. Conducted in Spanish. (Hum.)

**SPAN 3111-2-3. Composition: Analysis and Development I, II, III**

3-0-3 each. Prerequisite: SPAN 2023 or equivalent.

Writings from the Hispanic World used as springboard for the analysis and enrichment of self-expression and development of precision in written communication. Incorporates grammar review. (Hum.)

**SPAN 3121. Cultural History of Spain I: Reconquest and Renaissance**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

History of Spain from prehistoric times to 1500. Conducted in Spanish (Hum.)

**SPAN 3122. Cultural History of Spain II: Nineteenth- and Twentieth-Century Spain**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

History of Spain from Charles I to the Spanish-American War. Conducted in Spanish.

**SPAN 3125. Cultural History of Spain III: Spain Today**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Spain in the twentieth century. Selected contemporary writings reflecting social, economic, and political issues. Conducted in Spanish. (Hum.)

**SPAN 3135. Latin America Today**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Latin America in the twentieth century. Selected contemporary writings reflecting social, economic, and political issues. Conducted in Spanish. (Hum.)

**SPAN 3141. Individual/Family in Hispanic Literature**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Analysis and discussion of the portrayal of the individual and the family in selected readings from Hispanic literature. Conducted in Spanish. (Hum.)

**SPAN 3142. Society in Hispanic Literature**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Study of Hispanic society as reflected in selected literary works. Conducted in Spanish. (Hum.)

**SPAN 3143. Political Thought in Hispanic Literature**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Analysis and discussion of political thought in selected readings from Hispanic literature. Conducted in Spanish. (Hum.)

**SPAN 3170. Spanish Phonetics**

3-0-3. Prerequisite: SPAN 3101-2 or equivalent.

Spanish phonemic patterns, including dialects of Spain and Spanish America. Fundamentals of articulatory phonetics, practice in auditory discrimination, articulation and transcription. (Hum.)

**SPAN 3691. Business Communication and Correspondence in the Hispanic World**

3-6-5. Prerequisite: One year of college Spanish or equivalent. Corequisites: SPAN 3692 and SPAN 3693.

Refinement of accuracy/flexibility in oral/written expression. Focus on appropriate use of strategies, business negotiation protocols, lexical precision. Incorporates grammar review. Part of the Spanish intensive summer language program. See catalog p. 24. Admission by application only. (Hum.)

**SPAN 3692. Hispanic Business and Culture**

3-6-5. Prerequisite: One year of college Spanish or equivalent. Corequisites: SPAN 3691 and SPAN 3693.

Study of business and cultural issues, tendencies, and traditional patterns of behavior. Value systems and their manifestations, including regional variations. Part of the Spanish intensive summer language program. See catalog p. 24. Admission by application only. (Hum.)

**SPAN 3693. Hispanic Science and Technology**

3-6-5. Prerequisite: One year of college Spanish or equivalent. Corequisites: SPAN 3691 and SPAN 3692.

Study of organization and use of technology in the Spanish-speaking world. Specialized vocabularies. Background given by attention to geographical and anthropological aspects of selected situations. Part of the Spanish intensive summer language program. See catalog p. 24. Admission by application only. (Hum.)

**SPAN 3694. Seminar Abroad--Hispanic Business**

1-6-3.

Two-week tour of industry, government, and financial institutions in selected countries of South America. Journals and papers assigned. Admission by application only.

**SPAN 4023. Spanish Drama since 1920**

3-0-3. Prerequisite: SPAN 3111-2-3 or equivalent.

Emphasis on Garcia Lorca and Casona. Conducted in Spanish. (Hum.)

**SPAN 4026. Spanish Prose since 1920**

3-0-3. Prerequisite: SPAN 3111-2-3 or equivalent.

Emphasis on Spanish writers since the advent of the Franco regime. Conducted in Spanish. (Hum.)

**SPAN 4143. Hispanic Literature South America**

3-0-3. Prerequisite: 9 hours of 3000-level Spanish or equivalent.

Selected works by representative authors from South America. (Hum.)

**SPAN 4151. Hispanic Fiction I: The Short Story in Spain**

3-0-3. Prerequisite: SPAN 3113 or equivalent.

The short story in the literature of Spain from the Middle Ages to the twentieth century. Conducted in Spanish. (Hum.)

**SPAN 4155. Drama Workshop**

3-0-3. Prerequisite: SPAN 2023 or equivalent.

Literary and theatrical aspects of Hispanic drama are explored through class discussion and performance of a collection of contemporary one-act plays. (Hum.)

**SPAN 4170. Spanish Applied Linguistics**

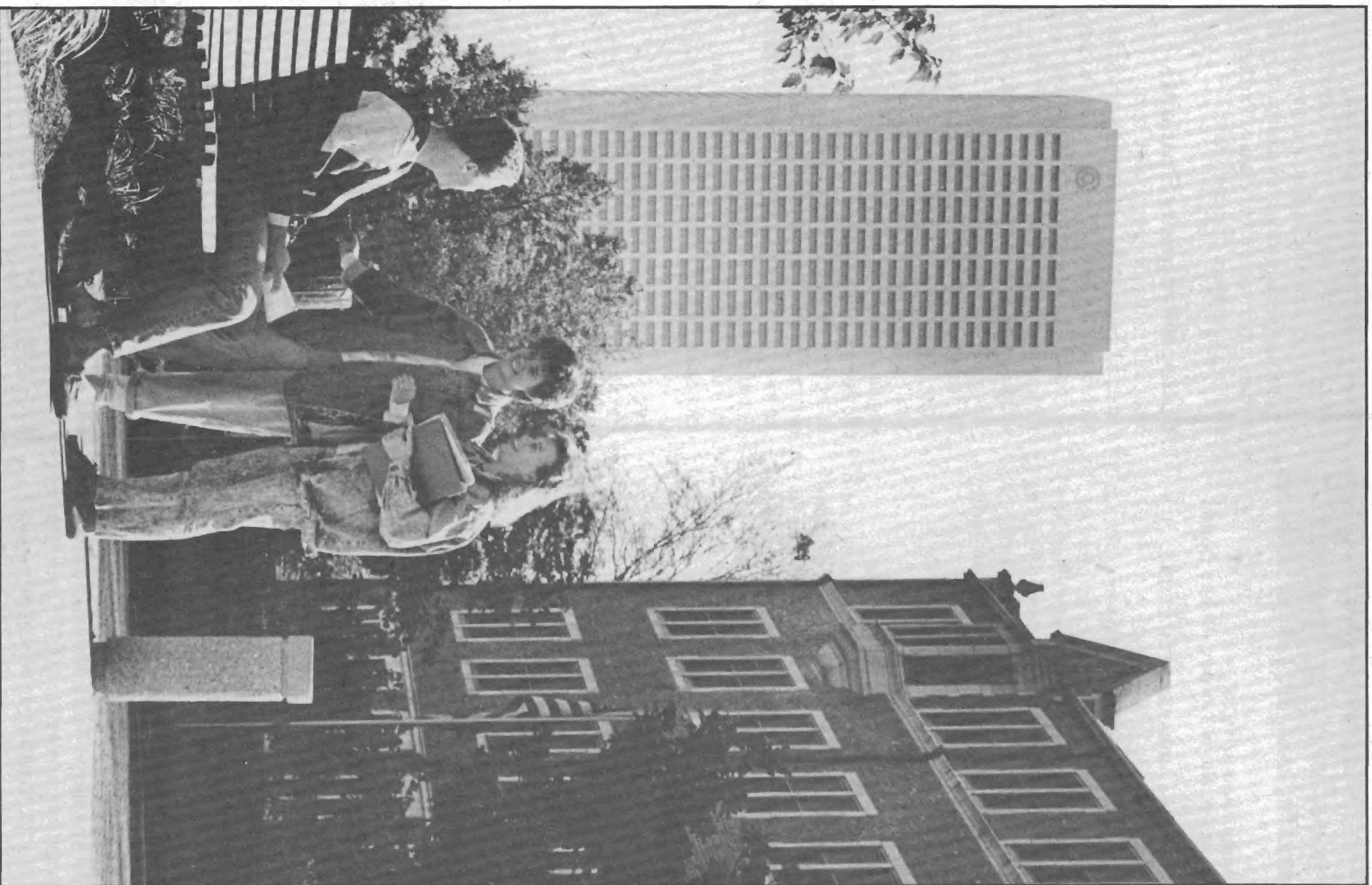
3-0-3. Prerequisite: 9 hours of 3000-level Spanish or equivalent.

Advanced linguistic analysis of the Spanish language, particularly as it contrasts with English. (Hum.)

**SPAN 4901-2. Special Problems in Spanish**

Credit to be arranged. Prerequisite: consent of the Department.

Provides the special instruction required under special programs. (Hum.)



## Department of Naval Science

**Established in 1926**

**Location: Naval Armory, Bobby Dodd Way**

**Telephone: 404-894-4771/4772**

*Commanding Officer and Professor of Naval Science*—William A. Rogers, Jr., USN; *Associate Professor*—Lieutenant Commander Vanessa O. Johnson, USN; *Assistant Professors*—Major Greg Kesselring, USMC; Lieutenant Charles Dennis, USN; Lieutenant John Griffiths, USN; Lieutenant Zachary Scruton, USN.

### General Information

The NROTC program offers students the opportunity to qualify for service as commissioned officers in the United States Navy or Marine Corps. The program's objectives are to provide students with an understanding of the basic concepts and principles of naval science, associated professional knowledge, and the requirements for national security. NROTC students receive an educational background that allows them to later undertake advanced education in the naval service. The NROTC program is an officer accession program for the unrestricted line. Upon graduation, the student is commissioned as an officer in the Naval Reserve or Marine Corps Reserve. Naval officers are ordered to active duty in submarines, surface combatants, or the aviation community. Marines undergo training leading to a variety of specialties. NROTC students are enrolled in one of the three categories outlined below.

### Scholarship Students

Four-year and three-year scholarship students are selected through nationwide competition. Selection criteria include SAT or ACT scores, high school academic performance, and extracurricular activities. The selection process is administered by the Naval Recruiting Command; however, the NROTC unit will provide guidance and information to applicants. The NROTC scholarship pays for tuition, fees, and textbooks. The Navy also provides uniforms and a \$100 per month subsistence allowance. The Naval Science Department conducts an orientation program

(INFORM) for all new NROTC scholarship students during the week prior to the start of the fall quarter. Scholarship students must complete the naval science curriculum and also participate in cruises from four to six weeks duration during the summers between academic years.

### College Program Students

Nonscholarship students may seek a naval commission through the NROTC College Program. Interested students may apply at the Naval Armory on campus. The process includes a review of previous academic performance and interviews with staff personnel. Students accepted into the College Program must complete the Naval Science curriculum and take a cruise between junior and senior years. The Navy provides uniforms and Naval Science texts. Students who enter advanced standing in the junior year receive a subsistence allowance of \$100 per month. College program students are eligible to compete for scholarships ranging from one to three years. Selection criteria are based on academic performance at Georgia Tech and military performance as a College Program student. For information, contact the Naval Science Department.

### Two-year Scholarship Program

Sophomores may apply and compete nationally for two-year NROTC scholarships. Those selected attend six weeks of training in Newport, Rhode Island, during the summer between the sophomore and junior years. Upon successful completion, the student joins the NROTC program on an equal footing with other students in the junior year naval science classes. Interested students should contact the Naval Science Department.

### Curriculum

In addition to the required naval science courses, all Navy Option Scholarship Students must take calculus (MATH 1507-8 or MATH 1517-8), physics (PHYS 2121-2 or 2141-2 series), INTA 3510 and 3520 (INTA 3300 and 3550 may be substituted), and one term of computer science. Marine Option students must also take the above listed international affairs courses or their equivalent as approved by the professor of naval science. Any additional requirements are based on

whether the student is in a technical or nontechnical major, is a Navy Option or Marine Option student, and a scholarship or nonscholarship recipient. Each student must obtain from the NROTC Department a complete description of program requirements since the above statement is only a general outline.

No more than six hours of credit in basic naval science courses and no more than nine hours of credit in advanced naval science courses will be applied toward degree requirements.

## **Courses of Instruction**

### **NS 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.

### **NS 1011. Naval Maritime History I** 2-0-2.

An examination of United States expansion and development as fostered by the use of seapower. The rise and fall of other nations will also be examined within the context of their effect on United States policies. Covers 1660 to 1918.

### **NS 1012. Naval Maritime History II** 2-0-2. Prerequisite: NS 1011

An examination of United States expansion and development as fostered by the use of seapower. The rise and fall of other nations will also be examined within the context of their effect on United States policies. Covers 1919 to the present.

### **NS 2021. Naval Systems Engineering I** 2-0-2.

This course develops and broadens the student's understanding of basic engineering concepts and principles as applied to naval engineering plants. The course also examines naval weapons engineering within the framework of naval weapons systems employed by the U.S. fleet. Part one of a three-part course.

### **NS 2022. Naval Systems Engineering II** 2-0-2. Prerequisite: NS 2021

This course develops and broadens the student's understanding of basic engineering concepts and principles as applied to naval engineering plants. The course also examines naval engineering within the framework of naval weapons systems employed by the U.S. fleet. Part two of a three-part course.

### **NS 2023. Naval Systems Engineering III** 2-0-2. Prerequisite: NS 2021

This course develops and broadens the student's understanding of basic engineering concepts and principles as applied to naval engineering plants. The course also examines naval engineering within the framework of naval weapons systems employed by the U.S. fleet. Part three of a three-part course.

### **NS 3001. Navigation I** 3-2-3.

Theory and technique of navigation at sea. Areas of emphasis include dead reckoning, piloting, rules governing waterborne traffic. Practical applications utilizing nautical charts, tables, and instruments.

### **NS 3002. Navigation II** 3-2-3. Prerequisite: NS 3001 or consent of the 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.

### **NS 3003. Naval Operations** 3-2-3. Prerequisite: NS 3002. NROTC students only.

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.

### **NS 3005-6. Evolution of Warfare I and II** 3-2-3 each.

Two-quarter sequence explores forms of warfare practiced by great peoples in history. Selected campaigns are studied, with emphasis on impact of leadership, evolution of tactics, weaponry, and principles of war.

### **NS 4004-5. Amphibious Warfare I and II** 3-2-3 each.

Two-quarter sequence designed to study projection of seapower ashore, with emphasis on evolution of amphibious warfare in the twentieth century. Strategic concepts, current doctrine discussed.

### **NS 4101. Naval Leadership and Management I** 3-1-3.

Survey of the development of managerial thought through functional, behavioral, and situational approaches. Managerial functions, communication, and major theories of leaders and motivation applied to the Navy organization. Culminates with focus on core values of integrity and leadership.

### **NS 4102. Naval Leadership and Management II** 2-1-2.

Discussion of the administrative duties and responsibilities of the junior naval officer for personnel management and division discipline, includes study of significant features of Navy regulations and military law.

### **NS 4103. Naval Leadership and Management III** 2-1-2.

Introduction to the Navy Human Resources Management Support System and detailed instruction in the areas of enlisted performance evaluation, advancement, and service records, including the junior naval officer's duties and responsibilities for material maintenance and personnel training. Other specific topics include terrorism, operational safety, rules of engagement, and tactics. Seminars in elements of personal affairs planning, including finances, orders, benefits, travel, and related topics.

# Philosophy of Science and Technology

## Courses of Instruction

*Faculty Coordinator*—Patrick Kelly, Professor, School of International Affairs; *Professors*—Nancy J. Nersessian, School of Literature, Communication, and Culture; Bryan G. Norton, Stanley R. Carpenter, School of Public Policy; *Assistant Professor*—Jon J. Johnston, School of Public Policy.

### General Information

Georgia Tech offers undergraduate courses in philosophy, with a particular focus on the Philosophy of Science and Technology. The courses are intended to broaden the students' perception of the world around them and to focus their understanding of the context of their lives as professionals and citizens. As indicated on p. 33 of the catalog, philosophy courses can be used to satisfy the distribution requirement in humanities.

A certificate program in philosophy is available for students who wish to concentrate course work in this field. The certificate program consists of 15 hours of course work, chosen in consultation with the faculty coordinator.

Students should consult the faculty coordinator or others in the philosophy faculty concerning the schedule of course offerings.

### PHILOSOPHY OF SCIENCE AND TECHNOLOGY

**PST 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.

**PST 1127. Science, Technology, and Human Values**  
3-0-3.

An examination of the ways engineering technology shapes and is shaped by societal values. Also considers the appropriate and intermediate technology movements.

**PST 3102. History of Ancient Philosophy**  
3-0-3.

A study of the development of philosophy from the early, pre-Socrates' scientific writings to Christian thought. The works of Plato and Aristotle are stressed.

**PST 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.

**PST 3104. Contemporary Philosophy**  
3-0-3.

A study of the diverse movements in philosophy from Hegel to Russell, with emphasis on the philosophical response to the development of modern scientific inquiry.

**PST 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 and ethical standards.

**PST 3107. Comparative Religions**  
3-0-3.

Introduction to the development of the most important concepts in modern religious systems. Emphasis will be placed on the contributions of philosophical analysis and theological debate.

**PST 3113. Symbolic Logic**  
3-0-3.

An introduction to the symbolic analysis of logical argument. Includes propositional calculus, truth tables, truth trees, and methods of deduction.

**PST 4110. Theories of Knowledge**  
3-0-3. Prerequisite: PST 1126 or 1127 or consent of the instructor.

Critical examination of perception, verification, a priori a posteriori knowledge, meaning and criteria of truth, presuppositions and cognitive significance of scientific and philosophical propositions.

**PST 4115. Philosophy of Science**  
3-0-3. Prerequisite: PST 1126 or 1127 or consent of the instructor.

Examination of selected problems such as causality, inductions, scientific explanation, development of scientific knowledge, social and philosophical import of scientific theories.

**PST 4757. Technology Assessment**  
3-0-3. Prerequisite: junior standing.

Systematic efforts to anticipate impacts on society that may occur when a technology is introduced, extended, or modified. Considers concepts, organization, and uses of various specific assessment methods.

**PST 4875-6-7. Special Topics in the Philosophy of Science and Technology**  
3-0-3. Topics to be selected.

**PST 4944-5-6-7-8. Selected Problems in the History of Science**  
Credit to be arranged.

**PST 4949. Special Problems**  
Credit to be arranged.

**PST 8549. Special Problems**  
Credit to be arranged.

# Political Science

## Courses of Instruction

### *Faculty Coordinator and Associate*

*Professor*—Sandra W. Thornton, School of History, Technology, and Society (HTS) and International Affairs (INTA); *Professors*—Barry Bozeman, Public Policy (PUBP); Linda P. Brady, INTA; John E. Endicott, INTA; John W. Garver, INTA; Robert Kennedy, INTA; Daniel Papp, INTA; J. David Roessner, PUBP; Michael D. Salomone, INTA; Dorothy C. Yancy, HTS; *Associate Professors*—Richard P. Barke, PUBP; John J. Havick, PUBP; William J. Long, INTA; John R. McIntyre, Management and INTA; Georgia A. Persons, PUBP; David Wilsford, INTA; Assistant Professors—Peter Brecke, INTA; William R. Clark, INTA; Gordon Kingsley, PUBP; Fei-ling Wang, INTA; Brian Woodall, INTA.

### General Information

Georgia Tech offers undergraduate courses in political science that are intended to broaden the students' perceptions of political processes and governmental institutions. As indicated on p. 33 of this catalog, political science courses may be used to satisfy the distribution requirement in social sciences, including the state-mandated requirement on the Constitutions of the United States and Georgia. This requirement may be satisfied by completion of POL 1251 or 3200. The requirement also may be satisfied by examination.

A certificate program in political science is available for students who wish to concentrate course work in this discipline. The certificate program requires 15 hours of course work, chosen in consultation with the faculty coordinator or other political science faculty member.

Students should be aware that some political science courses are offered in International Affairs (INTA) and Public Policy (PUBP). Students should consult with the faculty coordinator or others of the political science faculty concerning course offerings.

### 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 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. Gives exemption from United States and Georgia Constitution examination.

#### **POL 3210. National Legislative Processes**

3-0-3.

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 or consent of the School.

Source, nature, and use of presidential power, the roles of the President. Recent historical examples emphasized.

#### **POL 3215. Public Opinion**

3-0-3. Prerequisite: POL 1251 or consent of the School.

Public opinion polling techniques, including sampling, questionnaire construction, and interpretation. Analysis of actual opinion data collected on a national basis.

#### **POL 3216. American Political Parties**

3-0-3. Prerequisite: POL 1251 or consent of the School.

Study of political party developments and their role in the electoral process.

#### **POL 3217. State and Local Government**

3-0-3. Prerequisite: POL 1251 or consent of the School.

Analysis of structure and function of state, county, and municipal government.

#### **POL 3220. Urban Government and Political Problems**

3-0-3. Prerequisite: POL 1251 or consent of the School.

An examination of political institutions and processes in the urban setting, including metropolitan government and intergovernmental relations.

#### **POL 3221. Urban Political Problems**

3-0-3. Prerequisite: POL 1251 or consent of the School.

A consideration of urban political behavior, including brokerage politics, politics in suburbia, and community power structures.

#### **POL 3250. Public Administration and Public Policy**

3-0-3. Prerequisite: POL 1251 or consent of the School.

Study of decision-making and organization theory, bureaucratic policy making, intergovernmental relations, taxing and spending policy.

#### **POL 4205. Mass Communications and the Political Process**

3-0-3. Prerequisite: POL 1251.

Examination of communications policies, the political process that shapes these policies, and the role of the mass media in the political process.

**POL 4210. Science, Technology, and Public Policy**  
3-0-3. Prerequisite: POL 1251 or consent of the School.

Examination of relationship between science and government, including the effect of each area on the other in decision-making processes.

**POL 4212. Government Policy and Technological Innovation**

3-0-3. Prerequisite: POL 1251 or equivalent, or consent of the instructor.

Explores the relationship between government policy and the development and use of new technology in the private economy, and between technological innovation and economic growth.

**POL 4250. Policy Analysis and Evaluation**

3-0-3.

Study of the policy adviser in and out of government, social indicators and social accounting, evaluation of public policy, evaluation research techniques.

**POL 4755. Sex Roles: Their Development and Cultural Influence**

3-0-3.

Psychological principles, legal facts, and literary explications are integrated in an examination of the roles of men and women from three time perspectives: historical, current, and future. Also listed as ENGL 4755 and PSY 4755.

**POL 4875-6-7. Special Topics in Political Science**

3-0-3.

**POL 4950, 4953-4-5-6. Special Problems in Political Science**

Credit to be arranged.

**POL 4951. Georgia Internship Program**

Credit to be arranged (15 hours maximum).

Work-study program assigning student to project in state or local government. Student prepares research paper under jurisdiction of faculty member.

**POL 4952. Legislative Intern Program**

Credit to be arranged.

Service learning program combining an academic study of the legislative process with an internship at the Georgia legislature in winter quarter. Interns selected competitively each year.

**POL 6952. Legislative Intern Program**

Credit to be arranged.

Service learning program combining an academic study of the legislative process with an internship at the Georgia legislature in winter quarter. Interns selected competitively each year.

**POL 8574. Special Problems in Political Science**

Credit to be arranged.

Topics to be selected.

## School of Public Policy

**Established in 1990**

**Location: D. M. Smith Building**

**Telephone: 404-894-3196**

*Director and Professor*—Barry Bozeman;  
*Southern Bell Professor of Telecommunications Policy*—William H. Read; *Professors*—Ronald H. Bayor (Joint Appointment), Stanley R. Carpenter, Bryan G. Norton, Alan L. Porter (Joint Appointment), J. David Roessner, David S. Sawicki (Joint Appointment); *Associate Professors*—Richard P. Barke, Michael L.P. Elliott (Joint Appointment), John J. Havick, Arthur C. Nelson (Joint Appointment), Georgia A. Persons, Michael O. Rodgers (Joint Appointment), Philip Shapira; *Assistant Professors*—Ann Bostrom, Jon J. Johnston, Gordon Kingsley.

### General Information

Planning national investments in new technology, managing hazardous and radioactive wastes, pricing new telecommunications services, using computers to assist local economic development, and balancing a society's needs for economic growth with the needs of ecological systems are just a few examples of the ways that the causes and consequences of scientific and technological change are becoming increasingly important to public policymakers. Public policy studies at Georgia Tech therefore have claim to the specialized knowledge and understanding that are now essential to the development and evaluation of effective policy in a technical world.

The School of Public Policy offers an M.S. in Public Policy as well as undergraduate course work in several social science disciplines whose theories and methods contribute to the systematic study of public policy problems. The School shares responsibility for offering undergraduate courses in political science, philosophy, and other social sciences with the other units in the Ivan Allen College. Undergraduates interested in public policy will also find relevant courses offered by the city planning program in the College of Architecture. Bachelor's and doctoral degrees in public policy are expected to be implemented by Fall 1995.



## Certificates

Certificate programs enable students to concentrate on course work in areas of their particular interest. Each program provides for the systematic examination of ideas and problems that enrich the students' understanding of the social and cultural dimensions of their professional majors. To aid students planning graduate studies in law, medicine, business, or a field such as public policy, the certificate program also strengthens the students' background by allowing them to gain competence in areas additional to their majors.

The School of Public Policy currently offers three undergraduate certificate programs. Two are in the traditional disciplines of philosophy and political science, and the third cuts across disciplinary boundaries to provide a foundation in public policy.

Students interested in planning a certificate program in one of these areas should contact the School for further information. A faculty adviser assists each student in planning a program of study to meet his or her needs and interests.

## Graduate Programs in Public Policy

The Master of Science in Public Policy is designed for students with strong analytical backgrounds, such as those received in engineering, natural science, or an analytically oriented social science or humanities curriculum. Graduate studies in public policy focus on areas in which either the consequences of scientific and technological activity have significant public policy implications, or technical and scientific information is a significant input to the policy making process. The M.S. program has the following distinctive features:

1. Emphasizes research and teaching in policy areas that have significant scientific or technological content.
2. Carefully balances analytical rigor and technical aspects of the curriculum against explicit, systematic treatment of ethical and value dimensions of the consequences of policy choice, and of the methods for analyzing policy alternatives.
3. Ensures that students have great flexibility in their choice of course work and area of policy concentration.

The M.S. in Public Policy requires 72 credit hours of study, including either six hours devoted to producing a professional paper or 15 hours for a thesis. In general, it is expected that students planning to enter employment upon completing the degree will choose the paper option, while students planning to continue their graduate work will choose the thesis option.

### Non-thesis Option

Core curriculum	30 hrs.
Elective courses	36 hrs.
Research Paper	6 hrs.
<b>TOTAL</b>	<b>72 hrs.</b>

### Thesis Option

Core curriculum	30 hrs.
Elective courses	27 hrs.
Thesis	15 hrs.
<b>TOTAL</b>	<b>72 hrs.</b>

Although the curriculum is sufficiently flexible to accommodate the interests of students in many policy areas that involve science and technology, students generally focus on one or more of the following areas of concentration: environmental policy, urban and regional policy, economic development and science and technology policy, and telecommunications policy. Students are encouraged to develop their own programs of study, usually based in one of these areas, by taking courses and conducting research in other units such as international affairs; environmental engineering; biology; city planning; management; economics; earth and atmospheric sciences; and industrial and systems engineering.

The first year emphasizes core courses in policy processes and methods of analysis, while the second year focuses on electives in the student's area of concentration. Students must achieve a grade of *B* or higher in all core courses. A summer internship, work experience, or co-op assignment between the first and second year offers the student insight into a research or professional setting related to his or her career interests. Regardless of the areas of concentration, students will pursue rigorous analytical study based in the social sciences, engineering, science, planning, management, and the humanities appropriate for understanding the complex

relationships among science, technology, and public policy.

Students may apply at any time. Core curriculum is designed primarily for entering fall students, but it is possible to begin winter or spring. Candidates for admission must take the GRE. Application materials may be obtained from the School's office.

## **Financial Aid**

Fellowships and assistantships (some of the latter associated with work on thesis-related research projects) are frequently available to qualified students. They include eligibility to waive out-of-state tuition. Students with graduate research assistantships cannot be employed elsewhere without the express permission of the School. Students who wish to apply for financial aid for fall quarter matriculation must submit their application materials by March 1.

## **Co-op**

The School participates in the Georgia Tech Co-op Program, administered by the Graduate Studies and Research Office. Reports and analyses written in a co-op situation may fulfill the requirement for the non-thesis option paper, while at the same time provide a useful product for the co-op employer. (See "Information for Graduate Students.")

## **Placement**

Students trained in the policy aspects of science and technology, such as graduates of the Georgia Tech MSPP program, will find appropriate employment in business, government, and nonprofit agencies. The typical graduate with this goal will be employed as a policy analyst or a strategic or environmental planner in government, industry, or a consulting firm.

The unique features of the M.S. in public policy at Tech also make the degree a natural springboard to doctoral study in interdisciplinary fields such as urban and environmental policy, science and technology policy, telecommunications and information policy, and the management of technology.

## **Courses of Instruction**

(\* indicates a core course)

### **\*PUBP 6010. Ethics and the Policy Profession** 3-0-3.

Examination of the role of values in public decision-making, with special emphasis on the effects of personal values of professionals on public institutions and private sector organizations.

### **\*PUBP 6012. Policy Formulation and Development** 3-0-3.

Theories of public policy (e.g., rationalist, incrementalist, pluralist); stages of the policy process; public participation and policy analysis; and theories of policy behavior.

### **\*PUBP 6014. Organization Theory** 3-0-3.

Provides advanced knowledge of the bureaucratic, political, and social behaviors in complex organization. Examines organizational factors in developing new policies and implementing them.

### **\*PUBP 6016. Logic of Policy Inquiry** 3-0-3. Prerequisites: PUBP 6010 and 6012.

The conceptual foundations of models of policy inquiry: scientific, rational-actor, and ethical. Ethical values underlying cost-benefit analysis, pareto optimal models, and market models.

### **\*PUBP 6018. Policy Implementation and Administration**

3-0-3. Prerequisite: PUBP 6012, or consent of the instructor.

Theoretical and practical difficulties in executing, managing, and evaluating public policies. Includes the behavior of administrative bodies and the compliance of target groups.

### **\*PUBP 6110. Statistical Analysis in Public Policymaking** 2-3-3.

Probability, statistical analysis, and hypothesis testing in a public policy context. The course is taught in a spreadsheet/microcomputer environment with policy examples.

### **\*PUBP 6112. Research Design in Policy Science**

2-3-3. Prerequisite: PUBP 6110 or consent of the instructor.

Conceptual and methodological issues in policy research, including causality and explanation, data collection, hypothesis formulation, operationalization of variables, validity, and reliability.

### **\*PUBP 6114. Data Analysis in Policy Science**

2-3-3 Prerequisites: PUBP 6110 and 6112 or consent of the instructor.

Expands statistical skills to linear models of multivariate data. Topics include the broader concepts involved in research design as well as model building with application to public problems.

### **\*PUBP 6116. Microeconomic Analysis in Public Policymaking**

3-0-3. Prerequisite: Graduate standing or consent of the instructor.

Microeconomic theory with applications to public policy problems, introduction to welfare economics; categories of market failure and the public sector's role; methods of program analysis.

**\*PUBP 6118. Public Finance and Public Policy**

3-0-3. Prerequisite: PUB 6116 or consent of the instructor.

Theory and policy implications of alternative federal, state, and local budgeting and financing practices.

**PUBP 6200. The Legal Context of Urban Policymaking**

3-0-3. Prerequisite: PUBP 6012 or consent of the instructor.

Background on law; private and public regulatory analysis; fundamental rights and equal protection; statutory civil rights; land use controls; building, safety, and housing codes; taxation as regulation; anti-trust; eminent domain; urban finance.

**PUBP 6210. Public Information Systems**

2-3-3. Prerequisites: PUBP 6110, 6112, and 6114 or consent of the instructor.

Design, development, and management of information systems for the public sector, including data base management, automated spreadsheets, and development of custom applications.

**PUBP 6212. Demographic and Economic Forecasting in Public Policy**

2-3-3. Prerequisite: Policy core or consent of the instructor.

The demographic and economic determinants of public policy are simultaneously explored, and economic/demographic methods for forecasting and analyzing population change are examined.

**PUBP 6214. Governmental Accounting and Financial Analysis**

2-3-3. Prerequisites: PUBP 6116 and 6118 or consent of the instructor.

This course is an extension of PUBP 6118. Public accounting and financial analysis; analysis of public financial statements; strategic planning using budgeting processes.

**PUBP 6216. Methods of Urban Policy Analysis**

2-6-4. Prerequisite: first year policy core or consent of the instructor.

This is a case study course that requires the students to synthesize and use the policy analysis methods and processes learned in the policy core.

**PUBP 6218. Quantitative Models in Public Policy**

2-3-3. Prerequisites: All first year methods courses plus PUBP 6216, or consent of the instructor.

Quantitative models for decision-making in public policy: an introduction to applied probability modeling, forecasting, decision analysis, project management, and linear programming.

**PUBP 6220. Applied Analysis of Urban Systems**

2-3-3. Prerequisites: All first year methods courses plus PUBP 6214, 6216, and 6218 or consent of the instructor.

Analysis of policies focused specifically on the physical urban infrastructure: water and sewer, transportation, solid waste disposal, etc.

**PUBP 6300. Earth Systems**

4-0-4.

Description of the operation and interaction of the various Earth systems including human impacts on these systems. Topics include the physical climate system, the hydrological cycle, and selected biogeochemical cycles.

**PUBP 6310. Environmental Issues**

3-0-3.

Seminar exploring the current environmental issues that impact environmental policy decisions. Current papers dealing with environmental issues are analyzed and debated.

**PUBP 6312. Economics of Environmental Policy**

3-0-3.

Basic concepts of environmental economics including externalities, efficiency, social welfare, and environmental quality as a public good. Study of environmental problems (i.e., water resources, air quality, urbanization) and vehicles of collective environmental action.

**PUBP 6314. Policy Tools for Managing the Environment**

3-0-3.

An interdisciplinary survey of tools and methods for managing environmental problems including regulation, market incentives, litigation, and risk assessment.

**PUBP 6316. Environmental Organizations and Political Process**

3-0-3. Prerequisites: graduate standing or consent of the instructor.

Examines the organizational and political basis for environmental decision-making policy setting and implementation. Includes both advocacy and governmental organization, their interaction within the political arena, and the consequent impacts on environmental management.

**PUBP 6318. Goals and Objectives in Environmentalism**

3-0-3.

An examination of the goals and objectives of environmentalists in four policy areas: resource use, pollution control, protection of biological diversity, and land use.

**PUBP 6320. Sustainable Systems: Concepts and Measures**

3-0-3.

Exploration of the concepts and models for understanding and measuring the sustainability of human productive systems, including economic and other social scientific models, ethical models, and natural scientific models.

**PUBP 6322. Computer-based Environmental Policy Analysis**

3-3-3.

Use of computer programs to develop and analyze environmental policies. Course introduces students to several computer programs dealing with water resources, air quality, and graphic information systems and their use for policy analysis and study.

**PUBP 6324. Environmental and Technological Risk Management**

3-0-3. Prerequisite: graduate standing or permission of the instructor.

Offers practical instruction on techniques of risk analysis and the theory and practice of risk management. Focuses on the sources of risk, approaches to understanding risk in organizations and in the public policy-making arena, and consequences of risk management strategies on environmental and technological policy.

**PUBP 6326. Environmental Ethics**

3-0-3.

Historical and analytical examination of the following questions: What is the proper relationship between humans and nature? What are the values of nature?

**PUBP 6328. Environmental Impact Assessment**

3-0-3.

Introduction to the environmental impact assessment process including environmental legislation, environmental impact statements, assessment of impacts, and local input and participation.

**PUBP 6330. Environmental Law**

3-0-3.

Presents a legal analysis of environmental law and its role in shaping environmental quality. Topics include policymaking processes, the legal basis for environmental regulation, the impact of environmental policy, and implementation and enforcement.

**PUBP 6332. Environmental History**

3-0-3.

A history of environmentalism in America from 1870 to 1970, tracing the attitudes and institutions of the movement from early concerns about forest depletion to Earth Day 1970.

**PUBP 6400. Social Institutions of Science and Technology**

3-0-3.

Examination of science and technology as social institutions, their changing roles in industrial societies, influences on the production of scientists, engineers, and scientific and technological knowledge.

**PUBP 6410. Science, Technology, and Public Policy**

3-0-3. Prerequisite: undergraduate course in American government or its equivalent.

Examination of the relationships between science, technology, and government including policies for support, control, and application of science and technology.

**PUBP 6412. Science, Technology, and Regulation**

3-0-3. Prerequisite: PUBP 6410.

Regulatory constraints and encouragement of science and technology; political and economic justifications; expert and public participation; impacts on technological development; policy controls for technological externalities.

**PUBP 6414. Technological Innovation and Government Policy**

3-0-3. Prerequisite: PUBP 6410.

Federal and state policies to stimulate innovation; sources and stimuli for innovation; roles of universities, industry-university agreements, joint R&D ventures, and consortia and technology transfer.

**PUBP 6416. Analytical Methods for Science and Technology Policy**

3-0-3. Prerequisite: PUBP 6410.

Techniques for evaluating basic research; science and technology indicators; causality in evaluating research projects; measuring technology transfer and diffusion; implications for national economic performance.

**PUBP 6418. Comparative Science and Technology Policy**

3-0-3. Prerequisite: PUBP 6410.

Government, cultural, and social influences on research and innovation in Europe, Japan, Soviet Union, developing nations; relationships between science and technology policy and social/economic objectives.

**PUBP 6420. Philosophy of Technology**

3-0-3.

Exploration of theories purporting to explain the relations between technology and society. Examined are cultural, economic, and technological determinism. "Appropriate" and intermediate technologies are also discussed.

**PUBP 6500. The Politics of Telecommunications**

3-0-3.

Impacts of government on telecommunications policy, technology, industry structure, and firm behaviors.

**PUBP 6510. Telecommunications Technologies**

3-0-3.

Introduction to telecommunications systems emphasizing the functional roles of component subsystems, their interactions, and mutual support. (Crosslisted with CS 4375, Introduction to Telecommunications Systems.)

**PUBP 6512. Telecommunications and Society (Gateway Course)**

3-0-3.

Analysis of the Information Age from four perspectives: technology, societal, forces/trends, and policy issues.

**PUBP 6514. Mass Communications Policy**

3-0-3.

Federal regulation of broadcasting, cable television, technical standards, spectrum allocations, and copyright.

**PUBP 6516. Applied Economic Analysis in Telecommunications Policy**

3-0-3.

The problems and policy options associated with economic regulation of communications corporations. (Crosslisted with ECON 4341, Economics of Regulated Industries.)

**PUBP 6518. Common Carrier Telecommunications Policy**

3-0-3.

Overview of telecommunications regulation at the federal, state, and judicial levels.

**PUBP 6520. Seminar in Telecommunications Policy**

3-0-3.

Explores the interface between technology and strategic management using, in part, case studies taken from the telecommunications industry. (Crosslisted with ISYE 6773 and MGT 6773.)

**PUBP 6800. Research Paper (Non-thesis option)**

6-0-6.

Either a professional policy research paper or a team research project including a co-authored policy research monograph prepared for a government or public affairs client.

**PUBP 7000. Master's Thesis**

A thesis meeting the Institute's requirements. Required.

**PUBP 8000. Graduate Seminar—Public Policy**

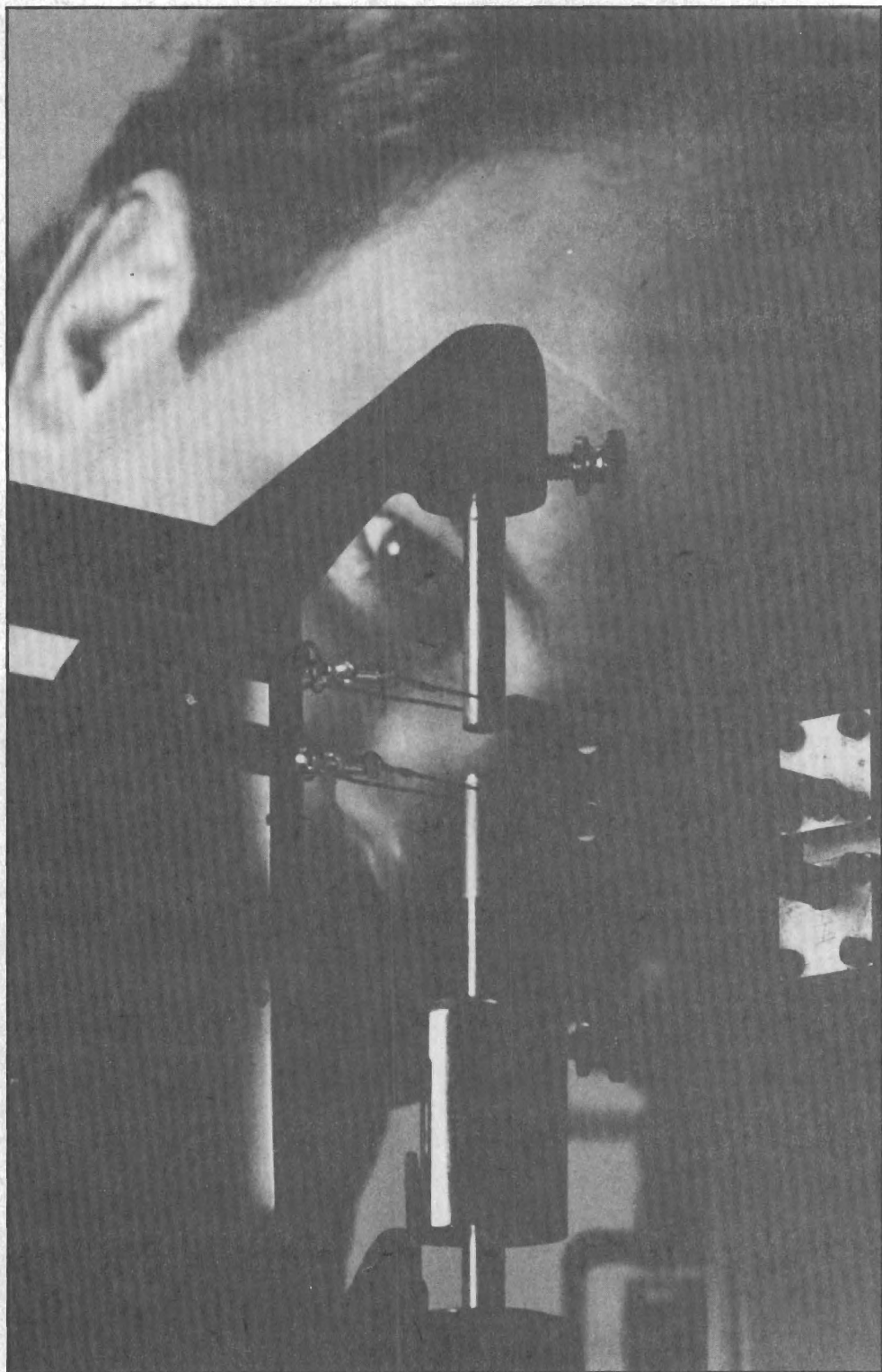
1-0-1.

**PUBP 8100-10-20-30-40-50-60-70-80-90. Special Topics**

1-0-1 thru 5-0-5 respectively.

**PUBP 8600-10-20-30-40-50-60-70-80-90. Special Problems**

Credit to be arranged.



# COLLEGE OF SCIENCES

*Dean*—Gary B. Schuster; *Associate Deans*—Kent E. Barefield, Anderson D. Smith ; *Assistant to the Dean*—Patricia W. Davis; *Regents' Professors*—Richard Browner, Raymond Flannery, Joseph Ford, Ronald Fox, Jack Hale, Uzi Landman, Sheldon May, James Powers, Leon Zalkow.

## General Information

The College of Sciences comprises six degree-granting schools—Biology, Chemistry and Biochemistry, Earth and Atmospheric Sciences, Mathematics, Physics, and Psychology, and one nondegree-granting department, Health and Performance Sciences.

The College of Sciences provides the courses in mathematics and the natural sciences that are necessary for all Tech undergraduates to acquire skills and basic principles for their majors.

A detailed description of each degree program in the College of Sciences is located under the appropriate school heading, as are descriptions of the courses offered. College of Sciences courses required or recommended by the degree-granting programs in the Colleges of Architecture, Engineering, Computing, and the Ivan Allen College are listed under the curricula for those degrees.

Another opportunity, especially rich at the graduate level, is to take advanced courses in interdisciplinary areas and even to undertake thesis research under the joint direction of faculty members from different departments. Interdisciplinary programs include biochemistry; biophysics; molecular genetics; microbiology; biopsychology; applied statistics; algorithms, combinatorics, and optimization; and technology and science policy.

A joint program with Georgia State University makes it possible for students in the College of Sciences to obtain T-4 Teacher Certification in

biology, chemistry, earth sciences, mathematics, physics, or broad-field science while pursuing their Georgia Tech degree. T-4 certification permits the recipient to teach in secondary schools (grades 7-12) in Georgia or in the 35 states having reciprocity with Georgia. This program, as well as a number of programs aimed at improving science and mathematics education in our schools, is managed by the Center for Education Integrating Science, Mathematics, and Computing (CEISM). The Center is a unit of the College of Sciences.

Certificate programs provide additional opportunities to students in good standing to broaden their areas of expertise or acquire skills or information beyond their major degree requirements. With approval of their major school and in consultation with a designated adviser or committee in the school or department offering the certificate program, students may develop a coherent plan of study tailored to meet their individual needs and interests. Students who complete this special program satisfactorily will receive a certificate of recognition.

## Certificate Programs College of Sciences

School/Department	Program
Chemistry and Biochemistry	Biochemistry/Organic Chemistry Chemical Analysis Physical/Inorganic Chemistry
Earth and Atmospheric Sciences	Geochemistry Geophysics

<b>Health and Performance Sciences and Biology</b>	Health Sciences
<b>Physics</b>	Applied Optics Computer-based Instrumentation Atomic, Molecular, and Chemical Physics
<b>Psychology</b>	Biopsychology Engineering Psychology Experimental Psychology Industrial/Organizational Psychology Social/Personality Psychology

Selective certificate programs are available at both the undergraduate and graduate degree levels.

## School of Biology

**Established in 1960**

**Location: Cherry Emerson Building**

**Telephone: 404-894-3700**

*Acting Director*—Roger M. Wartell;  
*Professors*—David B. Dusenbery, Dwight H. Hall, Jerry S. Hubbard, Thomas G. Tornabene, Edward K. Yeagers; *Associate Professors*—Jung Choi, E. Lloyd Dunn, Paul Edmonds, John J. Heise, Gunther U. Holzer, Terry W. Snell, Nancy W. Walls; *Assistant Professors*—Thomas J. DiChristina, Peggy R. Girard; *Adjunct Appointments*—Robert M. Nerem, Mindy Millard-Stafford.

## General Information

Programs of study offered by the School of Biology allow students to gain competence in biophysics, biotechnology, environmental biology, genetics, microbiology, and molecular biology. The Institute, with its strengths in science and technology, provides unique opportunities for training and research in the biological sciences. The curricula in all degree programs encourage breadth by incorporating course selections from other schools and departments.

The Bachelor of Science degree program consists of a combination of requirements and

electives that ensures a balanced background in cell structure, function, and biological processes. A variety of technical electives provides the flexibility to design a curriculum suited to individual interests and career objectives. The undergraduate curriculum in biology is well-suited to prepare students for employment in industrial, academic, and government laboratories; for graduate study; or for medical, dental, veterinary, or other health profession schools. The minimum number of total hours required for a bachelor's degree in biology is 201.

The School of Biology offers graduate programs leading to the M.S. and Ph.D. degrees. The degree programs include course work, student seminars, and independent research. Faculty members are actively engaged in research fields such as aquatic toxicology, biophysics, cell biology, molecular genetics, microbiology, microbial bioremediation and bioanalytical instrumentation.

## Bachelor of Science Curriculum (Suggested Schedule)

### Freshman Year

Course	1st Q.	2nd Q.	3rd Q.
<b>BIOL 1110-1-2</b> General Biology I, II, III	3-3-4	3-3-4	3-3-4
<b>CHEM 1101, 1112, 2110</b> General Chemistry	4-3-5	4-3-5	3-0-3
<b>CHEM 2181</b> Chemistry Lab	.....	.....	0-3-1
<b>ENGL 1001-2, 2XXX</b> Analysis of Literature and Language I, II; English Elective	3-0-3	3-0-3	3-0-3
<b>MATH 1507-8-9</b> Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>TOTALS</b>	15-6-17	15-6-17	14-6-16

### Sophomore Year

Course	1st Q.	2nd Q.	3rd Q.
<b>BIOL 3310</b> Microbiology I	.....	3-6-5	.....
<b>BIOL 3334</b> Genetics	3-3-4	.....	.....
<b>BIOL 3331</b> Cell Physiology	.....	.....	3-3-4
<b>PHYS 2121-2</b> Introductory Physics	.....	4-3-5	4-3-5
<b>BIOL 3335</b> General Ecology	3-0-3	.....	.....
<b>Humanities Electives</b>	3-0-3	.....	.....
<b>Social Sciences Electives</b>	3-0-3	3-0-3	3-0-3



<b>CHEM 3311-2</b>			
Organic Chemistry	3-0-3	3-0-3	.....
<b>CHEM 3381-2</b>			
Organic Chemistry			
Laboratory	.....	0-6-2	0-6-2
<b>Health and Performance Sciences</b>			
(requirements, p. 311)	.....	.....	X-X-3
<b>TOTALS</b>	15-3-16	13-15-18	X-X-17

## Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>BIOL 3332</b>			
Biostatistics	.....	4-3-5	.....
<b>BIOL 4XXX</b>			
Special Biology or			
Technical Electives	X-X-3	X-X-5	X-X-5
<b>PHYS 2123</b>			
Introductory Physics	4-3-5	.....	.....
<b>CHEM 3313</b>			
Organic Chem III	3-0-3	.....	.....
<b>Social</b>			
<b>Sciences Electives</b>	3-0-3	3-0-3	3-0-3
<b>Humanities</b>			
<b>Electives</b>	3-0-3	.....	3-0-3
<b>Free Electives</b>	.....	X-X-3	X-X-5
<b>TOTALS</b>	X-X-17	X-X-16	X-X-16

## Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>BIOL 4450</b>			
Senior Seminar	.....	.....	2-0-2
<b>BIOL 4XXX</b>			
Special Biology			
Electives	X-X-5	X-X-5	X-X-5
<b>Technical</b>			
<b>Electives</b>	X-X-5	X-X-5	X-X-5
<b>Electives</b>	X-X-7	X-X-7	X-X-5
<b>TOTALS</b>	X-X-17	X-X-17	X-X-17

**Total Credit Hours Required for Graduation = 201**

## Humanities and Social Sciences Electives

See "Humanities and Social Sciences Requirements," Information for Undergraduate Students, p. 33, for lists of approved courses. All students are required to take 18 hours each of social sciences and humanities. Students must also pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

## Special, Technical, and Free Electives

**Special biology electives:** Students select one of the three tracks given below for their junior and senior years and are required to take the course program in the track (21-22 hours).

**Technical electives:** Twenty-seven (27) to 28 hours must be earned in courses chosen from a list approved by the School of Biology and available in the School of Biology's main office. The list includes most upper level biology courses (including Special Problems Research experience) as well as courses in other schools. Courses must be taken for a letter grade.

**Free electives:** The remaining 21 hours beyond courses required for humanities, social sciences, and physical education are free electives.

## Special Biology Electives

### Microbial Biotechnology and Microbiology

BIOL 4406	Medical Bacteriology*	3-6-5
BIOL 4308	Microbial Genetics	3-0-3
BIOL 4309	Microbial Genetics Lab	0-6-2
BIOL 4418	Microbial Physiology	3-0-3
BIOL 4419	Microbial Physiology Lab	0-6-2
BIOL 4410	Microbial Ecology	3-0-3
BIOL 4411	Industrial Microbiology	3-0-3
BIOL 4438	Fermentation Lab*	2-9-5

**Total Hours in Track = 14(15)-21(18)-21**

\* One out of the two courses

### Environmental Biology

BIOL 3337	Ecology Lab	0-6-2
BIOL 4410	Microbial Ecology	3-0-3
BIOL 4413	Air & Water Pollution	3-0-3
BIOL 4415	Intro. to Radiation Biology	3-3-4
BIOL 4010	Aquatic Ecology	3-0-3
BIOL 4011	Aquatic Ecology Lab	0-6-2
BIOL 44XX	Physiology Lecture*	3-0-3
BIOL 44XX	Physiology Lab*	0-6-2

**Total Hours in Track = 15-21-22**

\* One out of the three physiology lecture and laboratory courses (animal, plant, or microbial).

### Molecular Biology and Molecular Genetics

BIOL 4405	Virology	3-0-3
BIOL 4308	Microbial Genetics	3-0-3
BIOL 4309	Microbial Genetics Lab	0-6-2
BIOL 4469	Molecular Genetics	3-0-3
BIOL 4433	Recombinant DNA Lab	1-6-3

BIOL 4464	Developmental Genetics	3-0-3
BIOL 44XX	Physiology Lecture*	3-0-3
BIOL 44XX	Physiology Lab*	0-6-2
<b>Total Hours in Track = 16-18-22</b>		

\*One out of the three physiology lecture and laboratory courses (animal, plant, or microbial).

## Graduate Programs

The School of Biology provides advanced training in a variety of areas ranging from molecular biology to ecology and including both fundamental and applied research. Specific areas of current research include regulation of gene expression in procaryotic and mammalian systems, characterization of pathogenic microbes, microbial biodegradation, environmental microbiology, development of bioanalytical techniques, sensory mechanisms in small animals, ecosystem toxicology, cell biology of endothelial cells, molecular biology of plant cell development, and salt marsh plant physiology.

## Master of Science Degree

The requirements for the M.S. degree are a master's thesis and 30 quarter hours of class work, which includes 18 credit hours in a major field. Eighteen of the quarter hours must be in formal graduate-level courses. The thesis must be defended in an oral examination. A non-thesis master's degree is also available.

## Doctor of Philosophy Degree

Each Ph.D. student must acquire a thorough knowledge of a selected area of specialization, a broad knowledge of the field, and competence in the basic sciences. The main emphasis is on the successful completion of an original and independent research project. Credit hour requirements total 62, including 17 research credit hours and 15 credit hours in an approved minor. A maximum of 25 credit hours from an M.S. program may be applied to the doctoral program. Admission to candidacy is obtained by passing a written comprehensive examination in three areas and an oral presentation of a research proposal. Each Ph.D. student must write a comprehensive dissertation based on the student's scholarly research problem, some portion of which must be submitted for publication prior to

the final defense of the dissertation. Additional information on the graduate program is available by writing to the Graduate Coordinator in the School of Biology.

## Courses of Instruction

### BIOL 1110. General Biology I

3-3-4. It is recommended but not required that General Biology be taken in the sequence 1110, 1111, and 1112.

An introduction to general biology at the cellular level with emphasis on cell structure, metabolic processes, and genetics.

Text: at the level of Raven and Johnson, *Biology*, 3rd Edition.

### BIOL 1111. General Biology II

3-3-4.

An introduction to general biology at the whole organism level with an emphasis on physiological processes and integration of growth and development.

Text: at the level of Raven and Johnson, *Biology*, 3rd Edition.

### BIOL 1112. General Biology III

3-3-4.

An introduction to general biology with an emphasis on evolution, ecology, animal behavior, and the diversity of living organisms.

Text: at the level of Raven and Johnson, *Biology*, 3rd Edition.

### BIOL 1730. Biological Principles for Engineers

3-0-3.

An introduction to biology with an emphasis on microbiology and ecology and the interactions of human technology and biological systems. The implications of biology to individuals and to human technological societies will be stressed.

### BIOL 3310. Introductory Microbiology I

3-6-5. Prerequisite: BIOL 1110, CHEM 3311, or consent of the School.

Basic biology of bacteria, fungi, algae, protozoa, and viruses, with particular emphasis on bacteriology.

Text: at the level of Brock, *Biology of Microorganisms*.

### BIOL 3331. Cell Physiology

3-3-4. Prerequisite: BIOL 1110-1, CHEM 3311, or consent of the School.

Structure and functions of cells and their organelles, catabolism and energy metabolism, introductions to photosynthesis and biosynthesis, membrane structure and permeability properties.

Text: at the level of Wolf, *Biology of the Cell*, 2nd Edition.

### BIOL 3332. Biostatistics

4-3-5. Prerequisite: MATH 1508.

An introduction to statistical methods and their uses in the preparation and interpretation of biological experiments.

Text: at the level of Milton, *Statistical Methods in the Biological and Health Sciences*, 2nd Edition.

### BIOL 3334. Genetics

3-3-4. Prerequisite: BIOL 1110 or consent of the School.

The principles of inheritance as described by Mendelian and biochemical genetics.

Text: at the level of Ayala and Kiger, *Modern Genetics*.

## **BIOL 3335. General Ecology**

3-0-3. Prerequisite: either BIOL 1112 or 1720 or consent of the School.

Introduction to the principles and implications of ecology; designed for biology majors but appropriate for interested nonmajors. Emphasizes structure and function of natural populations, communities, and ecosystems.

Text: at the level of Colinvaux, *Ecology*.

## **BIOL 3337. General Ecology Laboratory**

0-6-2. Prerequisite: BIOL 3335 or 1720 or consent of the School; concurrent with or following BIOL 3335.

An introduction to the analytical techniques and physical and chemical methods useful in modern ecological studies and practical applications of these techniques in field studies in major ecosystems of the southeastern United States.

Text: at the level of Cox, *Laboratory Manual of General Ecology*, 5th Edition.

## **BIOL 3425. Computer Applications in Biology**

2-3-3.

A computer-based approach to solving numerical problems and to simulating phenomena in the life sciences. No previous experience in computer programming is assumed.

## **BIOL 3751. Anatomy and Physiology**

3-0-3. Prerequisite: junior standing or consent of the School.

Study of human anatomy and fundamental physiological mechanisms. Topics include nervous, musculoskeletal, and cardiorespiratory systems. Designed for the advanced student in fields interdisciplinary with the life sciences. Free elective credit for biology majors.

Text: at the level of Marieb, *Human Anatomy/Physiology*.

## **BIOL 3752. Anatomy and Physiology II**

3-0-3. Prerequisite: BIOL 3751 or consent of the School.

This course is a continuation of BIOL 3751. Topics emphasize physiological mechanisms such as gastrointestinal, renal, and endocrine systems.

## **BIOL 3801-2-3-4-5. Special Topics**

1-0-1 to 5-0-5 respectively.

These courses enable the School of Biology to provide offerings dealing with areas of particular current interest in biological science.

## **BIOL 4010. Aquatic Ecology**

3-0-3. Prerequisite: BIOL 3335 or BIOL 1720 or consent of the School.

Physics, chemistry, and ecology of aquatic communities and ecosystems. Physical, chemical, and biological investigations of lakes, streams, and estuaries.

Text: at the level of Goldman and Horne, *Limnology*.

## **BIOL 4011. Aquatic Ecology Laboratory**

0-6-2. Prerequisites: BIOL 3335 and BIOL 3337

Experimental methods and analysis employed in characterizing aquatic ecosystems. Course includes several field trips.

## **BIOL 4308. Microbial Genetics**

3-0-3. Prerequisite: BIOL 3310, 3331, 3334, or consent of the School.

Microbial genetics with special emphasis on the integration of genetic studies with biochemical and physical analysis of synthesis, structure, and function of nucleic acids and proteins.

Text: at the level of Freifelder, *Microbial Genetics*.

## **BIOL 4309. Microbial Genetics Laboratory**

0-6-2. Prerequisite: BIOL 3310, 3331, 3334, or consent of the School.

Laboratory experiments in microbial genetics emphasizing creating, detecting, and characterizing bacterial mutants.

## **BIOL 4405. General Virology**

3-0-3. Prerequisite: BIOL 3310, 3331, or consent of the School.

An integrated view of virology, bringing unity to the diversity of bacterial, mammalian, insect, and plant viruses, with special emphasis on biochemical characterization of viruses and their reproduction.

Text: at the level of Fraenkel-Courat, Kimball, and Levy; *Virology*, 2nd Edition.

## **BIOL 4406. Medical Bacteriology**

3-6-5. Prerequisite: BIOL 3310 or consent of the School.

Advanced study of bacteria of medical importance and their role in diseases and immunity.

Text: at the level of Burrows, *Textbook of Microbiology*.

## **BIOL 4410. Microbial Ecology**

3-0-3. Prerequisite: BIOL 3310 or consent of the School.

Advanced discussions on microorganisms occupying key roles in recycling processes, microbial ecosystems, and microbial evolution.

Text: at the level of Ailas and Bartha, *Microbial Ecology: Fundamentals and Applications*.

## **BIOL 4411. Industrial Microbiology**

3-0-3. Prerequisite: BIOL 3310 or consent of the School.

The biochemistry, genetics, and technological applications of microorganisms used in commercial processes.

Text: at the level of Crueger and Crueger, *Biotechnology, a Textbook of Industrial Microbiology*.

## **BIOL 4413. Air and Water Pollution**

3-0-3.

An introduction to environmental, social, and economic problems resulting from air and water pollution and from current pollution abatement practices. Emphasis on concerns of engineers and biologists in environmental assessment.

Text: at the level of Hodges, *Environmental Pollution*, 2nd ed., and selected references.

## **BIOL 4414. Hazardous Wastes and Ecological Principles**

3-0-3.

Hazardous materials and the current biological problems generated by them are examined. Analysis of biological, chemical, and engineering technologies and the capabilities of biological systems to respond.

**BIOL 4415. Introductory Radiation Biology**

3-3-4. Prerequisite: consent of the School.

A general survey of the responses of biological systems to various kinds of radiations.

Text: at the level of Grosch and Hopwood, *Biological Effects of Radiations*.

**BIOL 4416. Industrial Hygiene**

3-0-3.

A survey of chemical, physical, and biological hazards in the occupational environment to include adverse effects on the body, methods of evaluation, general control measures, and governmental regulations.

Text: at the level of Olshifski and McElroy, *Fundamentals of Industrial Hygiene*, 2nd Edition, and selected references.

**BIOL 4418. Microbial Physiology**

3-0-3. Prerequisites: BIOL 3310, 3331, or consent of School.

Discussions on the physiology of growth and metabolic activities of microorganisms.

Text at the level of Neidhardt, *Physiology of the Bacterial Cell: A Molecular Approach*.

**BIOL 4419. Microbial Physiology Laboratory**

0-6-2. Prerequisites: BIOL 3310, 3331, or consent of School and current or previous enrollment in BIOL 4418.

Laboratory investigations on the physiology of growth and metabolic activities of microorganisms.

**BIOL 4423. Population Biology**

3-0-3. Prerequisite: BIOL 1112 or consent of the School.

Population ecology and population genetics including: population structure, population dynamics, demographic analysis, population regulation, genetic variation, evolutionary forces, gene flow, inbreeding, genetic divergence.

**BIOL 4433. Recombinant DNA Laboratory**

1-6-3. Prerequisite: BIOL 4408 or consent of the School.

Laboratory projects utilizing methods of recombinant DNA technology including preparation and cloning of DNA, PCR amplification, and biochemical methods of analysis.

Text: at the level of Rodriguez and Tait, *Recombinant DNA Techniques: An Introduction*.

**BIOL 4434. Immunochemistry**

2-6-4. Prerequisite: BIOL 4408 or consent of the School.

Principles and methods of immunology used in cell molecular biology. Experiments and projects include ELISA assay, western blot, and other immunochemical procedures.

**BIOL 4438. Fermentation Laboratory**

2-9-5. Prerequisites: BIOL 4418, 4419, or consent of the School.

Laboratory principles of microbial technology with fermentations and the modifications of plant and animal products for food, beverages, feed, and products of industrial importance.

Text: at the level of Crueger and Crueger, *Biotechnology, a Textbook of Industrial Microbiology*.

**BIOL 4440. Plant Physiology**

3-0-3. Prerequisites: BIOL 3331, CHEM 3312.

Chemical transformations in photosynthesis, photophysiology and water relationships, organic nutrition and effects of hormones on growth and development in plants.

Text: at the level of Salisbury and Ross, *Plant Physiology*, 4th Edition.

**BIOL 4442. Plant Physiology Laboratory**

0-6-2. Prerequisites: BIOL 3331, CHEM 3311, current or previous enrollment in BIOL 4440.

Experiments designed to familiarize students with current methods used in plant physiology and plant molecular biology.

Text: at the level of Ross, *Plant Physiology Laboratory Manual*.

**BIOL 4446. General Animal Physiology I**

3-0-3. Prerequisite: BIOL 3331, CHEM 3312, or consent of the School.

Systems physiology, including muscles, nerves, circulation, and respiration.

Text: at the level of Eckert, *Animal Physiology*.

**BIOL 4450. Seminar**

2-0-2.

Normally taken in the senior year. Students presentations of recent research topics based on laboratory experience and/or literature searches.

**BIOL 4464. Developmental Genetics**

3-0-3. Prerequisite: BIOL 3334 or consent of the School.

Transcriptional, translational, and post-translational control of gene expression in cell differentiation, mechanisms of genomic regulation in eukaryotes, nucleocytoplasmic interactions, and genetic aspects of morphogenesis.

**BIOL 4469. Molecular Genetics**

3-0-3. Prerequisite: BIOL 3334 or consent of the School.

Topics in eucaryotic molecular genetics including DNA structure, RNA splicing, gene regulation, and protein processing.

**BIOL 4478. Physical Biology**

4-0-4. Prerequisite: PHYS 2123, CHEM 3312, or consent of the School.

Biophysical description of structure and function of biological systems at molecular levels. Emphasis on nucleic acids and proteins.

**BIOL 4801-2-3-4-5. Special Topics**

1-0-1 to 5-0-5 respectively.

This designation enables the School of Biology to provide new lecture courses dealing with areas of current interest in biological science.

**BIOL 4960-1-2. Special Problems**

Credit hours to be arranged.

Research problem in biology under supervision of a faculty member. To be given any quarter with credit to be arranged. Seven hours is maximum allowed for technical elective credit.

**BIOL 6170. Biophysical Genetics**

3-0-3. Prerequisite: BIOL 3334 or equivalent.

Current understanding of the molecular mechanisms of genetic processes, DNA conformation in the cell, mechanisms of replication, transcription, and translation. Emphasis on bacterial systems.

**BIOL 6608. Advanced Microbial Genetics**

3-0-3. Prerequisite: BIOL 4408 or consent of the School.

Genetics of bacteria, plasmids, and viruses. Organization and regulation of expression of genetic material, with special emphasis on new techniques such as genetic engineering.

Text: at the level of Watson et al., *Molecular Biology of the Gene*, 4th Edition.

**BIOL 6609. Advanced Microbial Genetics Laboratory**

0-6-2. Prerequisite: BIOL 4408 or consent of the School.

Production, isolation, and characterization of mutants. Testing for mutagens.

**BIOL 6611. Advanced Microbial Physiology**

3-0-3. Prerequisites: BIOL 4409 and CHEM 4511-12 or consent of the School.

Advanced studies of selected aspects of the physiology of prokaryotic and eukaryotic microorganisms.

Text: selected references.

**BIOL 6612. Microbial Metabolism and Nutrition**

3-0-3. Prerequisite: BIOL 6611.

A study of microbial systematics and microbial chemistry, with particular emphasis on catabolic events.

**BIOL 6622. Topics in Ecology**

1-2-2. Prerequisite: consent of the School.

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

**BIOL 6626. Physiological Ecology**

3-3-4. Prerequisites: BIOL 3335 and either 4440 or 4446, or consent of the School.

Physiological adaptations of plants and animals to their environment. Measurements and analysis of environmental factors as well as organismal physiological responses to light, temperature, water, and mineral nutrients are emphasized.

Text: literature, references, and review articles.

**BIOL 6628. Aquatic Toxicology**

4-0-4. Prerequisites: BIOL 3331, BIOL 3335, or consent of the School.

The biological effects of toxicants in aquatic environments, routes of exposure, biotransformations, mechanisms of toxic action, factors modifying toxicity, measuring toxicity with acute and sublethal tests, biomarkers, ecological risk assessment.

**BIOL 6730. Biological Effect of Radiations**

3-3-4. Prerequisite: consent of the School.

An introduction to the effects of nuclear radiation upon biological systems for graduate students in the nuclear science and engineering curriculum.

Text: at the level of Grosch and Hopwood, *Biological Effects of Radiations*.

**BIOL 7000. Master's Thesis****BIOL 7668. Eucaryotic Molecular Genetics**

4-0-4. Prerequisite: BIOL 3334 or consent of School.

Current understanding of molecular genetics with emphasis on eucaryotic organisms. Topics include DNA structure, gene expression, and genetic engineering techniques.

Text at the level of Darnell, Lodish, and Baltimore, *Molecular Cell Biology*.

**BIOL 7710. Separation of Nucleic Acids and Proteins**

3-0-3. Prerequisite: consent of School.

Topics include theory of chromatographic retention, different chromatographic and electrophoretic methods used in the separation of nucleic acids and proteins.

**BIOL 8001. Seminar**

2-0-2. Prerequisite: graduate standing.

Discussion group composed of staff and graduate students. Presentation is required.

**BIOL 8002-3-4. Seminar**

1-0-1. Prerequisite: graduate standing

Discussion group composed of staff and graduate students.

**BIOL 8013-4-5. Seminar in Microbiology**

2-0-2 each. Prerequisite: graduate standing.

Topics of current interest in microbial physiology, applied microbiology, microbial ecology, and medical microbiology.

**BIOL 8023-4-5. Seminar in Ecology**

2-0-2 each. Prerequisite: graduate standing.

Topics of current interest in the general areas of population growth and limitation, and the structure and stability of ecosystems.

**BIOL 8063-4-5. Seminar in Genetics**

2-0-2 each. Prerequisite: graduate standing.

Topics of current interest in the areas of molecular genetics and cell molecular biology. Student and faculty presentations.

**BIOL 8101-2-3-4-5. Special Topics**

1-0-1 to 5-0-5, respectively.

This designation enables the School of Biology to provide new graduate lecture courses dealing with areas of current interest in biological science.

**BIOL 8504-5-6. Special Problems**

Credit to be arranged.

**BIOL 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**BIOL 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**BIOL 9000. Doctoral Thesis**

## School of Chemistry and Biochemistry

**Established in 1906**

**Location: Boggs Chemistry Building**

**Telephone: 404-894-4002**

*Director and Professor*—Laren M. Tolbert;  
*Director of Graduate Studies and Professor*—  
 Lawrence A. Bottomley; *Director of*  
*Undergraduate Studies and Professor*—E. Kent  
 Barefield; *Institute and Regents' Professor*—  
 Leon H. Zalkow; *Regents' Professors*—Richard F.  
 Browner, Sheldon W. May, James C. Powers;  
*Julius Brown Chair*—Mostafa A. El-Sayed;  
*Professors*—Raymond F. Borkman, Edward M.  
 Burgess, Ronald H. Felton, Sidney L. Gordon,  
 Charles L. Liotta, Thomas F. Moran, Robert A.  
 Pierotti, Gary B. Schuster, Paul H. Wine, Nai-Teng  
 Yu; *Associate Professors*—Kenneth L. Busch,  
 Richard A. Ikeda, William Rees; *Assistant*  
*Professors*—David M. Collard, John N. Haseltine,  
 Kenneth D. Hughes, Stephen Quirk, Angus  
 Wilkinson, Loren D. Williams; *Laboratory*  
*Coordinators*—Toby F. Block (Research Scientist  
 II), Robert A. Braga (Research Scientist II).

### General Information

Included in the School are courses in chemistry required for various engineering and science curricula, for students interested in medical school, for the degree Bachelor of Science in Chemistry, and for graduate work leading to the degrees Master of Science in Chemistry and Doctor of Philosophy in Chemistry.

### Undergraduate Program

The Bachelor of Science in Chemistry degree program consists of a combination of requirements and electives that ensure a strong foundation in physical, inorganic, organic, and analytical chemistry while providing the flexibility to tailor the curriculum to satisfy specific interests or career goals. Biochemistry and polymers options are available for students who wish to include these fields as substantial components of their program. In addition, the 88 hours of

electives permit students to take the course work required to achieve certificate programs in written and oral communications, foreign languages, social sciences, geochemistry, and other available programs of the Institute. Students who wish to prepare for the Georgia Teaching Certificate (T-4) may do so by taking the necessary teacher education courses. The judicious use of free electives also enables the student to achieve considerable knowledge of other disciplines at Georgia Tech such as chemical engineering, physics, mathematics, management, textiles, ceramics, and biology. These electives enable those who are interested in medical or dental schools to meet admission requirements of these schools.

### Certificate Programs

The School of Chemistry and Biochemistry offers for nonchemistry majors programs of study leading to certificates in three emphasis areas: biochemistry/organic chemistry, chemical analysis, and physical/inorganic chemistry. These certificate programs should be of interest to students considering careers in medicine or chemical-related industries, as well as those who wish to strengthen their background in areas of chemistry that are not required by their major.

Each certificate program requires 16 hours of general prerequisites, followed by 12-17 additional hours at the 3000-level or higher consisting of three courses in the emphasis area plus one additional course from any emphasis area. Each course must be completed with a grade of C or better. Courses required by the student's major may be used only to satisfy the general prerequisites. Courses which may be taken to satisfy the certificate requirements are as follows:

#### General Prerequisites

CHEM 1101 or CHEM 1100. General Chemistry I  
 CHEM 1102 or CHEM 1112. General Chemistry II  
 CHEM 3311. Organic Chemistry I  
 CHEM 3312. Organic Chemistry II  
 or CHEM 3412. Physical Chemistry II

#### Biochemistry/Organic Chemistry Certificate

CHEM 3312. Organic Chemistry II  
 CHEM 3313. Organic Chemistry III

CHEM 3343. Organic Reactions of Polymers  
 CHEM 3511. Biochemistry  
 CHEM 4311. Organic Reactions I  
 CHEM 4341. Applied Spectroscopy  
 CHEM 4511. Biochemistry I  
 CHEM 4512. Biochemistry II  
 CHEM 4513. Biochemistry III  
 CHEM 4582. Biochemistry Laboratory

## Chemical Analysis Certificate

CHEM 3281. Instrumental Analysis for Engineers  
 or CHEM 4212. Instrumental Analysis II  
 CHEM 3411. Physical Chemistry I  
 CHEM 4211. Instrumental Analysis I  
 CHEM 4231. Advanced Instrumental Analysis  
 CHEM 4341. Applied Spectroscopy

## Physical/Inorganic Chemistry Certificate

CHEM 3121. Advanced Inorganic Chemistry I  
 CHEM 3122. Advanced Inorganic Chemistry II  
 CHEM 3411. Physical Chemistry I  
 CHEM 3412. Physical Chemistry II  
 CHEM 3413. Physical Chemistry III  
 CHEM 4182. Synthetic Inorganic Chemistry  
 CHEM 4341. Applied Spectroscopy  
 CHEM 4401. (Advanced) Physical Chemistry  
 CHEM 4452. Chemistry of the Solid State

Additional information regarding undergraduate programs is available by writing to the Director of Undergraduate Studies, School of Chemistry and Biochemistry, Georgia Institute of Technology, Atlanta, Georgia 30332-0400.

## **Bachelor of Science in Chemistry Curriculum (Suggested Schedule)**

### **Freshman Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 1101, 1112</b> General Chemistry	4-3-5	4-3-5	.....
<b>CHEM 2110</b> Chemical Structures and Properties	.....	.....	3-0-3
<b>CHEM 2115</b> Quantitative Measurements	.....	.....	1-6-3
<b>MATH 1507-8-9</b> Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>ENGL 1001-2</b> Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>Modern Languages</b>			

<b>Electives</b>	3-0-3	3-0-3	3-0-3
<b>Health and Performance Sciences</b> (requirements, p. 311)	.....	.....	3-0-3
<b>Free Electives</b>	2-0-2	2-0-2	2-0-2
<b>TOTALS</b>	17-3-18	17-3-18	17-6-19

### **Sophomore Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 3311-2-3</b> Organic Chemistry	3-0-3	3-0-3	3-0-3
<b>CHEM 3381-2</b> Organic Chemistry Laboratory	.....	0-6-2	0-6-2
<b>CHEM 3411</b> Physical Chemistry	.....	.....	3-0-3
<b>MATH 2507-8</b> Calculus IV, V	5-0-5	3-0-3	.....
<b>PHYS 2121-2-3</b> Physics	4-3-5	4-3-5	4-3-5
<b>English Elective</b>	.....	.....	3-0-3
<b>Free Electives</b>	3-0-3	3-0-3	.....
<b>TOTALS</b>	15-3-16	13-9-16	13-9-16

### **Junior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 3383</b> Organic Chemistry Laboratory	0-6-2	.....	.....
<b>CHEM 3412-3</b> Physical Chemistry	3-0-3	3-0-3	.....
<b>CHEM 3481-2</b> Physical Chemistry Laboratory	.....	0-6-2	0-6-2
<b>CHEM 3121-2</b> Inorganic Chemistry	3-0-3	3-0-3	.....
<b>CHEM 4211-2</b> Instrumental Analysis I, II	3-6-5	3-6-5	.....
<b>Chemistry Elective</b>	.....	.....	X-X-6
<b>English Elective</b>	3-0-3	.....	.....
<b>Social Sciences</b>			
<b>Electives</b>	.....	3-0-3	3-0-3
<b>Free Electives</b>	.....	.....	X-X-5
<b>TOTALS</b>	12-12-16	12-12-16	X-X-16

### **Senior Year**

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Chemistry Electives</b>	X-X-3	X-X-3	X-X-3
<b>Social Sciences</b>			
<b>Electives</b>	6-0-6	3-0-3	3-0-3
<b>Free Electives</b>	X-X-6	X-X-9	X-X-8
<b>TOTALS</b>	X-X-15	X-X-15	X-X-14

**Total Credit Hours Required for Graduation = 195**

## Electives

### Modern Languages Electives

The School of Chemistry and Biochemistry requires that a modern language (French, German, or Russian) be taken and recommends that it be taken in the freshman year. However, if social sciences are elected in the freshman year, nine credit hours of a modern language must be taken later.

### English Electives

The School of Chemistry and Biochemistry recommends that two courses be taken from among these written and oral communication courses: ENGL 3010, 3015, 3020, 4015, 4020; however, the student may prefer to elect two literature courses in English.

### Social Sciences Electives

See "Information for Undergraduates" for information relative to the Institute requirement of 18 hours of humanities and 18 hours of social sciences (p. 33). All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

### Free Electives

These free electives may be taken at any time during a student's course of study. However, if six credit hours of basic ROTC are elected, ROTC should be scheduled the first quarter the student is enrolled (see p. 31).

The required hours of free electives (40) allow the student to take additional courses in chemistry beyond those required for the B.S. degree or courses in other disciplines. Students may wish to use their free electives to take a substantial number of courses in a particular discipline or closely related group of disciplines outside of chemistry. The School of Chemistry and Biochemistry has identified several groups of courses that constitute coherent programs in areas related to chemistry. A student who elects to take 20 hours or more of credit from such an approved group of courses outside of chemistry may apply for approval to substitute up to six

hours of the credit earned for a portion of the chemistry elective credit required for the B.S. degree. Information about these programs can be obtained from the undergraduate coordinator or from undergraduate academic advisers. In order to minimize scheduling problems, students are advised to plan their free elective programs during the early part of the sophomore year.

### Chemistry Electives

The required hours of chemistry electives allow students to specialize in a particular area of chemistry by taking advanced undergraduate and/or graduate courses for which they are qualified. The 15 credit hours in elective chemistry must include at least two lecture-laboratory courses selected from the following list: CHEM 3387, 3492, 4182, 4231, 4582. The remaining nine credit hours of chemistry electives may consist of up to four credit hours in special problems (CHEM 4901-3), CHEM 3511, courses numbered 4XXX, 6XXX, or other courses approved by the School. Alternatively, a portion of these nine credit hours of chemistry electives may be replaced by credits earned in a discipline outside of chemistry, as described above under "Free Electives."

### Biochemistry Option

Students who wish to prepare for careers that require proficiency in biochemistry may do so by choosing the biochemistry option under the Bachelor of Science in Chemistry curriculum. This option may be of interest to students who plan careers in medicine, teaching, or research, as well as those who wish to broaden their curriculum by including this rapidly growing field.

The biochemistry option consists of 28 quarter hours of specified course work in biology and chemistry. These credits satisfy 13 of the 40 hours of free electives and the 15 hours of chemistry electives required in the B.S. curriculum.

		Quarter Hours
<b>BIOL 1110</b>	General Biology I	4
<b>BIOL 1111</b>	General Biology II	4
<b>CHEM 4511</b>	Biochemistry I	3
<b>CHEM 4512</b>	Biochemistry II	3
<b>CHEM 4513</b>	Biochemistry III	3
<b>CHEM 4582</b>	Biochemistry Laboratory	3
<b>BIOL 3XXX</b>		
<b>or 4XXX</b>	Electives	8
<b>TOTAL</b>		<b>28</b>



It is recommended that students who wish to follow this option complete BIOL 1110 and 1111 no later than the end of the second year. The Biochemistry I-III sequence should be taken during the junior year followed by biology electives during the senior year.

### Electives

The eight hours of biology elective courses are to be selected from a list approved by the faculty of the School of Chemistry and Biochemistry. Those courses selected may be lecture/laboratory or laboratory courses but must include at least two hours of laboratory credit.

### Polymers Option

Students who wish to prepare for careers where a knowledge of polymers would be beneficial may do so by choosing the polymers option under the Bachelor of Science in Chemistry curriculum. This option may be of interest to students who plan careers in industry, teaching, or research, as well as those who wish to broaden their curriculum by including this important field.

The polymers option consists of 15 quarter hours of specified course work in polymer science and chemistry, which satisfy the 15 hours of chemistry electives required in the B.S. in Chemistry curriculum.

		Quarter Hours
CHEM 3343	Organic Chemistry of Polymers	3
CH E/TEX 4750	Polymer Science and Engineering I	3
CH E/TEX 4751	Polymer Science and Engineering II	3
CH E/TEX 4760	Polymer Science and Engineering Laboratory	3
Approved Elective		3
TOTAL		15

### Electives

The three-hour elective course is to be selected from a list of polymer related courses approved by the faculty of the School of Chemistry and Biochemistry.

### Graduate Programs

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

The requirements for the master's degree consist of an accepted program of 30 quarter hours of course work plus an original research

thesis on the master's level. The student and his or her advisory committee design the program, which may be largely or totally in chemistry, to suit the needs and objectives of the individual.

The goal of the doctoral program is greater proficiency and depth in the chemical area, with particular emphasis being placed on original, independent, and scholarly research. The only course work demanded is the Institute requirement of a minimum of 15 earned credit hours in a minor field, which may be any field of study chosen by the student in consultation with his or her adviser. The area need not necessarily be beyond the broad area of chemistry. Most students, however, do take a number of courses during their studies beyond the minor requirements. The numbers of such other courses vary with individuals, the major field interests, and previous background, as well as long-range goals.

Active research fields include (1) biochemistry—proteolytic enzymes and inhibitors, neurochemistry, DNA and protein X-ray crystallography, molecular modeling, Raman and fluorescence spectroscopy of proteins, spectroscopy and photochemistry of ocular lenses and proteins, and antitumor agents of natural and synthetic origin; (2) inorganic chemistry—synthesis and properties of transition metal and main group organometallic and coordination compounds, kinetics and mechanisms of reactions, metal hydrides, models for biologically active metal-containing compounds, X-ray diffraction methods, CVD precursors to electronic materials and solid state chemistry; (3) organic chemistry—multistep synthesis, physical organic chemistry, heterocyclic chemistry, natural products, organometallic chemistry, crown ethers, electrochemistry, theoretical organic chemistry, carbanions, polymer chemistry including electroconductive polymers, and phase transfer catalysis; (4) physical chemistry—molecular and ion beam kinetics, ab initio calculations, electronic spectroscopy, nanocluster properties, Raman spectroscopy, surface phenomena, surface analysis and molecular beam etching, protein dynamics and photochemistry, bonding theory, XAFS, and NMR spectroscopy; (5) analytical

chemistry—electrochemistry, mass spectrometry, atomic absorption, RF plasmas, and scanning probe microscopy. Additional information regarding graduate work is available by writing to the Director of Graduate Studies, School of Chemistry and Biochemistry, Georgia Institute of Technology, Atlanta, Georgia 30332-0400.

## Courses of Instruction

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

### CHEM 1100. General Chemistry I

4-4-5. Prerequisite: consent of the School.

This course, covering the fundamental laws and theories of chemistry, is identical to CHEM 1101. It may be taken, upon approval, by students who may need additional lecture, drill, or laboratory periods in order to complete the regular first-quarter work in college chemistry. Credit is not allowed for both CHEM 1100 and CHEM 1101. The course serves as a prerequisite to CHEM 1102 or 1112.

Text: at the level of Oxtoby, Nachtrieb, Freeman, *Chemistry: Science of Change*, 2nd Edition.

### CHEM 1101. General Chemistry I

4-3-5 each.

Fundamental laws and theories of chemistry. Topics include atomic structure; bonding theory; stoichiometry; properties of solids, liquids, and gases; solutions; and chemical thermodynamics.

Text: at the level of Oxtoby, Nachtrieb, Freeman, *Chemistry: Science of Change*, 2nd Edition.

### CHEM 1102. General Chemistry II

4-3-5. Prerequisite: CHEM 1101 or 1100.

A continuation of CHEM 1101 for students who do not plan to take advanced chemistry courses. Topics include chemical equilibrium, kinetics, acids and bases, organic chemistry, and biochemistry as well as other topics.

Text: at the level of Oxtoby, Nachtrieb, Freeman, *Chemistry: Science of Change*, 2nd Edition.

### CHEM 1112. General Chemistry II

4-3-5. Prerequisite: CHEM 1101 or 1100.

A continuation of CHEM 1101 for students planning to pursue advanced courses in chemistry. In-depth studies of chemical principles and the techniques of quantitative analysis necessary for further studies in chemistry.

Text: at the level of Oxtoby, Nachtrieb, Freeman, *Chemistry: Science of Change*, 2nd Edition.

### CHEM 2110. Chemical Structures and Properties

3-0-3. Prerequisite: CHEM 1102 or 1112.

The application of general chemistry principles to topics of descriptive chemistry. Emphasis will be on the descriptive chemistry of materials and other applied areas.

Text: at the level of Wulfsberg, *Principles of Descriptive Inorganic Chemistry*.

### CHEM 2115. Quantitative Measurements

1-6-3. Prerequisite: concurrent with or following CHEM 2110.

Experimentation concerned with synthesis, analysis, and data interpretation. For chemistry majors.

### CHEM 2181. Quantitative Chemical Properties

0-3-1. Prerequisite: CHEM 1102 or 1112.

Laboratory experimentation emphasizing quantitative measurement, chemical principles, and properties of matter.

### CHEM 2801-2-3. Special Topics—Chemistry

1-0-1 to 3-0-3, respectively.

Lecture courses in special topics of current interest in chemistry and biochemistry. Topics will vary from year to year.

### CHEM 2901-2-3. Special Problems—Chemistry

Credit hours to be arranged. Prerequisites: CHEM 1112 and consent of the School.

Individualized instruction, which will include library, conference, and laboratory experiences.

### CHEM 3121-2. Advanced Inorganic Chemistry I, II

3-0-3. Prerequisites: CHEM 2110 and CHEM 3411.

A study of the reactions and structures of inorganic compounds and the principles, generalizations, and theories that assist in understanding their behavior.

Text: at the level of Huheey, *Inorganic Chemistry*, 4th Edition.

### CHEM 3281. Instrumental Analysis for Engineers

3-1-4. Prerequisites: CHEM 3381 and 3411.

Provides a background to modern analytical chemistry and to instrumental methods of analysis with applications to engineering and other areas.

Text: at the level of Skoog and Leary, *Principles of Instrumental Methods*, 4th Edition.

### CHEM 3311-2-3. Organic Chemistry I, II, III

3-0-3 each. Prerequisite: CHEM 1112 or consent of the School.

Principal classes of organic compounds, aliphatic and aromatic.

Text: at the level of Carey, *Organic Chemistry*, 2nd Edition.

### CHEM 3343. Organic Chemistry of Polymers

3-0-3. Prerequisites: CHEM 3311-2.

Application of organic functional group chemistry to polymer synthesis and reactivity. Emphasis is on types of polymerization mechanisms and structural features of resulting bulk polymers.

### CHEM 3381-2. Organic Chemistry Laboratory I, II

0-6-2 each. Pre- or corequisite: CHEM 3312; CHEM 3381

prerequisite to 3382.

Studies of reactions, preparations, and the techniques used in the organic laboratory.

### CHEM 3383. Organic Chemistry Laboratory

0-6-2. Prerequisite: CHEM 3382. Pre- or corequisite: CHEM 3313.

Studies of reactions, preparations, and the techniques used in the organic laboratory.

### CHEM 3387. Advanced Organic Chemistry Laboratory

1-6-3. Prerequisite: CHEM 3382. Pre- or corequisite: CHEM 3383.

Advanced study of organic reactions, preparations, separations, instrumentation, and techniques.

## **CHEM 3411. Physical Chemistry I**

3-0-3. Prerequisites: CHEM 1112, PHYS 2122, MATH 2507.

Quantum mechanics and atomic structure, bonding theory, molecular spectroscopy.

Text: at the level of Atkins, *Physical Chemistry*, 4th Edition.

## **CHEM 3412. Physical Chemistry II**

3-0-3. Prerequisites: CHEM 1112, PHYS 2122, MATH 2507.

Chemical thermodynamics, energetics of chemical reactions, and changes of state.

Text: at the level of Atkins, *Physical Chemistry*, 4th Edition.

## **CHEM 3413. Physical Chemistry III**

3-0-3. Prerequisite: CHEM 3412.

Electrochemistry, rates of chemical reactions, kinetic theory of gases, statistical mechanics.

Text: at the level of Atkins, *Physical Chemistry*, 4th Edition.

## **CHEM 3481. Physical Chemistry Laboratory I**

0-6-2. Prerequisite: CHEM 3412, or CHE 3320 with CHEM 3412 as a corequisite.

Applications of physical chemistry principles.

## **CHEM 3482. Physical Chemistry Laboratory II**

0-6-2. Prerequisite: CHEM 3481. Pre- or corequisite: CHEM 3413.

Applications of physical chemistry principles.

## **CHEM 3492. Physical Chemistry Laboratory III**

1-6-3. Prerequisite: CHEM 3482. Pre- or corequisite: CHEM 4401 or consent of the School.

Application of electronic spectroscopy to vibrational, rotational, and electronic properties of simple molecules. Kinetic properties of reacting systems emphasizing molecular, dynamic properties.

## **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.

Text: at the level of Lehninger, *A Short Course in Biochemistry*.

## **CHEM 4182. Synthetic Inorganic Chemistry**

1-6-3. Pre or corequisite: CHEM 3121.

Preparation and characterization of inorganic compounds, with special emphasis on the apparatus and techniques employed in modern synthetic inorganic chemistry.

## **CHEM 4211. Instrumental Analysis I**

3-6-5. Prerequisite: CHEM 2115. Pre- or corequisite: CHEM 3411.

Introduction to both theory and practice of modern instrumental methods: polarography, spectroscopy, colorimetry, microscopy, polarimetry, electroanalytical methods.

Text: at the level of Skoog and Leary, *Principles of Instrumental Methods*, 4th Edition.

## **CHEM 4212. Instrumental Analysis II**

3-6-5. Prerequisite: CHEM 4211; pre- or corequisite: CHEM 3412.

Continuation of Instrumental Analysis I.

Text: at the level of Harris, *Quantitative Chemical Analysis*, 3rd Edition.

## **CHEM 4231. Advanced Instrumental Analysis**

1-6-3. Prerequisite: CHEM 4211 or consent of the School.

Advanced analytical techniques and investigations of newer analytical methods in the practice of analysis.

## **CHEM 4311. Organic Reactions I**

3-0-3. Prerequisite: CHEM 3313.

Theoretical interpretation of reactivity, reaction mechanisms, and molecular structures of organic compounds.

## **CHEM 4341. Applied Spectroscopy**

3-0-3. Prerequisite: CHEM 3313.

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

## **CHEM 4401. Physical Chemistry**

3-0-3. Prerequisites: CHEM 3411, PHYS 2123, and MATH 2508 or consent of the School.

Theory of molecular spectroscopy, electron diffraction, X-ray diffraction, neutron diffraction, and magnetic methods applied to the determination of molecular structure.

## **CHEM 4452. Chemistry of the Solid State**

3-0-3. Prerequisite: CHEM 3411 or consent of the School.

Applications of the concepts of physical chemistry to the structure of solids and their chemical and physical properties.

## **CHEM 4511-2-3. Biochemistry I, II, III**

3-0-3. Prerequisite: CHEM 3312 or consent of the School.

The chemistry and biochemistry of proteins, lipids, carbohydrates, nucleic acids, and other biomolecules.

Text: at the level of Voet & Voet, *Biochemistry*.

## **CHEM 4582. Biochemistry Laboratory**

1-6-3. Prerequisite: CHEM 3511, CHEM 4511, or consent of the School.

Laboratory techniques in the isolation and characterization of proteins and nucleic acids, with special emphasis on modern practices in biochemistry.

## **CHEM 4801-2-3. Special Topics—Chemistry**

1-0-1 through 3-0-3 respectively. Prerequisite: junior standing or consent of the School.

Lecture courses in special topics of current interest in chemistry. Topics will vary from year to year.

## **CHEM 4901-2-3. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

Individualized instruction, which will include library, conference, and laboratory work.

## **CHEM 6111-2. Advanced Inorganic Chemistry I, II**

3-0-3 each. Prerequisite: consent of the School.

The theory of bonding and structure of inorganic compounds and the chemistry of the elements.

Text: at the level of Huheey, *Inorganic Chemistry*, 4th Edition.

## **CHEM 6141. Chemical Applications of Group Theory**

3-0-3. Prerequisite: CHEM 3122 or consent of the School.

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 Flurry, *Symmetry Groups*.

**CHEM 6151. Chemical Crystallography**

3-0-3. Prerequisite: consent of the School.

Applications of X-ray diffraction to the determination of crystal structures, including crystal symmetry, reciprocal lattice, intensity of diffraction, the phase problem, and refinement of structure parameters.

**CHEM 6211-2. Analytical Chemistry I, II**

3-0-3 each. Prerequisite: consent of the School.

Theoretical principles and uses of modern instrumental methods: spectroscopy, microscopy, colorimetry, polarography, polarimetry, and electroanalytical methods.

Text: at the level of Skoog and West, *Fundamentals of Analytical Chemistry*, 4th Edition, and Skoog and Leary, *Principles of Instrumental Analysis*, 4th Edition.

**CHEM 6220. Applied Mass Spectrometry**

3-0-3. Prerequisite: consent of the School.

Application of modern techniques of mass spectrometry to problems in chemical analysis.

Text: at the level of Chapman, *Practical Organic Mass Spectrometry*.

**CHEM 6231. Electroanalytical Chemistry**

3-0-3. Prerequisite: CHEM 4212 or consent of the School.

Coulometry, electrolytic separations, polarography, chronopotentiometry, coulometric titrations, voltametry, and hydrodynamic electrochemical methods of analysis.

Text: at the level of Bard and Faulkner, *Electrochemical Methods*.

**CHEM 6241. Advanced Analytical Chemistry**

3-0-3. Prerequisite: consent of the School.

Competing equilibria, including polybasic acids, differential precipitation, complex ion formation. Complexometric titrations and homogeneous precipitation. Adsorption, partition, ion exchange, and gas chromatography.

**CHEM 6250. Atomic Spectrometry**

3-0-3. Prerequisite: consent of the School.

Elemental analysis using atomic absorption, atomic emission, and atomic fluorescence spectrometries. Inductive coupled plasma mass spectrometry.

Text: at the level of Ingle and Crouch, *Spectrochemical Analysis*.

**CHEM 6260. Automated Chemical Analysis**

3-0-3. Prerequisite: consent of the School.

Principles and practice of automation applied to modern techniques of instrumental analysis.

**CHEM 6311-2-3. Organic Chemistry I, II, III**

3-0-3 each. Prerequisites: CHEM 3313 and consent of the School.

A more advanced study of the fundamental reactions and theories of structure of various classes of organic compounds.

**CHEM 6321-2-3. Reactivity, Mechanism, and Structure in Organic Chemistry I, II, III**

3-0-3 each. Prerequisite: consent of the School.

Theoretical interpretations of reactivity, reaction mechanisms, and molecular structures of organic compounds.

**CHEM 6343. Chemical Literature and Structural Analysis**

3-0-3. Prerequisite: CHEM 3313 or 3382.

Methods for searching the chemical literature and for analyzing and displaying chemical structure information.

**CHEM 6411-2. Molecular Structure and Chemical Principles I, II**

3-0-3 each. Prerequisite: consent of the School.

A discussion of molecular structure based upon quantum mechanical principles.

**CHEM 6421-2. Chemical Thermodynamics I, II**

3-0-3 each. Prerequisites: CHEM 3411-2-3.

Laws of thermodynamics and their chemical applications. Introduction to chemical kinetics and statistical mechanics.

**CHEM 6451. Surface Equilibria**

3-0-3. Prerequisite: consent of the School.

Classical and statistical thermodynamics of surface systems, intermolecular forces at the gas-solid interface, adsorption phenomena, and capillarity.

**CHEM 6501-2-3. Biochemistry I, II, III**

3-0-3. Prerequisite: consent of the School.

The chemistry and biochemistry of proteins, lipids, carbohydrates, nucleic acids, and other biomolecules.

Text at the level of Voet & Voet, *Biochemistry*.

**CHEM 6511-2. Advanced Enzymology I, II**

3-0-3 each. Prerequisite: CHEM 4513 or consent of the School.

Structure and chemistry of proteins, enzyme structure and mechanism, enzyme kinetics, enzyme inhibitors, and medicinal chemistry.

**CHEM 6521. Structure of Proteins and Nucleic Acids**

2-3-3. Prerequisites: CHEM 4511-2-3 or equivalent.

Principles of protein, nucleic acid, and membrane structure. Major emphasis on protein folding, detailed description of three-dimensional structure of proteins and nucleic acids.

**CHEM 6522. Protein Crystallography**

2-3-3. Prerequisite: CHEM 6151 or consent of the School.

Application of crystallographic principles to the structure determination of macromolecules by molecular replacement, isomorphous replacement. High-speed data collection methods and cryocrystallography.

**CHEM 6531. Molecular Biology and Biochemistry**

3-0-3. Prerequisite: CHEM 4513 or consent of the School.

Current topics in molecular biology including eukaryotic transcription, RNA processing, repair and recombination, immunity, viruses, DNA fingerprinting, and genome sequencing.

**CHEM 6541. Advanced Biophysical Chemistry**

3-0-3. Prerequisites: CHEM 3411 and 3412, or consent of the instructor.

Applications of the principles and techniques of physical chemistry in biochemistry, with emphasis on the equilibrium and dynamic behavior of macromolecules in solution.

**CHEM 6551. Medicinal Chemistry**

3-0-3. Prerequisites: CHEM 3313 and CHEM 4512 or consent of the instructor.

Application of principles of chemistry and biology to the creation of knowledge leading to the introduction of new therapeutic agents.

**CHEM 6754. Electrochemistry**

3-0-3. Prerequisite: consent of the School.

A study of electrochemical instrumentation; thermodynamics, structure, double layer theory, and kinetics of simple and complex electrode processes. Also taught as CHE 6754.

**CHEM 7000. Master's Thesis**

**CHEM 7121. Ligand Field Theory**

3-0-3. Prerequisite: CHEM 6141.

Introduction to theory of electronic structure of transition metal compounds and its application to the interpretation of physical and chemical properties of these compounds—especially spectral and magnetic properties.

**CHEM 7141. Mechanisms of Inorganic Reactions**

3-0-3. Prerequisite: CHEM 3122 or consent of the School.

Discussion of mechanisms of inorganic reactions based on kinetic and stereochemical studies—the substitutions and redox reactions of coordination complexes in solution.

**CHEM 7421. Statistical Thermodynamics**

3-0-3. Prerequisite: CHEM 6422 or consent of the School.

A study of statistical mechanical ensembles, partition functions and their relationship to thermodynamics, lattice statistics, molecular distribution and correlation functions, the theories of liquids and solutions, phase transitions, and cluster theory.

**CHEM 7431-2-3. Principles of Quantum Mechanics I, II, III**

3-0-3. Prerequisite: CHEM 6411 or PHYS 4143.

Important concepts of quantum chemistry at the intermediate level, including angular momentum, perturbation theory, electronic structure of molecules, and radiation matter interaction. Applications will vary from year to year.

**CHEM 7451. Chemical Kinetics and Reaction Dynamics**

3-0-3. Prerequisites: CHEM 6421-2.

Mechanisms of chemical reactions, cross sections, and rate constants. Elastic, inelastic, and rearrangement channels are discussed, using quantum and semiclassical techniques.

**CHEM 8000. Seminar—Chemistry**

**CHEM 8111-2. Special Topics in Inorganic Chemistry**

3-0-3 each. Prerequisite: consent of the School.

Topics to be discussed vary from year to year but will include mechanisms of inorganic reactions, Ligand field theory, and bonding in inorganic compounds.

**CHEM 8211. Special Topics in Analytical Chemistry**

2-3-3. Prerequisite: consent of the School.

Discussions of specialized areas of analysis, including spectrophotometry, chemometrics, chromatography, and others. Content of course varies from year to year.

**CHEM 8311-2. Special Topics in Organic Chemistry**

3-0-3 each. Prerequisite: consent of the School.

Topics vary from year to year but will include subjects such as evaluation of synthetic methods and their application to research in organic chemistry.

**CHEM 8351-2. Special Topics in Biochemistry**

3-0-3 each. Prerequisite: CHEM 4513 or consent of the School.

Topics vary from year to year but will include proteins, enzyme mechanisms, metabolism, membranes, and nucleic acids.

**CHEM 8411-2. Special Topics in Physical Chemistry**

3-0-3 each. Prerequisite: CHEM 3413 or consent of the School.

Topics vary from year to year, will include subjects such as photochemistry, solid state, surface chemistry, and radiation chemistry.

**CHEM 8500-1-2. Special Problems—Chemistry**

Credit to be arranged. Prerequisite: consent of the School.

A laboratory course dealing with special problems of current interest in chemistry.

**CHEM 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**CHEM 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**CHEM 9000. Doctoral Thesis**

**School of Earth and Atmospheric Sciences**

**Established in 1970**

**Location: 221 Bobby Dodd Way**

**Telephone: 404-894-3893**

*Director and Professor*—Philip N. Froelich; *Associate Director and Associate Professor*—Kevin C. Beck; *Institute Professor*—Chia Szu (C.S.) Kiang; *Professors*—William L. Chameides, George Chimonas, Douglas Davis, L. Timothy Long, Robert P. Lowell, E. Michael Perdue, Robert G. Roper, Charles E. Weaver (emeritus), Paul Wine; *Associate Professors*—Charles O. Pollard, Michael O. Rodgers, J. Marion Wampler; *Assistant Professors*—Donald E. Canfield, Patricia M. Dove, Dana E. Hartley, Carolyn D. Ruppel, Lars P. Stixrude, Philippe Van Cappellen; *Principal Research Scientists*—Fred N. Alyea, John D. Bradshaw, Derek M. Cunnold; *Senior Research Scientist*—Scott Sandholm; *Research Scientists*

*II*—Robert X. Black, Carlos A. Cardelino, Leslie J. Garland, Prasad Kasibhatla, Jose E. Martinez; *Adjunct Professors*—Paul Cruzen, Richard Jahnke, Hiram Levy, Leonard Newman, Stuart Wakeman, Herbert L. Windom; *Adjunct Associate Professors*—Charlene Bayer, Mikhail Bele'kii, Jackson O. Blanton, Fred L. Eisele, Thomas Gross, Carmen Nappo, John C. Nemeth, Shahrokh Rouhani, Francisco Esteban Werner; *Adjunct Assistant Professors*—Clark R. Alexander, Beatriz Cardelino, Albin Gasiewski, Vijay Madiseti.

## General Information

The School of Earth and Atmospheric Sciences is the principal academic unit at Georgia Tech focusing on the earth, its physical and chemical environment, and its resources. All facets of the earth's system (including its geosphere, atmosphere, and hydrosphere) are studied within the School, and an Earth System Science approach is emphasized. These studies provide basic information for assessing the earth's resources and environmental quality, as well as the evolution of the earth's environment and the possible future changes to this environment on the local, regional, and global scale.

The School has, until recently, offered only graduate degrees and emphasized research and graduate education. Only a limited number of undergraduate courses were offered. In Winter Quarter 1993 the School initiated an undergraduate degree, Bachelor of Science in Earth and Atmospheric Sciences.

The undergraduate degree program offers students an introduction to the Earth System, including aspects of environmental science, by way of holistic and integrative Earth System Science approach. The prime objective of our undergraduate program is to provide a technically rigorous education for the next generation of earth and atmospheric scientists, providing them with the qualitative and quantitative understanding of the complex interplay among the global dynamic systems of the earth, oceans, atmosphere, and biota. Selected courses in the degree program are designed to play an important service role in providing Earth System Science literacy to students of science, engineering, management, and public policy.

In the area of graduate education, the School

offers programs leading to the degrees Master of Science and Doctor of Philosophy. Persons with a bachelor's degree in atmospheric science, biology, chemistry, engineering, geology, mathematics, meteorology, or physics, and a keen desire to understand the chemistry and physics of our natural environment are invited to apply to the School's graduate program. Because of the varied backgrounds and interests of our students, the program of study for each student is typically adjusted to accommodate his or her needs.

The School's educational program is divided into three coupled and interdependent areas of specialization: 1) atmospheric sciences (including atmospheric chemistry, dynamic meteorology, and physical meteorology); 2) geochemistry; and 3) solid earth geophysics. In addition to these areas of specialization, students can carry out multidisciplinary studies in areas such as biospheric-atmospheric interactions, crystallography (crystal physics), engineering geology, environmental studies and public policy, nuclear geochemistry, organic geochemistry, and remote sensing.

The School's research and study in oceanography is carried out in cooperation with the staff of the Skidaway Institute of Oceanography at Savannah, Georgia. Students with interests in oceanography can conduct their thesis research at Skidaway after completing course work at Georgia Tech.

## Undergraduate Program

The Bachelor of Sciences in Earth and Atmospheric Sciences program is based on 42 hours of core courses within the School and 62 hours of required courses in mathematics/computing and science. These ensure a strong foundation in earth system science, including "hands-on" experiences in environmental data gathering and interpretation and in predictive modeling. Technical electives (24 hours), both within this School and in other units of Georgia Tech, allow students considerable flexibility in tailoring their degree program according to individual career goals within earth and atmospheric sciences/earth system science fields. Appropriate selection of tracks, involving consultation with the School's undergraduate coordinator, will allow a student to proceed to further graduate study in the field or immediately

to careers in, but not restricted to, such fields as environmental chemistry, environmental monitoring, remote sensing, exploration geophysics, geological engineering and geological hazards, impact assessment, meteorology, and environmental policy.

An undergraduate enrolled in another Georgia Tech school may develop a substantial background in the earth and atmospheric sciences by proper choice of electives within his or her own degree program. For example, the School of Physics recommends a specific set of upper-level courses for physics majors who are interested in solid earth geophysics.

## Certificate Programs

The School of Earth and Atmospheric Sciences offers for non-School majors programs of study leading to certificates in two emphasis areas: surficial geochemistry and solid earth geophysics. Course requirements—each course must be completed with a grade of C or better—are listed below:

### General Prerequisites

EAS 2501 Geology I (3-0-3)

EAS 2102 Geology Laboratory (0-3-1)

### Geochemistry Certificate

EAS 2502 Geology II (3-0-3)

EAS 3311 Chemical Principles in Earth Systems (4-0-4)

EAS 3312 Geochemistry of Minerals and Waters (3-0-3)

One additional approved EAS course (3000-level or above,  $\geq 3$  hours); suitable courses include, but are not restricted to:

EAS 3000 Earth Resources (3-0-3)

EAS 3313 Atmospheric Chemistry (3-0-3)

EAS 3400 Mineralogy (3-3-4)

EAS 4300 Oceanography (3-0-3)

EAS 4411 Earth System Modeling (3-0-3)

EAS 4412 Biogeochemical Cycles (3-0-3)

EAS 4420 Environmental Field Study (1-6-3)

### Geophysics Certificate

EAS 2502 Geology II (3-0-3)

EAS 3513 Physics of the Earth's Interior (4-0-4)

One or other of:

EAS 4551 Seismic Reflection Methods in Exploration Geophysics (3-0-3)

EAS 4552 Potential Methods in Exploration Geophysics (3-0-3)

One additional EAS course (3000 level or above,  $\geq 2$  hours). This may include that one of the two courses, EAS 4551 and EAS 4552, not selected above. Additional suitable courses include:

EAS 3511 Geophysical Fluid Dynamics (3-0-3)

EAS 4803 Fluids in the Earth's Crust (3-0-3)

EAS 4900 Special Problems

Additional information regarding undergraduate programs is available by writing to the Undergraduate Coordinator, School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, Georgia 30332-0340.

## Bachelor of Science in Earth and Atmospheric Sciences Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 1507-8-9</b>			
Calculus I,II,III	5-0-5	5-0-5	5-0-5
<b>CHEM 1101-1112</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>BIOL 1110</b>			
General Biology I	.....	.....	3-3-4
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I,II	3-0-3	3-0-3	.....
<b>English Elective</b>	.....	.....	X-X-3
<b>EAS 1101-2-3</b>			
Introduction to Earth Systems I,II,III	3-0-3	3-0-3	3-0-3
<b>HPS 1040</b>			
Health Education	.....	.....	3-0-3
<b>TOTALS</b>	<b>15-3-16</b>	<b>15-3-16</b>	<b>X-X-18</b>

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 2507-8</b>			
Calculus IV,V	5-0-5	3-0-3	.....
<b>CHEM 2110</b>			
Chemical Structures	.....	.....	3-0-3
<b>PHYS 2121-2-3</b>			
Physics	4-3-5	4-3-5	4-3-5

<b>Humanities/Social Sciences Electives</b>	X-X-3	.....	X-X-3
<b>BIOL 1111</b>			
General Biology II	.....	3-3-4	.....
<b>CS 1700</b>			
Digital Computer Organization/Program.	.....	.....	3-0-3
<b>Technical Electives</b>	X-X-3	.....	X-X-3
<b>Free Elective</b>	.....	X-X-4	.....

<b>TOTALS</b>	X-X-16	X-X-16	X-X-17
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### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Humanities/Social Sciences Electives</b>	X-X-3	X-X-6	X-X-3
<b>EAS 3311</b>			
Chemical Principles in Earth Systems	4-0-4	.....	.....
<b>EAS 3312</b>			
Geochemistry of Minerals, Waters	.....	3-0-3	.....
<b>EAS 3313</b>			
Atmospheric Chemistry	.....	.....	3-0-3
<b>EAS 3511</b>			
Geophysical Fluid Dynamics	3-0-3	.....	.....
<b>EAS 3512</b>			
Physics of Atmos., Oceans	.....	3-0-3	.....
<b>EAS 3513</b>			
Physics of Earth's Interior	.....	.....	4-0-4
<b>Technical Electives</b>	X-X-3	.....	X-X-3
<b>Free Electives</b>	X-X-3	X-X-3	X-X-3
<b>TOTALS</b>	X-X-17	X-X-15	X-X-15

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>Humanities/Social Sciences Electives</b>	X-X-3	X-X-3	X-X-3
<b>EAS 4411</b>			
Earth System Modeling	.....	.....	3-0-3
<b>EAS 4412</b>			
Biogeochemical Cycles	.....	3-0-3	.....
<b>EAS 4420</b>			
Environmental Field Study	1-6-3	.....	.....
<b>EAS 4430</b>			
Remote Sensing, Data Analysis	.....	3-3-4	.....
<b>Technical Electives</b>	X-X-6	X-X-3	X-X-3
<b>Free Electives</b>	X-X-3	X-X-3	X-X-6
<b>TOTALS</b>	X-X-15	X-X-15	X-X-15

Total Credit Hours Required for Graduation = 192

## Substitutions

With permission from the School other courses in computing may be substituted for CS 1700, other courses in biology may be substituted for BIOL 1110-1, an alternative MATH/PHYS course may be substituted for CHEM 2110, and HPS 1061 may be substituted for HPS 1040.

## Electives

### Humanities, Social Sciences and Health Sciences Electives

See "Information for Undergraduates" for information relative to the Institute requirement of 18 hours of humanities and 18 hours of social sciences (p. 33). All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement. All students must satisfactorily complete a health sciences requirement, HPS 1040 or 1061, during their freshman year (p. 311).

### Technical Electives

The 24 hours of technical electives must form a cohesive set (a track) in the general Earth System field. They must include a laboratory course and a thermodynamics course selected from approved lists made available in the School. Tracks are to be designed with the advice of the School's undergraduate coordinator.

### Free Electives

The required hours (25) of free electives are unrestricted, but provide opportunities for students to add breadth to their program in such areas as modern languages, environmental management, and public policy. Students should consult the School's undergraduate coordinator for advice on their selections.

## Master's Degree Programs

There are three basic programs of study that lead to the degree Master of Science in the School of Earth and Atmospheric Sciences. These are the programs in atmospheric sciences, geochemistry, and solid earth geophysics. Multidisciplinary programs of study are also permitted upon the approval of the faculty of the School. In order to take the courses required in the graduate study



program in earth and atmospheric sciences, students will need a background that includes a minimum of one year of university-level courses in mathematics, chemistry, and physics. Students who enter without this background will be required to take remedial work without graduate credit.

In order to qualify for the degree Master of Science in the School of Earth and Atmospheric Sciences, a student must complete a faculty approved set of academic courses and a thesis. Students who wish to include more course work in a special technical area or not complete a thesis may pursue a program of study that does not meet all the requirements for the designated master's degree. Such a program of study must be approved by the faculty of the School and leads to an undesignated Master of Science.

Graduate students in the School can also qualify for a Master of Science degree under the Multidisciplinary Program in Geohydrology by electing certain course in hydrology (see the section Multidisciplinary Programs in Engineering, p. 100).

## Doctoral Program

The major academic role in the School of Earth and Atmospheric Sciences is the education of graduate students pursuing the doctoral degree. Toward this end we have developed and will maintain an internationally recognized program of research with faculty that is both accessible to the students and active at the forefront of scientific investigation. Persons with a strong background in the basic sciences and mathematics, the potential for high achievement in research, and a strong desire to expand humankind's knowledge and understanding of its physical and chemical environment are invited to apply to the School's doctoral program. A wide range of individual programs of study and research are available within the School's three main specialty areas and in Earth System Science combinations of these. Multidisciplinary programs are also permitted upon approval of the faculty.

## Courses of Instruction

### EAS 1101. Introduction to Earth System Sciences I

3-0-3. Prerequisite: none.

Introduction to earth systems. The material earth, its energy sources, and their immediate consequences. Introduction to earth system cycles.

### EAS 1102. Introduction to Earth System Sciences II

3-0-3. Prerequisite: EAS 1101.

The weather/climate system, the atmosphere and its processes, and biogeochemical systems. Particular emphasis is placed on change, interactions, and the development of models of earth system cycles.

### EAS 1103. Introduction to Earth System Sciences III

3-0-3. Prerequisite: EAS 1102.

Changes in the earth system over time. Emphasis is placed on understanding causes, perturbations and their consequences, and possible future states.

### EAS 2102. General Geology Laboratory

0-3-1. Corequisite: EAS 2501.

Exercises on minerals, rocks, topographic maps, and geologic maps.

### EAS 2501. Geology I

3-0-3. Prerequisites: CHEM 1102 or 1112; Corequisites: EAS 2102, PHYS 2121.

Introduction to minerals, rocks, geological structures, and seismicity. Geologic interpretation of the surface features of the earth.

### EAS 2502. Geology II

3-0-3. Prerequisite: EAS 2501.

The interior of the earth and its processes; interpretation of the history of the solid earth, oceans, atmosphere, and life.

### EAS 2750. Physics of the Weather

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. Cross listed as PHYS 2750.

### EAS 3000. Earth Resources

3-0-3. Prerequisite: EAS 1102 or EAS 2501.

A study of the earth's physical resources—fresh water, land (soils), minerals, and fuels—emphasizing the geologic origin, geographic distribution, and future availability of the resources.

### EAS 3311. Chemical Principles in Earth Systems

4-0-4. Prerequisites: CHEM 1112; EAS 1101 or EAS 2501.

Application of chemical principles to atmospheric chemistry and geochemistry.

### EAS 3312. Geochemistry of Minerals and Waters

3-0-3. Prerequisite: EAS 3311.

Geochemical processes in the earth's surface environment. Chemical kinetics and equilibria in soils, sediments, and natural waters.

**EAS 3313. Atmospheric Chemistry**

3-0-3. Prerequisite: EAS 3311.

Major topics to be covered include chemistry of the natural troposphere, photochemistry of the natural stratosphere, and air pollution/atmospheric environmental issues.

**EAS 3400. Mineralogy**

3-3-4. Prerequisite: EAS 2102 or consent of the instructor.

Crystal bonding and symmetry, crystal structure and crystal chemistry, application to geologically important minerals. Laboratory devoted to crystallography, hand specimen identification, X-ray diffraction.

**EAS 3511. Geophysical Fluid Dynamics**

3-0-3. Prerequisite: MATH 2508.

Introduction to the basics of geophysical fluid dynamics as applicable to atmospheric science, physical oceanography, and the fluid dynamics of the earth's interior.

**EAS 3512. Physics of the Atmosphere and Ocean**

3-0-3. Prerequisite: EAS 3511.

Introduction to the basic physics of earth's atmosphere and oceans, emphasizing thermodynamics and radiative transfer. Applications for global observation by remote sensing and climate change.

**EAS 3513. Physics of the Earth's Interior**

4-0-4. Prerequisites: PHYS 2121; EAS 1101 or EAS 2501, or consent of the instructor.

Introduction to physics of the earth's interior. Composition, properties, structure, and evolution of the core, mantle, and crust.

**EAS 4300. Introduction to Physical and Chemical Oceanography**

3-0-3. Prerequisite: EAS 2501 or consent of the instructor.

Ocean geometry, physical properties of sea water, water movements and energy fluxes, sediments, chemical cycles and geochemistry, ocean history.

**EAS 4411. Earth System Modeling**

3-0-3. Prerequisites: CS 1700 and senior standing.

An introduction to mathematical modeling in earth systems.

**EAS 4412. Biogeochemical Cycles**

3-0-3. Prerequisites: EAS 1103, EAS 3311, and EAS 3313.

Analysis of the biological, geochemical, and physical processes responsible for the global cycling of the elements essential to maintain life on earth. Effects of human-induced perturbations of these cycles.

**EAS 4420. Environmental Field Study**

1-6-3. Prerequisite: Senior standing.

An introduction to Earth System monitoring and field research.

**EAS 4430. Remote Sensing and Data Analysis**

3-3-4. Prerequisites: PHYS 2123, CS 1700 or equivalent, and EAS 1102.

Introduction to remote sensing of the atmosphere and Earth. Laboratory examples of data and image analysis for remote sensing applications.

**EAS 4550. Applied Geophysics**

3-3-4. Prerequisites: EAS 2501, PHYS 2123.

Theory of electrical, magnetic, gravity, seismic refraction and reflection exploration methods. The laboratory provides exercises in instrumentation and data interpretation.

**EAS 4551. Seismic Reflection Methods in Exploration Geophysics**

3-0-3.

Seismic wave propagation, ray theory, and refraction data interpretation. Seismic reflection data acquisition and interpretation techniques. Application of seismic data to the search for oil.

**EAS 4552. Potential Methods in Exploration Geophysics**

3-0-3.

Potential theory, the earth's gravitational field, reduction of gravity data. Modeling gravity anomalies. Magnetic field of the earth and magnetic anomalies. Techniques of electrical methods.

**EAS 4801-2-3-4-5. Special Topics**

1-0-1, 2-0-2, 3-0-3, 4-0-4, 5-0-5, respectively.

**EAS 4900. Special Problems**

Credit hours to be arranged.

**EAS 6049. Geophysics I—Deformation of Earth Materials**

3-0-3.

Theoretical survey of the elastic and inelastic behavior of the earth's materials and implications for tectonics, heat flow, and the earth's interior.

**EAS 6051. Geophysics II—Gravity**

3-3-4.

An intense theoretical survey of terrestrial geophysics. Topics include potential theory, shape of the earth, and physical geodesy.

**EAS 6052. Geophysics III—Geomagnetism and Paleomagnetism**

3-0-3. Prerequisite: EAS 6051 or consent of the instructor.

Topics include magnetohydrodynamics, origin, and description of the earth's magnetic field, rock magnetism, remanent magnetism, geophysical evidence for global tectonics, and tectonic mechanisms.

**EAS 6100. Clay Mineralogy**

3-0-3. Prerequisite: consent of the instructor.

The composition and structure of clay minerals, physical and chemical properties, X-ray identification, geologic distribution and significance, origin.

**EAS 6110. Advanced Clay Mineralogy**

2-3-3. Prerequisite: EAS 6100.

Clay-water relations; cation exchange; effects of crystal structure and composition on physical and chemical properties, X-ray, electron microscope, and other techniques.

**EAS 6150. Sedimentary Geology**

3-3-4. Prerequisite: consent of the instructor.

Composition, texture, and structure of sediments and sedimentary rocks, sedimentary processes, diagenesis, environments of deposition, stratigraphy of sedimentary rocks.

## **EAS 6160. Stratigraphy and Sedimentation**

3-0-3. Prerequisite: EAS 6150.

Continuation of EAS 6150 with emphasis on sedimentary environments, recent and ancient. Principles of correlation, stratigraphic mapping, and stratigraphic analysis.

## **EAS 6210. Global Tectonics**

3-0-3. Prerequisite: EAS 3513.

A seminar that explores the recent revolution in understanding the dynamic behavior of the earth through readings from the literature and student presentations.

## **EAS 6300. Principles of Physical Oceanography**

3-0-3. Prerequisite: consent of the instructor.

Temperature, salinity, and density in the oceans. Dynamics of ocean currents. Theory of ocean waves. Selected topics with application to coastal and estuarine circulation.

## **EAS 6400. Igneous Petrology**

3-3-4. Prerequisite: EAS 6425.

Microscopic study, classification, physical chemistry, and evolution of igneous rocks.

## **EAS 6425. Geologic Phase Diagrams**

3-0-3. Prerequisite: consent of the instructor.

Practical application of available phase diagrams to problems in metamorphic and igneous petrology. Phase rule is used extensively.

## **EAS 6450. Metamorphic Petrology**

3-3-4. Prerequisite: EAS 6425.

Study and classification of chemical and physical changes induced in rocks upon metamorphism. Microscopic laboratory study.

## **EAS 6510. Analytical Methods in Geophysics I**

3-3-4. Prerequisite: EAS 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.

## **EAS 6520. Analytical Methods in Geophysics II**

3-3-4. Prerequisite: consent of the instructor.

Hankel transforms and applications, electrical soundings. Propagation of plane waves in nonhomogeneous media, the W.K.B.J. approximation, magneto-telluric soundings. Radiation of a dipole over a layered conducting half space, electromagnetic soundings.

## **EAS 6550. Observational Seismology**

3-3-4.

A study of the nature of earthquake motion and the damage it causes. The laboratory provides exercises in the interpretation of seismograms.

## **EAS 6560. Theoretical Seismology**

3-3-4. Prerequisites: MATH 4320, 4581, 4582, EAS 6550.

Theory of elastic wave propagation in the earth. Topics include reflection of waves, surface waves, and Cagniard theory of body waves.

## **EAS 6600. Aqueous Geochemistry**

3-0-3. Prerequisite: CHEM 3412, EAS 2501, or consent of the instructor.

Equilibrium and dynamic processes that regulate the composition of waters at or near the surface of the earth.

## **EAS 6610. Organic Geochemistry**

3-0-3. Prerequisite: CHEM 3313 or consent of the instructor.

Origin and transformation of organic matter in the carbon cycle, with emphasis on the properties and reactions of highly complex mixtures such as humic substances.

## **EAS 6620. Nuclear Geochemistry**

3-0-3.

Nuclear reactions and radioactive decay in nature. Geochemistry of radionuclides. Age measurements based on radioactive decay. Abundance variations of radiogenic and cosmogenic stable nuclides.

## **EAS 6625. Stable Isotope Geochemistry**

2-0-2.

Variations in isotopic composition of the elements owing to isotope effects in natural physical and chemical processes. Application of isotope ratio measurement to geochemistry, hydrology, oceanography, and paleoclimatology.

## **EAS 6764. Ocean Acoustics**

3-0-3. Prerequisite: EAS 4300 or consent of the School. MATH 4321, 4582, ESM 6760 recommended.

Propagation of sound waves in the oceans. Stress-strain relationships, asymptotic ray theory. Propagation in shallow water and deep water. Cross listed with ME 6764, ESM 6764.

## **EAS 6791. Atmospheric Turbulence**

3-0-3. Prerequisite: consent of the instructor.

Introduction to turbulence, turbulent transport of momentum and heat, sources of turbulence in the atmosphere, the dynamics of turbulence, statistical description, correlation functions and the spectral dynamics of turbulence.

## **EAS 6792. Air Pollution Meteorology**

3-0-3. Pre- or corequisite: EAS consent of the instructor.

Vertical temperature and wind structure, topographic effects, natural removal processes, atmospheric dispersion of stack effluents, air pollution climatology, meteorological management of air pollution.

## **EAS 6793. Atmospheric Boundary Layer**

3-0-3. Prerequisite: EAS 6811.

Structure and aerodynamics of atmospheric boundary layer, turbulent transport of contaminants in the environment, stratified and disturbed atmospheric boundary layer, free convection layer, current problems.

## **EAS 6810. Introduction to Geophysical Fluids**

3-0-3. Prerequisite: MATH 3308.

The course is designed to introduce the student to the basic concepts of geophysical flows. The theory of flows in a rotating spherical layer is presented; fundamental theorems and their applications in meteorology are described.

## **EAS 6811. Dynamic Meteorology I**

3-0-3. Prerequisite: EAS 6810.

Review of the mechanics of motion in the atmospheric shell. Fundamental nondimensional parameters defining geophysical flows. Vorticity equation. Synoptic scale motions in the context of shallow-water theory. Gravity waves, stability criteria, clear air turbulence.

**EAS 6812. Dynamic Meteorology II**

3-0-3. Prerequisite: EAS 6811.

Quasigeostrophic motion in the presence of stratification. General considerations on instability theory, energetics analysis of atmospheric motions. Baroclinic instability. Fronts and frontogenesis. Blocking and barotropic instability.

**EAS 6813. Geophysical Fluid Dynamics**

3-0-3. Prerequisite: EAS 6812.

The objective of the course is to provide as uniform a presentation as possible of the principles and characteristics of the dynamics of the atmosphere and the ocean.

**EAS 6820. Introduction to Atmospheric Chemistry**

3-0-3. Prerequisite: MATH 3308.

Basic chemical principles relating to atmospheric chemistry: electrostatics, atomic structure, chemical bonding, molecular geometry, chemical thermodynamics, chemical reactivity, gas phase kinetics, photochemistry, free radical mechanisms, properties of solutions, homogeneous and heterogeneous kinetics.

**EAS 6821. Atmospheric Chemistry**

3-0-3. Prerequisite: EAS 6820 or consent of the instructor.

Topical areas covered include sources and sinks of natural and anthropogenic tropospheric chemical constituents, tropospheric and stratospheric chemical transformations, large-scale biogeochemical cycles of the elements carbon, sulfur, and nitrogen, and human perturbations to the planetary atmospheric system.

**EAS 6830. Introduction to Physical Meteorology**

3-0-3. Prerequisites: MATH 3308, PHYS 3141.

Fundamental principles of atmospheric physical processes. Hydrostatic equilibrium and static stability; physics of clouds, precipitation, and thunderstorms.

**EAS 6831. Physical Meteorology**

3-0-3. Prerequisite: EAS 6830.

Radiative transfer in the atmosphere. The atmospheric green-house effect and the earth's energy budget.

**EAS 6915. Synoptic Meteorology**

3-0-3. Prerequisite: EAS 6811.

Terrestrial winds, cyclones and anticyclones, the general circulation of the atmosphere, air masses and fronts, tropical cyclones-hurricanes, weather analysis and interpretation.

**EAS 6922. Chemistry and Physics of Atmospheric Aerosols**

3-0-3. Prerequisite: EAS 6821 or consent of the instructor.

Chemical and physical properties of natural and anthropogenic atmospheric aerosols. Formation and removal mechanisms involved in various atmospheric sources, sinks, and transformation processes.

**EAS 6927. Photokinetics and Spectroscopy**

3-0-3. Prerequisite: EAS 6821 or equivalent kinetics courses.

This course will examine the spectroscopy of atomic and molecular species as well as the photodynamics and kinetics resulting from photofragmentation processes.

**EAS 6932. Meteorology for Solar and Wind Energy**

2-3-3. Prerequisite: consent of the instructor.

Solar radiation instruments, measurement and calibration techniques. Atmospheric attenuation, effects of clouds and turbidity. Meteorological factors of wind energy system design, performance evaluation and siting.

**EAS 6934. Atmospheric Optics and Radiation Transfer**

3-0-3. Prerequisite: EAS 6830.

Quantitative treatment of radiative transfer in the atmosphere; absorption and scattering by atmospheric molecules and particulates; atmospheric visibility and optical effects.

**EAS 6940. Introduction to Climate**

3-0-3. Prerequisite: EAS 6811.

Physical parameters controlling the climate and general circulation. Diagnostic analysis of present climate. The quasigeostrophic theory of general circulation.

**EAS 6941. Atmospheric Modeling**

3-0-3. Prerequisite: EAS 6821 or consent of the instructor.

Application of modern numerical methods to the prediction of atmospheric chemical and physical compositions; specific applications using computer models developed by the students are included.

**EAS 7000. Master's Thesis**

**EAS 7911. Upper Atmospheric Dynamics**

3-0-3. Prerequisite: EAS 6811.

The dynamics of the neutral atmosphere in the stratosphere, mesosphere, and lower thermosphere—prevailing winds, jet streams, waves, tides, and turbulence; winter stratwarms, coupling mechanisms.

**EAS 7999. Preparation for the Comprehensive Examination**

Credit TBA. Audit only.

**EAS 8011-2-3. Seminar**

1-0-1 each. Pass/fail or audit only.

A forum for graduate students in geophysical sciences to present and discuss topics related to their research interests.

**EAS 8102-3. Special Topics**

2-0-2, 3-0-3.

**EAS 8111-2-3-4-5. Special Topics**

1-0-1, 2-0-2, 3-0-3, 4-0-4, 5-0-5 respectively.

**EAS 8123. Special Topics**

3-0-3.

**EAS 8133. Special Topics**  
3-0-3.

**EAS 8143. Special Topics**  
3-0-3.

**EAS 8153. Special Topics**  
2-3-3.

**EAS 8500-1-2. Special Problems**  
Credit to be arranged.

**EAS 8999. Preparation for Doctoral Dissertation**  
Credit TBA. Audit only.

**EAS 9000. Doctoral Thesis**

## **Department of Health and Performance Sciences**

**Established in 1990**  
**(formerly Physical Education and Recreation, est. 1942)**  
**Location: Callaway Student Athletic Complex**  
**Telephone: 404-894-3986**

*Department Head and Professor*—James A. Reedy; *Professors*—Robert J. Gregor, Phillip B. Sparling; *Associate Professors*—Bill D. Beavers, Mindy Millard-Stafford; *Assistant Professor*—David Houser; *Research Associates II*—Linda J. DiCarlo, Linda B. Roskopf; *Research Associate I*—Elizabeth O'Donnell; *Instructors*—Jean Desdunes, James P. Hebron, Kirk D. McQueen; *Research Technician I*—Teresa K. Snow; *Adjunct Professors*—John D. Cantwell, David Dalrymple, Sanford J. Matthews.

### **General Information**

The curriculum and programs of the Department of Health and Performance Sciences emanate from the premise that sound health practices, physical fitness, and basic neuromuscular skills are important contributions to the total education and peak functioning of the individual, as well as the foundations of a balanced and productive life. The Department therefore seeks to offer unique

experiences to educate and motivate students toward a lifetime commitment to optimal personal health and to assist each student in obtaining the necessary knowledge and skills to achieve and maintain it. Moreover, the department offers upper-level courses in the health and exercise sciences to augment professional preparation for careers in science and engineering.

### **The Health Sciences Requirement**

All students entering Georgia Tech must satisfactorily complete the health sciences requirement. The requirement should be taken during the freshman year and consists of one three-hour course—either HPS 1040, Health Education, or HPS 1061, Fitness: Theory, Evaluation, and Conditioning. It is suggested that students with physical disabilities enroll in HPS 1040 rather than HPS 1061. The Department will grant credit to transfer students for comparable courses completed at other institutions. Students who have completed their health sciences requirement are encouraged to elect additional courses of interest in health, exercise science, and physical education.

Other Health and Performance Sciences (HPS) courses may be used as free electives or technical electives, if approved by the major school. Individual schools may allow up to three hours of physical education (PE) courses to be counted toward degree requirements. Students should check the curricula of their individual schools to determine the number of hours they may apply toward the degree.

To supplement the experiences in the health sciences requirement, students are encouraged to participate in associated programs sponsored by the Department and the Division of Student Affairs, including those offered by the Wellness Center headquartered at the Student Health Center.

### **Certificate Program in Health Sciences**

The Department of Health and Performance Sciences, in conjunction with the School of Biology, offers a multidisciplinary certificate program in the health sciences. It is designed for

students from any major who wish to broaden or supplement their educational experiences and career opportunities in areas related to the health sciences, human biology, or bioengineering. The certificate program is based in human anatomy and physiology, but allows students the flexibility to elect courses in specific areas of interest such as personal health, the environment, or exercise science. HPS 3751 and 3752 (Human Anatomy and Physiology I and II) are required with other courses selected from an approved list of courses. Specific information regarding the certificate may be obtained by contacting the HPS Office in the Callaway Student Athletic Complex.

## **Courses of Instruction**

### **HEALTH AND PERFORMANCE SCIENCES**

#### **HPS 1040. Health Education**

3-0-3.

Guest lecturers from the medical and allied health professions acquaint the student with contemporary personal health concerns, including drugs, nutrition, emotional health, and sex education.

#### **HPS 1061. Fitness: Theory, Evaluation, and Conditioning**

2-2-3.

Basic concepts on which lifetime fitness programs are founded. Role of exercise in health, weight control, and quality of life. Assessment of personal fitness and individualized exercise program for each student, lectures, discussion groups, and conditioning activities.

#### **HPS 3000. Introduction to Human Movement Analysis**

3-0-3. Prerequisite: HPS/BIOL 3751.

Selected concepts from applied biomechanics and physiology that serve as the scientific basis for human movement analysis. An integrative approach with examples from industry, medicine, and athletics.

#### **HPS 3400. Contemporary Issues in Substance Abuse**

3-0-3. Prerequisite: HPS 1040 recommended.

A comprehensive presentation of medical, social, and legal issues related to drug abuse and addictive behaviors in contemporary society.

#### **HPS 3500. Nutrition in Health and Disease**

3-0-3. Prerequisites: junior standing, must have completed HPS 1040 or HPS 1061.

Study of human nutrition as an applied science. Nutrition physiology: metabolism, energy production, biochemical aspects. Role of nutrients, weight control mechanisms, preventive nutrition in health management.

#### **HPS 3751. Human Anatomy and Physiology I**

3-0-3.

Study of human anatomy and fundamental physiological mechanisms with concentration on skeletal, integumentary, muscular, nervous, circulatory, and respiratory systems. This course is cross listed as BIOL 3751.

#### **HPS 3752. Human Anatomy and Physiology II**

3-0-3. Prerequisites: HPS/BIOL 3751.

Study of human anatomy and physiology with emphasis on gastrointestinal, renal, endocrine, immune, and reproductive systems. Cross listed as BIOL 3752.

#### **HPS 3801-2-3-4. Special Topics**

Credit hours equal last digit of course number. Prerequisite: consent of the instructor.

Current topics in health/exercise science are presented as demand or interest warrants.

#### **HPS 3901-2-3-4. Special Problems**

Credit to be arranged. Prerequisite: HPS 4100 or 4200, and prior consent of faculty member.

Exposure to research investigation including laboratory procedures and instrumentation.

#### **HPS 4100. Exercise Physiology**

3-3-4. Prerequisite: HPS 3000.

Physiology of human physical activity with emphasis on metabolic, cardiorespiratory, and musculoskeletal aspects; associated topics include body composition, thermoregulation, and ergogenic aids.

#### **HPS 4200. Kinesiological Basis of Human Movement**

3-3-4. Prerequisites: PHYS 2121 or equivalent, and HPS 3000.

Analysis of human movement from the broad perspectives of kinesiology, neural control and human anatomy, to include the study of locomotion, lifting, cycling, jumping, and throwing.

### **PHYSICAL EDUCATION**

The following courses are offered on a Pass/Fail basis only.

- PE 1005. Beginning Swimming
- PE 1011. Swimming
- PE 1051. Aerobic Conditioning: Running
- PE 1071. Aerobic Dance
- PE 1081. Aerobic Conditioning: Swimming
- PE 1091. Physical Conditioning: Strength Training
- PE 2051. Beginning Tennis
- PE 2052. Intermediate Tennis
- PE 2055. Beginning Golf
- PE 2061. Volleyball
- PE 2071. Racquetball
- PE 2072. Intermediate Racquetball
- PE 2081. Bowling
- PE 2111. Basketball
- PE 2131. Soccer
- PE 2151. Lifeguard Training
- PE 2171. Cardiopulmonary Resuscitation and Standard First Aid
- PE 2181. Weight Control through Diet and Exercise

**PE 1005. Beginning Swimming**

0-2-1.

Introduction to swimming fundamentals and safety skills. Open exclusively to nonswimmers.

**PE 1011. Swimming**

0-2-1.

Each student strives for maximum safety by thoughtful experimentation with simulated water emergencies.

Drownproofing evolves as the basic method for survival.

**PE 1051. Aerobic Conditioning: Running**

0-2-1.

Primary emphasis on improvement of endurance and cardiovascular and respiratory system efficiency through an individually tailored program of jogging/running and stretching.

**PE 1071. Aerobic Dance**

0-2-1.

Improvement of flexibility, strength, and primarily cardiorespiratory endurance through basic dance exercises. Course components also include fitness assessment and weight control.

**PE 1081. Aerobic Conditioning: Swimming**

0-2-1.

Primary emphasis on improvement of cardiorespiratory endurance as well as flexibility and muscular endurance through an individualized program of swimming and other aquatic exercises.

**PE 1091. Physical Conditioning: Strength Training**

0-2-1.

Instruction, demonstration, and practice of basic physical conditioning, with emphasis on muscular strength. Activities include running, stretching, calisthenics, and weightlifting.

**PE 2051. Beginning Tennis**

0-2-1.

Designed for the beginning player. Introduction to fundamentals; ground strokes, basic serve, and volley. Rules and etiquette included.

**PE 2052. Intermediate Tennis**

0-2-1.

Concentration on intermediate skills, stroke refinement, spins, singles and doubles strategy.

**PE 2055. Beginning Golf**

0-2-1.

Development of skills in the basic golf swing and five types of shots: woods, irons, chipping, putting, and sand shots.

**PE 2061. Volleyball**

0-2-1.

The serve, spiking, passing, team defensive and offensive play will be demonstrated and practiced, after which team competition is organized.

**PE 2071. Racquetball**

0-2-1.

Singles competition follows basic fundamentals and offensive and defensive strategies.

**PE 2072. Intermediate Racquetball**

0-2-1.

This course is intended to assist players, intermediate and advanced, who are interested in becoming complete racquetball players. The course will concentrate on strategies and drills.

**PE 2081. Bowling**

0-2-1.

Team and league bowling competition follows an instructional program utilizing both live and filmed demonstration of basic skills and techniques.

**PE 2111. Basketball**

0-2-1.

Instruction and practice in basic fundamentals followed by team competition.

**PE 2131. Soccer**

0-2-1.

Organization of teams and competition follows skills practice and demonstration of offensive and defensive strategy.

**PE 2151. Lifeguard Training**

0-2-1.

Formerly Advanced Lifesaving. Course leads to Red Cross certification. Class covers preventive lifeguarding, rescues, carries, pool management and maintenance. Advanced and intermediate swimming skills are a prerequisite.

**PE 2171. Cardiopulmonary Resuscitation and Standard First Aid**

0-2-1.

Basic CPR and emergency first aid skills designed to lead students to Red Cross certification.

**PE 2181. Weight Control Through Diet and Exercise**

0-2-1.

Designed to assist individuals with weight reduction through modification of eating habits and activity patterns. The course promotes immediate and long-term weight control.

## School of Mathematics

**Established in 1952**

**Location: Skiles Building**

**Telephone: 404-894-2700**

*Director and Professor*—Shui-Nee Chow;  
*Associate Director and Professor*—Alfred D. Andrew; *Associate Director and Associate Professor*—Dar-Veig Ho; *Coordinator of Graduate Programs and Professor*—William L. Green; *Coordinator of Undergraduate Programs and Associate Professor*—James M. Osborn; *Regents' Professors*—William F. Ames (emeritus), Jack K. Hale; *Professors*—Johan G. F. Belinfante, Leonid Bunimovich, George L. Cain, Jr., Richard A. Duke, Jeffrey S. Geronimo, Jamie J. Goode, Evans M. Harrell, James V. Herod, Theodore P. Hill, Robert H. Kasriel (emeritus), Robert P. Kertz, Gunter H. Meyer, Thomas D. Morley, John D. Neff, Daniel A. Robinson, Ronald W. Shenk, M. Carl Spruill, Michael P. Stallybrass, Yung L. Tong, Zhihong Xia; *Associate Professors*—Oscar P. Bruno, Eric A. Carlen, Nathaniel Chafee, Luca Dieci, Donald M. Friedlen, Roger D. Johnson (emeritus), John P. Line, Michael Loss, Konstantin Mischaikow, E. Juanita Pitts (emerita), William R. Smythe, Jr. (emeritus), Jonathan E. Spingarn, Frank W. Stallard (emeritus), Robin Thomas; *Assistant Professors*—Neil J. Calkin, Xu-Yan Chen, Jiangang Dai, Donald Estep, Christopher Heil, Christian Houdré, Shi Jin, Daniel A. Klain, Wing Suet Li, Mark D. Rothmann, Laurel L. Stell (temporary), Andrzej Swiech, Prasad Tetali, Yang Wang, Yingfei Yi, Xingxing Yu; *Instructors*—Rena Brakebill, Mary Beth Young.

### General Information

Mathematics forms an integral part of the curricula of most students at Georgia Tech. Consequently, the School of Mathematics offers a wide range of courses serving students in the various engineering, science, and management disciplines. In addition, the School offers programs of study leading to the bachelor's, master's, and doctoral degrees in mathematics. Such programs of study serve as preparation for

mathematics careers, professional schools, and graduate studies.

In addition to basic courses in mathematics, the School offers a variety of specialized courses at the undergraduate and graduate levels, emphasizing areas related to the research activities of the faculty. At present, these include mathematical analysis, applied mathematics, differential equations, scientific computing, probability, statistics, combinatorics, mathematical physics, topology, and algebra.

The School of Mathematics has excellent computer facilities that are used in conjunction with an increasing number of courses and programs of study.

A cooperative plan for students who wish to combine practical experience with academic work is available for mathematics majors.

### Undergraduate Program

The School of Mathematics offers programs leading to two undergraduate degrees: the Bachelor of Science in Applied Mathematics and the Bachelor of Science in Discrete Mathematics. Both programs emphasize the study of core mathematics as well as its applications. They thus provide excellent preparation for employment as well as graduate study in mathematics and related fields.

### Applied Mathematics

Reflecting the scientific environment at Georgia Tech, the bachelor's program in applied mathematics trains students in the traditional core mathematics curriculum, as well as in its applications. The undergraduate program is sufficiently flexible to accommodate the wide variety of interests of undergraduate majors, and yet by its scientific breadth, it prepares the student for the extensive employment opportunities that exist for applied mathematicians.

Students are encouraged to develop an expertise in another field related to mathematics. This can be accomplished by developing a program of study involving technical electives and an appropriate concentration within mathematics. Some of the more popular fields include physics,



computer science, electrical engineering, industrial engineering, operations research, and management. Concentrations within mathematics include scientific computing, engineering mathematics, mathematical physics, probability/statistics, and optimization. In addition, the School of Mathematics has a large computer lab and utilizes micro- and minicomputers throughout the undergraduate curriculum.

Students may count no more than three hours of course work in physical education toward graduation. Only free electives or MATH 4999 in the degree program may be taken on a pass/fail basis, and no more than 12 hours are allowed under this option.

In addition to the institutional requirement of at least a 2.0 grade point average for the entire academic program, the School of Mathematics requires a grade of C or better in each of MATH 4107, 4305, 4317, 4318, and 4320.

## Bachelor of Science in Applied Mathematics Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>English Elective</b>	.....	.....	3-0-3
<b>CHEM 1101-2 or 1101-12</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>CS 1501</b>			
Intro. to Computing	.....	3-3-4	.....
<b>CS 1502</b>			
Intro. to Programming	.....	.....	3-6-5
<b>Health and Performance Sciences</b> (requirements, p. 311)	X-X-3	.....	.....
<b>TOTALS</b>	X-X-16	15-6-17	15-9-18

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3308</b>			
Differential Equations	.....	.....	5-0-5
<b>MATH 3017</b>			

Transition to Higher Mathematics	.....	.....	3-0-3
<b>PHYS 2122-3</b>			
Electromagnetism, Optics and Modern Physics	4-3-5	4-3-5	.....
<b>Social Sciences or Humanities Electives</b>	3-0-3	3-0-3	3-0-3
<b>Free Electives</b>	3-0-3	6-0-6	6-0-6
<b>TOTALS</b>	15-3-16	16-3-17	17-0-17

### Junior and Senior Years

<i>Course</i>	<i>Credit Hours</i>
<b>MATH 3012, 4107, 4215, 4216, 4305, 4317, 4318, 4320, 4640</b>	27
<b>PHYS 3121</b>	5
Course work at or above the 3000-level in a single school in the College of Engineering, the College of Architecture, the College of Computing, the College of Sciences (other than mathematics), the School of Economics, or the School of Management	9
Mathematics courses at or above the 3000-level	18
Humanities and social sciences courses (the degree program must include either a year sequence in a modern language, or nine additional hours of English)	18
Free electives	9
<b>TOTAL</b>	86

Total Credit Hours Required for Graduation = 187

### Substitutions

PHYS 2141-2-3 may be substituted for 2121-2-3 respectively. CS 1501-2 may be replaced by CS 1700 and CS 2101 plus two hours of free electives.

### Electives

#### English Elective

Any English course that carries humanities credit.

### Humanities and Social Sciences Electives

The Institute requires 18 hours in the humanities and 18 hours in the social sciences. See "Information for Undergraduates," p. 33.

The School of Mathematics recommends a one-year sequence of courses in a modern language. It also recommends that each student begin the sequence of required 4000-level mathematics courses in his/her junior year.

All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

## Discrete Mathematics

Certain areas of mathematics have become increasingly important over the past 20 years due to the introduction of computing into nearly every aspect of science, technology, and business.

These are the branches of mathematics that are devoted to the study of "discrete" as opposed to "continuous" structures. The methods of discrete mathematics are used whenever objects are to be counted, when the relationships between finite sets are examined, and when processes involving a finite number of steps are studied. These methods become essential when, for example, computer algorithms are analyzed, transportation networks or communications systems are designed, or when optimal schedules are sought. Many problems associated with the transmission and storage of information, the design of complicated circuits, or the identification of organic chemicals require the tools of discrete mathematics.

Several fields of application, most notably operations research and computer science, not only use the techniques of discrete mathematics but have also contributed significantly to the development of the subject. For this reason the curriculum for this bachelor's degree program combines basic work in mathematics and science and advanced studies in discrete mathematics with substantial training in these areas of application.

The program requires a total of 192 quarter hours for graduation. Of these, 48 hours are devoted to mathematics; 29 to computing; 12 to operations research; and 28 to chemistry, electrical engineering, and physics. A total of 21 hours of technical electives are to be selected from an approved list of courses in mathematics, computing, electrical engineering, and operations research. Three hours of health and performance sciences, 36 hours in the humanities and social sciences, and 15 hours of free electives complete the program.

## Bachelor of Discrete Mathematics Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5

### ENGL 1001-2

Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>CS 1501</b>			
Intro. to Computing	3-3-4	.....	.....
<b>CS 1502</b>			
Intro. to Programming	.....	3-6-5	.....
<b>CS 1155</b>			
Understanding & Constructing Proofs	.....	.....	3-0-3
<b>CHEM 1101-2 or 1101-12</b>			
General Chemistry	.....	4-3-5	4-3-5
<b>Health and Performance Sciences</b>			
HPS 1040/1061	X-X-3	.....	...
<b>Humanities/Social Sciences Elective</b>	.....	.....	3-0-3
<b>TOTALS</b>	<b>X-X-15</b>	<b>15-9-18</b>	<b>15-3-16</b>

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 2501-2-3</b>			
Calculus w/Linear Algebra, Difference & Differential Equations, Algorithms	3-0-3	3-0-3	3-0-3
<b>PHYS 2121-2-3</b>			
Electromagnetism, Optics & Modern Physics	4-3-5	4-3-5	4-3-5
<b>MATH 3012</b>			
Applied Combinatorics	.....	3-0-3	.....
<b>MATH 3017</b>			
Transition to Higher Mathematics	.....	.....	3-0-3
<b>CS 2360</b>			
Knowledge Representation and Processing	.....	.....	3-3-4
<b>CS 2390</b>			
Modeling and Design	.....	3-3-4	.....
<b>CmpE 1700</b>			
Computer and Digital Design Fundamentals	3-0-3	.....	.....
<b>English Elective</b>	3-0-3	.....	.....
<b>Humanities/Social Science Electives</b>	.....	3-0-3	3-0-3
<b>Free Elective</b>	3-0-3	.....	.....
<b>TOTALS</b>	<b>16-3-17</b>	<b>16-6-18</b>	<b>16-6-18</b>

### Junior and Senior Years

<i>Course</i>	<i>Credit Hours</i>
<b>MATH 4022, 4107, 4215, 4220, 4305, 4317</b>	<b>18</b>
<b>CS 3156, 3158, 4158</b>	<b>9</b>
<b>ISYE 3231, 3232, 3233, 4006</b>	<b>12</b>
<b>Approved Technical Electives</b>	<b>21</b>
<b>Humanities/Social Sciences Electives</b>	<b>18</b>
<b>Free Electives</b>	<b>12</b>
<b>TOTAL</b>	<b>90</b>

**Total Credit Hours Required for Graduation = 192**

**Substitutions**

PHYS 2141-2-3 may be substituted for PHYS 2121-2-3.

CmpE 2500 may be substituted for CmpE 1700 and one hour of elective credit.

MATH 4580 may be substituted for ISyE 3231.

**Electives****English Elective**

Any English course that carries humanities credit.

**Health and Performance Sciences**

A maximum of three hours of PE may be used toward degree requirements; a three-hour course in health and performance sciences (HPS 1040 or HPS 1061) is required, and the elective courses may be scheduled from PE 1000- and 2000-level courses.

**Humanities and Social Sciences Electives**

The Institute requires 18 hours in the humanities and 18 hours in the social sciences. See "Information for Undergraduates," p. 33

The School of Mathematics recommends a one-year sequence of courses in a modern language. It also recommends that each student begin the sequence of required 4000-level mathematics courses in his/her junior year.

All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

**Graduate Programs**

The School of Mathematics provides opportunities for study in a wide range of mathematical disciplines. First-year graduate sequences include algebra, analysis, differential equations, numerical analysis, probability, statistics, and topology in addition to courses in methods of applied mathematics.

A program of study leading toward a master's degree should include analysis consisting of MATH 6327, 6328, 6321, and 6580. In addition, students should take six hours of course work at the 3000 level or higher outside of the School of Mathematics. The program should also include either a thesis (17 hours) and 15 additional hours of course work at the 4000 level or higher or 32 hours of course work at the 4000 level or higher, including nine hours of concentration in some field of mathematics, three hours in numerical

analysis, and three hours in probability, statistics, or stochastic processes (unless the student has previously had such training), and a sufficient number of hours at the 6000 level or higher to ensure that the program includes a total of at least 35 hours at this level. The courses MATH 4107, 4215, 4216, 4305, 4317, 4318, 4320, and 4640 do not carry graduate credit for mathematics students and may not be used to satisfy these requirements.

Students must maintain an overall grade point average of at least 2.7 and receive a grade of *C* or better in each mathematics course in the program of study.

Before admission to candidacy for the master's degree, each student must pass an oral comprehensive examination.

The doctoral program requires 77 hours of course work beyond the undergraduate degree. Fifteen of these hours must be taken outside the School of Mathematics in the student's minor field of study. Students must maintain an overall grade point average of 2.7 and a grade of *C* or better in each course of the program of study.

Prior to admission to candidacy for the doctoral degree, each student must pass the comprehensive examination, which consists of a written examination in real analysis and linear analysis and an oral examination in the student's proposed area of specialization. Doctoral students must demonstrate a reading knowledge of a language other than English in which there is significant mathematical publication, and must satisfy the Institute requirements with respect to the dissertation and final oral examination.

**Center for Dynamical Systems and Nonlinear Studies**

As part of the research and graduate programs in the School of Mathematics, the Center for Dynamical Systems and Nonlinear Studies sponsors distinct but interrelated activities in dynamical systems, differential equations, and nonlinear analysis and applications. The Center offers post-doctoral and visiting faculty appointments as well as financial aid to graduate students affiliated with the Center.

Much of the research is devoted to the study of qualitative properties of the solutions of nonlinear differential equations, including functional differential or delay differential equations,

reaction-diffusion systems, and hyperbolic partial differential equations. Specific topics emphasized are stability theory, nonlinear oscillations, bifurcation theory, singular perturbations, and asymptotic behavior of solutions.

The director of the Center is Professor Jack K. Hale.

## Program in Algorithms, Combinatorics, and Optimization

One of the most rapidly growing areas of research in applied mathematics, computer science, and operations research has been that dealing with discrete structures. This has been most evident in the fields of combinatorics, discrete optimization, and the analysis of algorithms. Increasingly, work in each of these subjects has come to depend on knowledge of all of them. Indeed, many of the most significant advances have resulted from the efforts of researchers in more than one, if not all three, of these areas.

In response to these developments, Georgia Tech has introduced a doctoral degree program in algorithms, combinatorics, and optimization (ACO). This multidisciplinary program is sponsored jointly by the School of Mathematics, the School of Industrial and Systems Engineering, and the College of Computing. Faculty for the program are drawn from these three sponsoring units, as well as from the School of Electrical and Computer Engineering and the School of Management.

The ACO program is arranged to bring together the study of discrete structures and the design and analysis of algorithms in areas such as graph theory, integer programming, combinatorial optimization, and polyhedral theory. It is intended for students possessing a strong background in one or more of the fields represented by the three sponsoring units. Each student in the program has a single home department chosen from the School of Mathematics, the School of Industrial and Systems Engineering, and the College of Computing. Courses for the program are drawn from all three of these units, and include study in such areas as combinatorial methods, algebraic structures, probability, the analysis of algorithms, computational complexity, linear programming, discrete optimization, and convex analysis.

## Program in Statistics

For information concerning the graduate program in statistics, refer to page 157.

## Courses of Instruction

### MATH 1301. Introduction to Mathematical Sciences

1-0-1. Prerequisite: none.

Elementary lectures in various areas of modern mathematics by the faculty of the School.

Text: at the level of Eves, *Great Moments in Mathematics*.

### MATH 1419. Geometry for Architecture

3-0-3. Prerequisite: MATH 1507.

Development of spatial relationships through the study of geometry; topics include trigonometry, conic sections, projective geometry, solar calculations, tiltings of the plane, and polyhedra.

Text: lecture notes.

### MATH 1507. Calculus I.

5-0-5. Prerequisite: SAT Math score of 550 or higher, or MATH 1708 or MATH 1709. Credit is not allowed for both MATH 1507 and MATH 1712 or for both MATH 1507 and MATH 1307.

Differential calculus. Cartesian and polar coordinates, real and complex numbers, algebraic and trigonometric functions, geometric and physical applications of the derivative.

Text: at the level of Grossman, *Calculus*.

### MATH 1508. Calculus II.

5-0-5. Prerequisite: MATH 1507. Credit is not allowed for both MATH 1508 and MATH 1713 or for both MATH 1508 and MATH 1308.

Integral calculus. Definite and indefinite integrals, techniques of integration, geometric and physical applications, approximate methods, improper integrals, separable and low-order linear differential equations.

Text: at the level of Grossman, *Calculus*.

### MATH 1509. Calculus III

5-0-5. Prerequisite: MATH 1508. Credit is not allowed for both MATH 1309 and MATH 1509.

Indeterminate forms. Sequences and series approximations. Geometry and vectors in Euclidean spaces. The differential calculus of functions of several variables, curvilinear motion.

Text: at the level of Grossman, *Calculus*.

### MATH 1517-8-9. Honors Calculus I, II, III

5-0-5.

The topics covered parallel those of MATH 1507-8-9, with a treatment somewhat more intensive and rigorous. Credit is not allowed for both an honors calculus course and a corresponding regular calculus course.

Text: at the level of Grossman, *Calculus*.

### MATH 1708. Precalculus Mathematics for Management

5-0-5.

Analytic geometry, function concept, polynomials, exponentials, logarithms, linear equations, mathematical induction.

Text: at the level of Cohen, *Precalculus*.

## **MATH 1709. Precalculus for Science and Engineering**

5-0-5.

Analytic geometry, the function concept, exponentials, logarithmic and trigonometric functions, theory of equations including trigonometric equations.

Text: at the level of Cohen, *Precalculus*.

## **MATH 1711. Mathematics for Management I**

5-0-5. Prerequisite: SAT math score of 550 or higher or MATH 1708 or 1709.

Linear equations and straight lines, matrices, linear programming, sets and counting, probability and statistics.

Text: at the level of Spence and Vanden Eynden, *Finite Mathematics*.

## **MATH 1712. Mathematics for Management II**

5-0-5. Prerequisite: MATH 1711. Credit is not allowed for both MATH 1712 and 1507.

The mathematics of finance, functions, the derivative, applications of the derivative, techniques of differentiation.

Text: at the level of Spence and Vanden Eynden, *Calculus with Applications to the Management, Life, and Social Sciences*.

## **MATH 1713. Mathematics for Management III**

5-0-5. Prerequisite: MATH 1712 or 1507. Credit is not allowed for both MATH 1713 and MATH 1508.

Integration, applications of integration to probability and statistics, multidimensional calculus.

Text: at the level of Spence and Vanden Eynden, *Calculus with Applications to the Management, Life, and Social Sciences*.

## **MATH 2012. Boolean Algebra and Applications**

3-0-3. Prerequisite: MATH 1507 or 1711.

Introduction to discrete algebraic structures such as partial orders, lattices, and Boolean algebras, including the algebra of sets and propositional logic with applications to circuits.

Text: at the level of Mendelson, *Boolean Algebra and Switching Circuits*.

## **MATH 2501. Calculus and Linear Algebra**

3-0-3. Prerequisite: MATH 1509. Credit is not allowed for both MATH 2501 and 2508.

Low-dimensional linear algebra and its applications, including linear systems. Affine and quadratic approximations. Introduction to multiple integrals.

## **MATH 2502. Elementary Difference and Differential Equations**

3-0-3. Prerequisite: MATH 2501 or 2508.

Sequences and series. Difference and differential equations, especially the linear case. Anti-differences and generating functions. Discrete approximations to differential equations, stability.

## **MATH 2503. Introduction to Algorithms and Optimization**

3-0-3. Prerequisite: MATH 2502 or 2508.

Algorithms for polynomials and matrices. Interpolation methods. Convexity and constrained optimization. Examples of discrete optimization problems.

## **MATH 2507. Calculus IV**

5-0-5. Prerequisite: MATH 1509. Credit is not allowed for both MATH 2308 and MATH 2507.

Unconstrained and constrained optimization. Calculus of vector-valued functions of several variables. Multiple integrals. Surface integrals and Theorems of Green, Gauss, and Stokes with applications.

Text: at the level of Grossman, *Calculus*.

## **MATH 2508. Calculus V**

3-0-3. Prerequisite: MATH 2507. Credit is not allowed for both MATH 2307 and MATH 2508 or for both MATH 2501 and MATH 2508.

Low-dimensional linear algebra through eigenvalues and eigenvectors. Applications to linear systems, least-squares problems, and the calculus, including elementary differential equations.

Text: at the level of Grossman, *Calculus* and Anton, *Elementary Linear Algebra*.

## **MATH 2517. Honors Calculus IV**

5-0-5.

The topics covered parallel those of MATH 2507 with a treatment somewhat more intensive and rigorous. Credit is not allowed for both an honors calculus course and a corresponding regular calculus course.

Text: at the level of Grossman, *Calculus*.

## **MATH 2518. Honors Calculus V**

3-0-3.

The topics covered parallel those of MATH 2508 with a treatment somewhat more intensive and rigorous. Credit is not allowed for both an honors calculus course and a corresponding regular calculus course.

Text: at the level of Grossman, *Calculus* and Anton, *Elementary Linear Algebra*.

## **MATH 2801-2-3-4-5. Special Topics**

1-0-1 through 5-0-5 (respectively).

Courses on special topics of current interest in mathematics.

## **MATH 3012. Applied Combinatorics**

3-0-3. Prerequisite: MATH 1508 or 1712.

Elementary combinatorial techniques used in discrete problem solving. Topics include basic counting methods, graph and network models, related algorithms for searching and selecting.

Text: at the level of Jackson and Thoro, *Applied Combinatorics with Problem Solving*.

## **MATH 3017. Transition to Higher Mathematics**

3-0-3. Prerequisite: MATH 2502 or 2508.

Algebra of sets, number systems, Euclidean algorithm, relations, functions, order and equivalence relations, well ordering and induction, algebraic structures.

## **MATH 3105. Introduction to Linear Algebra**

3-0-3. Prerequisite: MATH 1509 or 1713.

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 O'Nan, *Linear Algebra*.

**MATH 3308. Differential Equations**

5-0-5. Prerequisite: MATH 2502 or 2508.

Analytic and numerical solutions of elementary differential equations. Applications. Matrix treatment of linear systems: eigenvalue method and exponential matrix. Series methods.

Text: at the level of Rabenstein, *Elementary Differential Equations with Linear Algebra*.

**MATH 3640. Introduction to Scientific Computing**

3-0-3. Prerequisites: MATH 2502 or 2508 and knowledge of computer programming.

Solution of problems in economics, science, and technology employing algorithms for linear and nonlinear equations, integration and ordinary differential equations. Student use of computers emphasized.

**MATH 3720. Statistics and Applications**

3-0-3. Prerequisite: MATH 1508 or 1712.

Introduction to probability, probability distributions, point estimation, confidence intervals, hypothesis testing, linear regression, and analysis of variance. Credit is not allowed for mathematics majors.

Text: at the level of Devore, *Probability and Statistics for Engineering and the Sciences*.

**MATH 3801-2-3-4-5. Special Topics**

1-0-1 through 5-0-5 (respectively).

Courses on special topics of current interest in mathematics.

**MATH 4012. Discrete Algebraic Structures in Coding Theory**

3-0-3. Prerequisite: MATH 2501 or 2508.

Algebraic and combinatorial structures, including finite fields, rings, finite geometries, designs, and codes are introduced. Use of these structures in constructing error-correcting codes is emphasized.

**MATH 4022. Combinatorial Structures**

3-0-3. Prerequisite: MATH 3012 or equivalent.

The fundamentals of graph theory. Topics from transversal theory, matroid theory, and other combinatorial structures such as finite geometries and block designs. Associated algorithms.

**MATH 4032. Combinatorial Analysis**

3-0-3. Prerequisite: MATH 3012 or equivalent.

Problem-solving techniques involving discrete operations. Topics include sums, recurrences, elementary number theory, special sequences, generating functions, and asymptotic methods.

Text: at the level of Graham, Knuth, Patashnik, *Concrete Mathematics: A Foundation for Computer Science*.

**MATH 4107. Introduction to Abstract Algebra I**

3-0-3. Prerequisite: MATH 2502 or 2508.

An introduction to basic algebraic systems, with emphasis on groups, rings, and fields.

Text: at the level of Nicholson, *Introduction to Abstract Algebra*.

**MATH 4108. Introduction to Abstract Algebra II**

3-0-3. Prerequisite: MATH 4107.

A continuation of MATH 4107, with emphasis on modules, polynomial rings, and linear associative algebras.

Text: at the level of Nicholson, *Introduction to Abstract Algebra*.

**MATH 4150. Introduction to Number Theory**

3-0-3. Prerequisite: MATH 2502 or 2508.

Basic results and techniques of number theory, including Euclidean algorithm, prime factorization, Chinese remainder theorem, quadratic residues, Diophantine equations, primality testing, and applications to cryptography.

Text: at the level of Rosen, *Elementary Number Theory and Its Applications*.

**MATH 4215. Introduction to Probability**

3-0-3. Prerequisite: MATH 1713, 2502, or 2508.

Introduction to probability theory with applications, discrete and nondiscrete distributions, moments, laws of large numbers, central limit theorem with applications. Credit is not allowed for both MATH 4215 and 3215.

Text: at the level of Hogg and Tanis, *Introductory Probability and Statistical Inference*.

**MATH 4216. Introduction to Statistics**

3-0-3. Prerequisite: MATH 4215.

A problem-oriented introduction to basic concepts and techniques of statistical inference.

Text: at the level of Hogg and Tanis, *Probability and Statistical Inference*.

**MATH 4220. Elementary Stochastic Processes**

3-0-3. Prerequisite: MATH 4215 or equivalent.

Development of random walk, waiting-time processes, and other stochastic processes through a problem-oriented approach. Methods of solution include counting techniques, recurrence relations, and generating functions.

Text: at the level of W. Feller, *An Introduction to Probability Theory and Its Applications*, Vol. I.

**MATH 4221. Probability with Applications I**

3-0-3. Prerequisite: MATH 4215 or equivalent.

Introduction to renewal processes and Markov chains with applications.

Text: at the level of Ross, *Stochastic Processes*.

**MATH 4222. Probability with Applications II**

3-0-3. Prerequisite: MATH 4221 or equivalent.

Introduction to continuous-time Markov chains, Brownian motion, and martingales.

Text: at the level of Ross, *Stochastic Processes*.

**MATH 4225. Computer Usage in Probability**

3-0-3. Prerequisites: MATH 4215 and CS 1700.

Study of probability distributions, limit laws, and applications through the use of digital computer. Probability (Monte Carlo) methods applied to deterministic problems.

**MATH 4260. Introduction to Mathematical Statistics**

3-0-3. Prerequisites: MATH 2502 or 2508 and 4215.

Unified approach to statistical estimation and testing of hypotheses, including introduction to Bayesian methods. Exact and asymptotic sampling distributions. Applications. No credit allowed for both MATH 4260 and 4262.

Text: at the level of Hoel, Port, and Stone, *Introduction to Statistical Theory*.

**MATH 4262. Mathematical Statistics I**

3-0-3. Prerequisites: MATH 2502 or 2508 and 4215 or equivalent.

Sampling distributions. Normal,  $t$ , chi-square, and  $F$  distributions. Bivariate and multivariate normal distributions. Limiting distributions of sample means and of order statistics. No credit allowed for both MATH 4262 and 4260.

Text: at the level of Hogg and Craig, *Introduction to Mathematical Statistics*.

## **MATH 4263. Mathematical Statistics II**

3-0-3. Prerequisite: MATH 4262.

Point and interval estimation, Bayes estimates, UMP tests, likelihood ratio tests, goodness-of-fit tests and stochastic modeling. Analysis of variance and regression analysis.

Text: at the level of Hogg and Craig, *Introduction to Mathematical Statistics*.

## **MATH 4264. Mathematical Statistics III**

3-0-3. Prerequisite: MATH 4263.

Nonparametric methods. Sufficiency and completeness. The exponential family and stochastic ordering. Introduction to sequential analysis and multiple comparisons.

Text: at the level of Hogg and Craig, *Introduction to Mathematical Statistics*.

## **MATH 4280. Elements of Information Theory**

3-0-3. Prerequisite: MATH 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 4282. Introduction to Stochastic Processes**

3-0-3. Prerequisite: MATH 4215.

Second-order stochastic processes, especially stationary and weakly stationary processes. Gaussian processes. Spectral analysis.

Text: at the level of Hoel, Port, and Stone, *Introduction to Stochastic Processes*.

## **MATH 4305. Finite-dimensional Vector Spaces**

3-0-3. Prerequisite: MATH 2502 or 2508.

Finite-dimensional vector spaces, with emphasis on inner-product spaces, least squares, and linear transformation, including the spectral theorem for normal transformations.

Text: at the level of Strang, *Linear Algebra and Its Applications*.

## **MATH 4306. Applications of Finite-dimensional Vector Spaces**

3-0-3. Prerequisite: MATH 4305.

Applications of MATH 4305, with topics selected from the areas of convex sets, positive matrices, linear difference and differential equations, generalized inverses.

## **MATH 4317. Analysis I**

3-0-3. Prerequisite: MATH 2502 or 2508, and MATH 3017 recommended.

Real numbers, normed vector spaces, completeness, compactness, connectedness, sequences. Continuity of functions and convergence of sequences of functions.

Text: at the level of Bartle, *Elements of Real Analysis*.

## **MATH 4318. Analysis II**

3-0-3. Prerequisite: MATH 4317.

Differentiation of functions of one variable, Riemann-Stieltjes integral, infinite series, conditional and absolute

convergence, series of functions, and Fourier series.

Text: at the level of Bartle, *Elements of Real Analysis*.

## **MATH 4319. Analysis III**

3-0-3. Prerequisite: MATH 4318.

Improper integrals, differentiation in  $\mathbb{R}^n$ , implicit and inverse function theorems, extremum problems and Lagrange multipliers, integration in  $\mathbb{R}^n$ , change of variable in multiple integrals.

Text: at the level of Bartle, *Elements of Real Analysis*.

## **MATH 4320. Complex Analysis**

3-0-3. Prerequisite: MATH 2502 or 3308.

Topics from complex function theory, including contour integration and conformal mapping.

Text: at the level of Churchill, *Complex Variables with Applications*.

## **MATH 4347. Introduction to Partial Differential Equations I**

3-0-3. Prerequisite: MATH 3308 or equivalent.

Method of characteristics for first and second order partial differential equations. Classification of second order equations. Applications.

Text: at the level of Williams, *Partial Differential Equations*.

## **MATH 4348. Introduction to Partial Differential Equations II**

3-0-3. Prerequisite: MATH 3308 or equivalent.

Solutions of boundary value problems for partial differential equations by Green's functions. Representative solutions for potential and diffusion equations. Applications.

## **MATH 4431. Introductory Topology**

3-0-3. Prerequisite: MATH 4317 or consent of the School.

This course provides background for use of topological methods in analysis. Metric spaces. Continuous transformation. Topological spaces.

Text: at the level of Cain, *Introduction to General Topology*.

## **MATH 4432. Introduction to Algebraic Topology**

3-0-3. Prerequisites: MATH 4431 and 4107 or 4305.

Introduction to algebraic methods in topology. Includes homotopy, the fundamental group, covering spaces, simplicial complexes. Applications to fixed point theory and graph theory.

Text: at the level of Singer and Thorpe, *Elementary Topology and Geometry*.

## **MATH 4441. Differential Geometry**

3-0-3. Prerequisite: MATH 2508.

The theory of curves and surfaces, including the first and second fundamental forms of a surface and topics related to them.

Text: at the level of O'Neil, *Elementary Differential Geometry*.

## **MATH 4580. Linear Programming**

3-0-3. Prerequisite or corequisite: MATH 2502 or 2508.

A study of the linear programming problem, including the simplex method, duality, and sensitivity analysis with applications to matrix games, integer programming, and networks.

Text: at the level of Chvatal, *Linear Programming*.

**MATH 4581. Advanced Engineering Mathematics**

3-0-3. Prerequisite: MATH 3308 or equivalent.

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 3308 or equivalent.

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 2501 or 2507.

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 and Snider, *Introduction to Vector Analysis*.

**MATH 4591. Introduction to Mathematical Optimization**

3-0-3. Prerequisite: MATH 2501 or 2508.

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*.

**MATH 4640. Scientific Computing I**

3-0-3. Prerequisites: MATH 2502 or 2508 and knowledge of computer programming.

Topics include finding zeros of functions, direct and iterative methods for solving linear systems of equations, polynomial interpolation and numerical integration, including Romberg and adaptive methods.

**MATH 4641. Scientific Computing II**

3-0-3. Prerequisite: MATH 4640 or consent of the School.

Topics covered include solution of ordinary differential equations, nonlinear systems of equations, eigenvalue problems, least squares, and spline approximations.

**MATH 4755. Mathematical Biology**

2-3-3. Prerequisite: MATH 1509.

Problems from the life sciences and the mathematical methods for solving them are presented. The underlying biological and mathematical principles and the interrelationships are emphasized. Also listed as BIOL 4755.

**MATH 4777. Vector and Parallel Scientific Computation**

3-0-3. Prerequisites: MATH 2503 or Math 2508 and programming experience.

Scientific computational algorithms on vector and parallel computers. Speedup, algorithm complexity, interprocessor communication, synchronization, modern algorithms for linear systems, programming techniques, code optimization. Also listed as CS 4777.

**MATH 4800. Special Topics**

3-0-3. Prerequisite: consent of the School.

This course enables the School of Mathematics to comply with requests for courses in special topics. Given upon sufficient demand.

**MATH 4801-2-3-4-5. Special Topics**

1-0-1 through 5-0-5, respectively.

Courses on special topics of current interest in mathematics.

**MATH 4999. Reading or Research**

1 to 3 credits. Prerequisites: junior standing or above, consent of the School.

Pass/fail basis only. Not more than seven hours can be counted toward bachelor's degree. At most, three hours can be counted as mathematics elective.

**MATH 6012. Combinatorial Methods**

3-0-3. Prerequisite: MATH 4032 or consent of the School.

Fundamental methods in enumeration, including the use of inclusion/exclusion, recurrence relations and generating functions. Applications to counting strings, partitions, graphs, and colorings.

Text: at the level of Bender and Williamson, *Foundation of Applied Combinatorics*.

**MATH 6014. Graph Theory and Combinatorial Structures**

3-0-3. Prerequisite: MATH 4022 or consent of the School.

Rigorous treatment of topics of graph theory such as connectivity, colorings, factors, flows, and graph embeddings. Extremal problems and Ramsey theory.

Text: at the level of Bondy and Murty, *Graph Theory with Applications*.

**MATH 6021. Algebra and Topology in Finite-dimensional Spaces**

3-0-3. Prerequisites: MATH 4305 and 4317 or consent of the instructor.

Metric spaces, the topology of  $\mathbb{R}^n$ , norms, duality, continuous linear functionals, convexity, fixed-point theorems, Hahn-Banach separation theorem.

**MATH 6111. Algebraic Structures**

3-0-3. Prerequisites: MATH 4107 and 4305 or consent of the instructor.

Polynomial rings, principal ideal domains, unique factorization. Polynomials over finite fields. Finitely generated modules. Topics in group theory.

Text: at the level of Dean, *Classical Abstract Algebra*.

**MATH 6121. Modern Abstract Algebra I**

3-0-3. Prerequisites: MATH 4107, 4305.

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*.



## **MATH 6123. Modern Abstract Algebra III**

3-0-3. Prerequisite: MATH 6122.

Concept of the total matrix algebra. Introduction to linear associative algebras.

Text: at the level of Lang, *Algebra*.

## **MATH 6221. Topics in Probability**

3-0-3. Prerequisite: MATH 4220 or consent of instructor.

Fundamentals of probability theory, including discrete distribution, tail estimates and Martingales, the Lovasz Local Lemma, correlation inequalities, Poisson paradigm, random graphs and zero-one laws, random walks.

## **MATH 6241-2-3. Probability I, II, III**

3-0-3 each. Prerequisite: MATH 6327 or equivalent.

This sequence develops the probability basis requisite in modern statistical theories and stochastic processes. It includes a selection of topics from measure and integration theory, distribution functions, convergence concepts, Fourier integrals and central limit theory, conditional distributions and dependence and random analysis.

## **MATH 6251. Nonparametric Statistics**

3-0-3. Prerequisite: MATH 4260 or equivalent.

Properties and performance of distribution-free statistical methods including goodness-of-fit and rank tests are studied. Topics include central limit theory for dependent sums, locally best rank tests, the reflection principle, and Pitman efficiency.

Text: at the level of Randles and Wolfe, *Introduction to the Theory of Nonparametric Statistics*.

## **MATH 6252. Introduction to Categorical Data Analysis**

3-0-3. Prerequisite: MATH 4263 or MATH 4260.

Topics include cross classification, contingency tables, log-linear models, logit models, logistic regression, tests of goodness-of-fit, and the delta method.

## **MATH 6262. Advanced Statistical Inference I**

3-0-3. Prerequisite: MATH 4264.

Statistical decision theory, admissibility, completeness and Bayes rules, minimax rules. The separating hyperplane theorem and the complete class theorem. Exponential families and complete sufficient statistics.

Text: At the level of Ferguson, *Mathematical Statistics: A Decision Theoretic Approach*.

## **MATH 6263. Advanced Statistical Inference II**

3-0-3. Prerequisite: MATH 6262.

Invariant statistical decision problems, admissible and minimax invariant rules. Location and scale parameters. Lehmann-Scheffe Theorem and Rao-Blackwell Theorem, uniformly minimum variance unbiased estimators.

Text: at the level of Ferguson, *Mathematical Statistics: A Decision Theoretic Approach*.

## **MATH 6264. Advanced Statistical Inference III**

3-0-3. Prerequisite: MATH 6263.

The Neyman-Pearson Lemma, UMP tests, and UMP unbiased tests. Invariance in hypothesis testing. The general linear hypothesis and multiple comparisons. Multiple decision theory.

Text: at the level of Ferguson, *Mathematical Statistics: A Decision Theoretic Approach*.

## **MATH 6266. Linear Models**

3-0-3. Prerequisite: MATH 4262 or 4260.

Unified approach to regression analysis, analysis of variance and experimental design, making use of linear algebra and generalized inverses. Applications.

Text: at the level of Graybill, *Theory and Application of the Linear Model*.

## **MATH 6267. Multivariate Statistical Analysis**

3-0-3. Prerequisite: MATH 4263 or equivalent.

Multivariate normal distribution theory, correlation analysis, regression and prediction, sampling distributions, multivariate statistical inferences, applications (including classification, multivariate process control, and pattern recognition).

## **MATH 6300. Fractal Geometry**

3-0-3. Prerequisite: MATH 3308 or equivalent.

Introduction to fractal geometry and applications in science and engineering. Notions developed include metric spaces, iterated function systems, and fractal dimensions.

Text: M. F. Barnsley, *Fractals Everywhere*.

## **MATH 6305. Dynamics and Bifurcations I**

3-0-3. Prerequisites: MATH 4305 or 2508, and MATH 3308.

An introduction to the local and global behavior of nonlinear dynamical systems arising from both maps and ordinary differential equations. The emphasis is on bifurcation theory and related questions of stability.

Text: At the level of Hale, *Dynamics and Bifurcations*.

## **MATH 6306. Dynamics and Bifurcations II**

3-0-3. Prerequisite: MATH 6305.

A continuation of MATH 6305, Dynamics and Bifurcations I.

Text: At the level of Hale, *Dynamics and Bifurcations*.

## **MATH 6307-8-9. Ordinary Differential Equations I, II, III**

3-0-3 each. Prerequisites: MATH 3105, 4319.

This sequence develops the qualitative theory for systems of ordinary differential equations. Initial-value problems for systems and  $n$ th order equations. Differential inequalities. Stability of linear and perturbed linear systems, Liapunov functions. Boundary-value problems. Periodic solutions and behavior near periodic orbits. Oscillation and comparison theorems. Asymptotic behavior.

## **MATH 6321. Functions of a Complex Variable I**

3-0-3. Prerequisites: MATH 4318 and 4320, or consent of the School.

Topics include power series, contour integration, conformal mappings, harmonic functions, normal families, Riemann mapping theorem.

Text: at the level of Conway, *Functions of One Complex Variable*.

## **MATH 6322. Functions of a Complex Variable II**

3-0-3. Prerequisite: MATH 6321 or equivalent.

Analytic continuation, multi-valued analytic functions, Riemann surfaces, Rouche's theorem, and related topics.

Text: at the level of Conway, *Functions of One Complex Variable*.

**MATH 6327. Real Analysis I**

3-0-3. Prerequisite: MATH 4318 or consent of the School.

Topics include the foundations of measure and integration, including Lebesgue measure and integral, and integral convergence theorems.

Text: at the level of Royden, *Real Analysis*, 3rd Edition.

**MATH 6328. Real Analysis II**

3-0-3. Prerequisite: MATH 6327 or equivalent.

Topics include the Radon-Nikodym theorem, Fubini's and Tonelli's theorems,  $L_p$  spaces, the Baire Category theorem and consequences, and the Stone-Weierstrass theorem.

Text: at the level of Royden, *Real Analysis*, 3rd Edition.

**MATH 6329. Real Analysis III**

3-0-3. Prerequisite: MATH 6328 or equivalent.

Functional analysis, including normed linear spaces, linear operators, Hahn-Banach theorem, open mapping theorem, weak topologies, dual spaces, and Alaoglu's theorem.

Text: at the level of Royden, *Real Analysis*, 3rd Edition.

**MATH 6334. Operator Theory**

3-0-3. Prerequisite: MATH 6329, or MATH 6328 and MATH 6580.

Theory of linear operators on Hilbert space through spectral theory for bounded and unbounded normal operators.

Text: At the level of Conway, *A Course in Functional Analysis*.

**MATH 6335. Functional Analysis II**

3-0-3. Prerequisite: MATH 6329.

Elements of nonlinear functional analysis, fixed point theorems; locally convex linear topological spaces, Krein Milman theorem, spectral decomposition theorems, Banach algebras.

**MATH 6341. Partial Differential Equations I**

3-0-3. Prerequisites: MATH 4317, 4318, 4319.

Classification of partial differential equations, canonical forms, well posed problems, wave equation in  $\mathbb{R}^n$ , Huygen's principle, potential equation, heat equation, strong maximum principles, fundamental solutions.

**MATH 6342. Partial Differential Equations II**

3-0-3. Prerequisite: MATH 6341.

Existence theory for elliptic equations, single and double layer potentials, Schwarz alternating procedure, subharmonic functions, weak solutions in a Sobolev space, regularity of weak solutions.

**MATH 6343. Partial Differential Equations III**

3-0-3. Prerequisite: MATH 6342.

Finite dimensional approximation of weak solutions, existence theory for evolution equations, semigroups, fundamental solutions, regularity of solutions, nonlinear evolution equations.

**MATH 6350. Introduction to Dynamical Systems and Chaos**

3-0-3. Prerequisites: MATH 3308, 4317 or consent of the instructor.

Specific dynamical models illustrate recurrence and both regular and chaotic behavior. Notions developed include ergodicity, instability, and Lyapunov exponents.

Text: Robert L. Devaney, *An Introduction to Chaotic Dynamical Systems*; also, notes developed by Evans Harrell.

**MATH 6431-2-3. General Topology I, II, III**

3-0-3 each. Prerequisite: MATH 4431 or consent of the School.

Bases and subbases, filters, nets and convergence, 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 Wilansky, *Topology for Analysis*.

**MATH 6441-2-3. Algebraic Topology I, II, III**

3-0-3. Prerequisites: MATH 4431, 4107, and 4305 or consent of the School.

Introduction to homological algebra, Cech and singular homology and cohomology theories. Applications to fixed points of maps, spheres, invariance of domain, etc., homotopy, the fundamental group, covering spaces. Introduction to sheaf theory, category theory, spectral sequences.

Text: at the level of Spanier, *Algebraic Topology*.

**MATH 6501. Methods of Applied Mathematics I**

3-0-3. Prerequisite: MATH 3308 and 3105, or consent of the School.

Complex analysis. Credit not allowed toward graduate degrees in mathematics.

**MATH 6502. Methods of Applied Mathematics II**

3-0-3. Prerequisite: MATH 6501.

A continuation of MATH 6501. Partial differential equations and special functions. Credit not allowed toward graduate degrees in mathematics.

**MATH 6505. Discrete and Continuous Linear Mathematical Modeling**

3-0-3. Prerequisites: MATH 3105 and graduate standing.

This course covers, in a self-contained manner, discrete and continuous mathematical models in circuit theory, statics, mechanics, and operations research. The mathematical tools are developed as needed.

Text: at the level of Surang, *An Introduction to Applied Mathematics*.

**MATH 6580. Introduction to Hilbert Spaces**

3-0-3. Prerequisite: MATH 4305 or consent of the School.

Vector spaces, function spaces, inner products, projections, least squares, Fourier series, integral and differential operators, self-adjoint operators, compact operators, eigenvalues, eigenfunctions, contraction mappings.

**MATH 6581. Calculus of Variations**

3-0-3. Prerequisite: MATH 3308 or consent of the School.

Constrained and unconstrained problems involving single and multiple integrals and added terms. Natural boundary conditions. Transitivity. Broken extremals. Hamilton's principle.

**MATH 6582. Integral Transforms**

3-0-3. Prerequisites: MATH 4582 and 4320 or consent of the School.

Classical Fourier, Laplace, and Mellin transform theory with

applications to boundary-value problems. Special attention to the judicious choice of transform. Successive use of transforms.

## **MATH 6583. Integral Equations**

3-0-3. Prerequisite: MATH 3308 or consent of the School.

Linear integral equations and their relation to differential equations. Hilbert-Schmidt theory. Eigenvalues. Applications.

## **MATH 6584. Special Functions of Higher Mathematics**

3-0-3. Prerequisite: MATH 4320 or consent of the School.

The gamma function, Bessel functions, spherical harmonics, orthogonal polynomials, and other functions of particular interest in science and technology.

## **MATH 6586. Tensor Analysis**

3-0-3. Prerequisites: MATH 3105 and 4583, or consent of the School.

Tensor algebra, covariant differentiation, Cartesian tensors, curvilinear coordinates, introduction to differential forms.

Text: at the level of Simmonds, *A Brief on Tensor Analysis*.

## **MATH 6640. Applied Computational Methods for Partial Differential Equations**

3-0-3. Prerequisite: knowledge of computer programming, familiarity with partial differential equations and elements of scientific computation.

Algorithms using the finite differences and finite elements for the numerical solution of steady and transient problems of engineering and science. Student computer use emphasized.

## **MATH 6643. Numerical Linear Algebra**

3-0-3. Prerequisite: MATH 4305 or consent of the School.

Numerical solutions of linear equations; least squares problems, the singular value decomposition and generalized inverse; methods for determining eigenvalues including the QR algorithm.

## **MATH 6644. Numerical Solution of Nonlinear Equations**

3-0-3. Prerequisite: MATH 4305 or consent of the School.

Iterative methods for nonlinear systems, fixed point equations, Newton's and update methods, gradient methods, parameter continuation and bifurcation methods.

## **MATH 6645. Numerical Approximation Theory**

3-0-3. Prerequisite: MATH 4317 or consent of the School.

Theoretical and computational aspects of polynomial, rational and spline approximation, including Chebyshev and least squares approximation, linear methods of approximation, B-splines, mesh selection.

## **MATH 6646. Numerical Methods for Ordinary Differential Equations**

3-0-3. Prerequisite: MATH 4317 or consent of the School.

Single and multistep methods for initial value problems, error and stability analysis, implicit methods for stiff problems, shooting methods for boundary value problems.

## **MATH 6647. Theory of Numerical Methods for Partial Differential Equations**

3-0-3. Prerequisites: MATH 4317, 4305, familiarity with numerical methods.

Finite difference and finite element approximations for

elliptic and parabolic boundary value problems, error analysis for projection methods, characteristic methods for hyperbolic systems, stability analysis.

## **MATH 6750. Stochastic Models in Management Science**

3-0-3. Prerequisites: MATH 4215 and MATH 2508.

Stochastic process models for managerial contexts including production, congestion, cash flow, fisheries, and passenger reservations. Processes include birth and death, renewal and Markov. Also listed as MSC1 6750.

## **MATH 6761. Stochastic Processes I**

3-0-3. Prerequisite: ISyE 3027 or MATH 4215 or equivalent.

Introduction to Markov chains, Poisson processes and renewal processes. Transient and limiting behavior. Average cost and utility measures of systems. Modeling of inventories, cash management, system availability, storage facilities, and flows in manufacturing and computer networks. Also listed as ISyE 6761.

Text: at the level of Karlin and Taylor, *A First Course in Stochastic Processes*.

## **MATH 6762. Stochastic Processes II**

3-0-3. Prerequisite: ISyE/MATH 6761 or consent of the instructor.

Introduction to continuous-time Markov jump processes, Brownian motion, and discrete-time martingale optional sampling and convergence. Modeling of queues, storage, finance, and production. Also listed as ISyE 6762.

Text: at the level of Karlin and Taylor, *A First Course in Stochastic Processes*.

## **MATH 6763. Stochastic Optimization**

3-0-3. Prerequisites: ISyE 6661, ISyE/MATH 6762.

Optimization of stochastic systems over time, introduction to stochastic dynamic programming (Markov decision processes), and optimal stopping models. Also listed as ISyE 6763.

Text: at the level of Ross, *Introduction to Stochastic Dynamic Programming*.

## **MATH 6781. Reliability Theory**

3-0-3. Prerequisite: MATH 4215 or equivalent.

Structural properties and reliability of coherent systems. Parameter families of distributions in reliability theory. Monotone failure rates. Multivariate distributions and inequalities in reliability theory. Also listed as ISyE 6781.

Text: at the level of Barlow and Proschan, *Statistical Theory of Reliability and Life Testing*.

## **MATH 7000. Master's Thesis**

## **MATH 7761. Convex Analysis and Polyhedra**

3-0-3. Prerequisite: MATH 6021 and ISyE 6661 or consent of the instructor.

Separation results, including the Hahn-Banach theorem and Farkas' Lemma. Polarity and duality relations. Normal and tangent cones. Polyhedra. Convex functions. Applications to optimization. Also listed as ISyE 7761.

## **MATH 7999. Preparation for Doctoral Examinations**

Credit to be arranged. Audit only. Prerequisite: consent of the adviser.

**MATH 8101-11-21-31-41-51. Special Topics**

1-0-1. Prerequisite: consent of the School.

These courses enable the School of Mathematics to comply with requests for courses in selected topics.

**MATH 8102-12-22-32-42-52-62-72-82-92. Special Topics**

2-0-2.

**MATH 8103-13-23-33-43-53-63-73-83-93. Special Topics**

3-0-3.

**MATH 8104-14-24-34-44-54. Special Topics**

4-0-4.

**MATH 8105-15-25-35-45-55. Special Topics**

5-0-5.

**MATH 8203-13-23-33-43-53-63-73-83-93. Special Topics**

3-0-3.

**MATH 8501-8599. Special Problems**

Credit to be arranged. Prerequisite: consent of the adviser.

**MATH 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate teaching assistantships.

**MATH 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**MATH 9000. Doctoral Thesis**

## School of Physics

**Established in 1939**

**Location: Howey Building**

**Telephone: 404-894-5201**

*Acting Director and Professor*—Henry S. Valk; *Associate Director for Graduate Programs and Professor*—Helmut Biritz; *Associate Director for Undergraduate Programs and Professor*—Ian R. Gatland; *Callaway Chair and Regents' Professor*—Uzi Landman; *Regents' Professors*—Martin R. Flannery, Joseph Ford, Ronald F. Fox; *Professors*—David Finkelstein, James L. Gole, Don S. Harmer, Donald C. O'Shea, Eugene T. Patronis, Jr., Rajarshi Roy, Augustus L. Stanford, Edward W. Thomas, Roger M. Wartell, Robert L. Whetten, John L. Wood, Andrew

Zangwill; *Associate Professors*—Mei-Yin Chou, Edward H. Conrad, Ahmet Erbil, Joe P. Meyer (visiting), Kevin A. O'Donnell, A. Turgay Uzer, Kurt Wiesenfeld; *Assistant Professors*—William L. Ditto, Phillip N. First, T. A. Brian Kennedy; *Senior Research Scientists*—Robert N. Barnett, Eduard Bogachek, Charles L. Cleveland, Jianping Gao, William Luedtke; *Research Scientists II*—Constantine Yannouleas, Siquing Wei; *Research Scientist I*—Larry Sudduth.

*Adjunct Faculty*

Akit B. Balentekin, Fred Eisele\*, P.S. Gill, Christopher Summers\*, Michael K. Wilkinson, Richard M. Williamson.

\* *GTRI*

## General Information

Physics is primarily a basic science, and fundamental research into the principles of physics continues to occupy the attention of many physicists. 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 can provide an advantageous preprofessional foundation.

The School of Physics offers basic service courses to freshmen and sophomores, some advanced service courses for students of engineering, science, and mathematics, and advanced work leading to the bachelor's, master's, and doctoral degrees in physics. The School seeks to provide elective freedom in its undergraduate and graduate degree programs in order to enable students with a wide variety of interests to work out suitable 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 physics, chaos, computer science, elementary particles, general relativity, many-body theory, molecular physics, nonlinear mechanics, nuclear physics, optics and laser physics, quantum logic, 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 schools and departments, for undergraduate and graduate special problems, master's theses, and doctoral dissertations.

Information supplementary to this catalog that may be useful to students in the planning of programs of study is available from the School of Physics. A graduate brochure, which further describes the opportunities for graduate study and research, is available upon request. Students majoring in physics should consult frequently with the faculty advisers.

### **Undergraduate Programs**

The School of Physics offers two undergraduate degrees, the Bachelor of Science in Physics and the Bachelor of Science in Applied Physics. The basis of the former degree program is the traditional preparation of a student for graduate study in physics. The degree program in applied physics may be better suited for entry into industry or government upon graduation, preparation for further professional training (medicine, law, dentistry, or business), or preparation for graduate study in some other discipline. The two degree programs differ in that a few courses intended primarily as preparation for graduate study in physics in the traditional program are replaced by courses oriented toward the applications of physics in the applied physics program. Greater flexibility in the choice of technical electives is available in the applied physics program.

Each of the baccalaureate programs contains the following:

(a) courses needed to meet general institutional degree requirements; (b) a core of technical courses intended to give a strong background in mathematics and in the physical principles of mechanics, electricity and magnetism, thermodynamics, and the quantum theory that governs physical phenomena at the microscopic level of molecules, atoms, and nuclei; (c) technical electives that enable the student to explore areas of his or her choice in greater depth; and (d) free electives, about one-fifth of the total hours, which may be employed to

schedule additional technical or nontechnical courses.

The considerable flexibility inherent in the physics curricula is advantageous to students who wish to work out individual programs of study. At the same time, this flexibility suggests the need for consultation with advisers so students can make the best use of elective hours and avoid scheduling difficulties that may arise in later quarters.

Since some students who earn a degree in physics have transferred from other disciplines, the School has planned the degree programs to enable most students to transfer into physics with little or no loss of credit.

A total of 190 credit hours and a grade point average of at least 2.0 in physics courses numbered 3000 and higher are requisites for the bachelor's degree in physics.

Students may utilize their elective freedom in the physics curricula to specialize in particular areas of physics, to prepare for careers in interdisciplinary areas of science, to compose a preprofessional program, or to gain a background in other technical or nontechnical disciplines. To assist students in planning programs of study with emphasis directed toward a particular objective, the School has formulated suggestions for the use of elective hours. Supplementary material, available from the School office or from faculty advisers, includes suggestions relevant to the following areas of study: preparation for graduate study in physics; acoustics; applied optics; atomic, molecular, and chemical physics; biophysics; computational physics; computer-based instrumentation; nonlinear dynamics and chaos; solid-state physics; and preparation for teaching secondary education. A candidate for either baccalaureate degree in physics need not follow any one of these suggested areas of study but may combine features of several programs or devise individual programs of study.

Attention is also directed to the possibility of using elective hours for special problems (PHYS 3900-1-2 or 4900-1-2) conducted under the supervision of a faculty member.

### **Certificate Programs in Physics**

The School of Physics offers programs of study leading to certificates in Applied Optics; in Atomic,

Molecular, and Chemical Physics; and in Computer-based Instrumentation. The purpose of the programs is to prepare students for careers in industry where basic physical understanding is applied to the solution of technological problems. Course requirements, which are fulfilled in the junior and senior years, are detailed in brochures available from the School.

## Bachelor of Science in Physics Curriculum (Suggested Schedule)

### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>CHEM 1101,1112</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>ENGL 2XXX</b>			
English Elective	.....	.....	3-0-3
<b>Social Sciences or Humanities Electives</b>	3-0-3	3-0-3	3-0-3
<b>Health and Performance Sciences</b> (requirements, p. 311)	.....	.....	X-X-3
<b>TOTALS</b>	15-3-16	15-3-16	X-X-19

### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	.....
<b>MATH 3308</b>			
Differential Equations	.....	.....	5-0-5
<b>PHYS 2122-3</b>			
Electromagnetism, Optics & Mod. Physics	4-3-5	4-3-5	.....
<b>Social Sciences Electives</b>	3-0-3	3-0-3	3-0-3
<b>Humanities or Social Sciences Electives</b>	3-0-3	3-0-3	3-0-3
<b>Free Electives</b>	.....	3-0-3	6-0-6
<b>TOTALS</b>	15-3-16	16-3-17	17-0-17

### Junior and Senior Years

<i>Course</i>	<i>Credit Hours</i>
<b>PHYS 3121-2-3</b>	
Classical Mechanics, Electricity, Magnetism.....	15-0-15
<b>PHYS 3141</b>	
Thermal Physics .....	5-0-5
<b>PHYS 3143</b>	
Quantum Mechanics I.....	5-0-5
<b>PHYS 4601-2-3</b>	
Senior Student Seminars.....	3-0-3
<b>Physics Electives</b>	
At least three laboratory courses must be included. These electives must be approved by the School of Physics and must not include more than six hours below the 3000 level .....	
<b>Electives</b>	
To bring total hours to 190 .....	X-X-44
<b>TOTALS</b> .....	X-X-89

**Total Credit Hours Required for Graduation = 190**

### Electives

#### English Elective

ENGL 2XXX must be approved for credit toward the 18-hour humanities requirement. Students whose scores are sufficiently high on the College Board SAT-Verbal and the English achievement examinations may, in consultation with the School of Literature, Communication, and Culture, replace ENGL 1001 or 1002 with other English courses.

### Humanities and Social Sciences Electives

See "Information for Undergraduate Students," p. 33, for information relative to the 36 credit hour requirement in the humanities and the social sciences.

All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill this requirement.

### ROTC

If ROTC is elected, the first course should be scheduled during the first quarter the student is in attendance. A student may schedule additional hours during the freshman year, or certain courses may be deferred in order to schedule ROTC. A maximum of 15 hours of ROTC courses may be counted as free electives toward a degree in physics, of which no more than six hours may be in ROTC courses at the 1000-2000 level.

## Recommendations

Some students, e.g., biophysics students or premedical students, will find it advisable to commence upper-level chemistry courses during their sophomore year. They should schedule one of these in the third quarter of the freshman year and defer the start of the general physics sequence until the sophomore year.

Physics majors are encouraged to elect PHYS 1000 during the freshman year.

A course in computer programming is suggested during the freshman or sophomore years, e.g., CS 1700 or PHYS 3266.

Students who have demonstrated competence in mathematics are encouraged to substitute PHYS 2131-2-3 for PHYS 2121-2-3.

## Bachelor of Science in Applied Physics Curriculum (Suggested Schedule)

### Freshman Year

Course	1st Q.	2nd Q.	3rd Q.
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>CHEM 1101-1112</b>			
General Chemistry	4-3-5	4-3-5	....
<b>PHYS 2121</b>			
Particle Dynamics	.....	.....	4-3-5
<b>ENGL 1001-2</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>ENGL 2XXX</b>			
English Elective	.....	.....	3-0-3
<b>Social Sciences or Humanities Electives</b>	3-0-3	3-0-3	3-0-3
<b>Health and Performance Sciences</b>			
(requirements, p. 311)	.....	.....	X-X-3
<b>TOTALS</b>	15-3-16	15-3-16	X-X-19

### Sophomore Year

Course	1st Q.	2nd Q.	3rd Q.
<b>MATH 2507-8</b>			
Calculus IV, V	5-0-5	3-0-3	....
<b>MATH 3308</b>			
Differential Equations	.....	.....	5-0-5
<b>PHYS 2122-3</b>			
Electromagnetism, Optics and Mod. Physics	4-3-5	4-3-5	.....
<b>EGR 1170</b>			
Introduction to Visual Communication and Engineering Design I	.....	2-3-3	.....
<b>Computer Programming</b>			

<b>Elective</b>	.....	.....	3-0-3
<b>Social Sciences Electives</b>	3-0-3	3-0-3	3-0-3
<b>Humanities or Social Sciences Electives</b>	3-0-3	3-0-3	3-0-3
<b>Elective</b>	.....	.....	X-X-3
<b>TOTALS</b>	15-3-16	15-6-17	X-X-17

## Junior and Senior Years

Course	Credit Hours
<b>PHYS 3121</b>	
Classical Mechanics	5-0-5
<b>PHYS 3122</b>	
Classical Electricity	5-0-5
<b>PHYS 3141</b>	
Thermal Physics	5-0-5
<b>PHYS 3143</b>	
Quantum Mechanics I	5-0-5
<b>PHYS 3211</b>	
Electronics	5-6-7
<b>PHYS 4601-2-3</b>	
Senior Student Seminars	3-0-3
<b>Technical Electives</b>	
Technical electives must include at least three laboratory courses. These technical electives must be approved by the School of Physics and must not include more than six hours below the 3000 level	X-X-22
<b>Electives</b>	
To bring total hours to 190	X-X-37
<b>TOTAL</b>	89

**Total Credit Hours Required for Graduation = 190**

## Electives

### English Elective

ENGL 2XXX must be approved for credit toward the 18-hour humanities requirement. Students whose scores are sufficiently high on the College Board SAT-Verbal and the English achievement examinations may, in consultation with the School of Literature, Communication, and Culture, replace ENGL 1001 or 1002 with other English courses.

### Humanities and Social Sciences Electives

See "Information for Undergraduate Students," p. 33 for information relative to the 36 credit hour requirement in the humanities and the social sciences.

All students are required to pass examinations or courses in the history and constitutions of the United States and Georgia. HIST 1001 or 1002 and POL 1251 or 3200 fulfill these requirements.

**ROTC**

If ROTC is elected, the first course should be scheduled during the first quarter the student is in attendance. A student may schedule additional hours during the freshman year, or certain courses may be deferred in order to schedule ROTC. A maximum of 15 hours of ROTC courses may be counted as free electives toward a degree in physics, of which no more than six hours may be in ROTC courses at the 1000-2000 level.

**Computer Programming Elective**

Students should schedule one of the following courses during their freshman or sophomore years: CS 1700, PHYS 3266, or other computer course approved by the School of Physics.

**Recommendations**

Some students, e.g., biophysics students or premedical students, will find it advisable to commence upper-level chemistry courses during their sophomore year. They should schedule one of these in the third quarter of the freshman year and defer the start of the general physics sequence until the sophomore year.

**Physics**

Students who have demonstrated competence in mathematics are encouraged to substitute PHYS 2131-2-3 for PHYS 2121-2-3.

EGR 1170 may be replaced by another course with the approval of an academic adviser.

**Graduate Programs****Master's Programs**

The School of Physics offers two master's degrees, the Master of Science in Physics and the Master of Science in Applied Physics.

The Master of Science in Physics is the traditional physics degree and normally comprises the program a graduate student executes in the initial course of study toward a doctorate. Students may fulfill the requirements for the degree by taking 45 hours of course work or by electing a master's thesis in lieu of 15 hours of courses. Most students should include PHYS 6101-2-3-4-5-6-7. Students should also include a research component either through inclusion of special problems work or by election of a thesis.

The Master of Science in Applied Physics is intended to help prepare an individual for a

career in industrial, independent, or government laboratories. It is a good choice for a terminal master's degree. The program includes a practicum (PHYS 8591-2-3) of at least 12 credit hours in an area of applied physics. Examples of available areas include acoustics, instrumentation, optics, and physical characterization of materials. Students should take PHYS 4121, 4143, 4262, 6132, and additional courses in support of the practicum.

**Doctoral Program**

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

Fifteen credit hours must be earned in a minor field, which may be any approved technical or nontechnical field the student chooses in consultation with his or her adviser. Completion of the seven core courses, PHYS 6101-2-3-4-5-6-7, and the seminar series, PHYS 8001-2-3, is advisable prior to taking the comprehensive examination. A course in preparation for the exam, PHYS 6110, is offered each summer quarter. Mathematics equivalent to MATH 6501-2 is recommended for most doctoral candidates. A grade point average of 2.9 in courses taken while a graduate student is required to register for the comprehensive examination and is requisite for the degree.

The School encourages students to commence participation in a research program early in their graduate careers. The undertaking of a doctoral thesis is reserved until the comprehensive examination is passed, which should occur at the start of the second year. A thesis proposal should be prepared for the reading committee in the first year of research.

**Courses of Instruction****PHYS 1000. Physics Orientation**  
1-0-1.

Guest lectures will describe career opportunities in physics, the role physicists play in education, government, and industrial laboratories, and programs available to physics majors.



## **PHYS 1001. Survey of Great Advances in Modern**

### **Physics**

1-0-1.

A series of lectures, each of which deals with an important area of physics research or application, e.g., superconductivity, lasers, nuclear structure and energy, transistors.

## **PHYS 2001. Physics of Space and Time**

3-0-3. Prerequisite: PHYS 2121 or 2011.

An introduction to special and general relativity. Principle of relativity. Speed of light. Space contraction. Time dilation. Mass, momentum, and energy. Principle of equivalence.

Text: at the level of Einstein, *Relativity: the Special and the General Theory*.

## **PHYS 2011-2-3. Elementary College Physics I, II, III**

4-0-4, 3-0-3, 3-0-3, respectively. PHYS 2011 should be taken first; PHYS 2012 and 2013 may be taken in either order, but it is preferable that 2012 precede 2013. Credit is not allowed for both 2011-2-3 and PHYS 2121-2-3 (or 2131-2-3).

This sequence of three courses treats the physical principles of mechanics; heat, wave motion, electricity, and magnetism; and light and modern physics, respectively, for students in the less technical curricula. Method of teaching and subject matter are chosen to give an understanding of scientific methods and a background of scientific information needed to comprehend the commercial, cultural, and political significance of scientific progress.

Text: at the level of Hooper and Gwynne, *Physics and the Physical Perspective*.

## **PHYS 2021. Introduction to Astronomy I**

3-0-3.

The nature of behavior of the earth and the other members of the solar system will be examined.

Text: at the level of Abell, *Exploration of the Universe*.

## **PHYS 2022. Introduction to Astronomy II**

3-0-3. (PHYS 2021 is not a prerequisite for PHYS 2022.)

The nature and behavior of the stars and galaxies will be examined.

Text: at the level of Abell, *Exploration of the Universe*.

## **PHYS 2030. Physics of Music**

3-0-3.

A descriptive introduction to the physical principles of the various sources of music tones, how the sounds are generated, transmitted, and received by the listener.

Text: at the level of Rigden, *Physics and the Sound of Music*.

## **PHYS 2121. Particle Dynamics**

4-3-5. Corequisite: MATH 1509.

Introduction to classical mechanics. Topics include particle kinematics, dynamics, energy, momentum, and elementary treatments of rotational motion. Laboratory based on kinematics, dynamics, and energetics of simple harmonic motion.

Text: at the level of Halliday and Resnick, *Fundamentals of Physics*.

## **PHYS 2122. Electromagnetism**

4-3-5. Prerequisite: PHYS 2121. Corequisite: MATH 2507.

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. Prerequisites: PHYS 2122 and MATH 2507.

Wave propagation, interference, diffraction, and sound. Particle aspects of electromagnetic radiation and wave aspects of material particles. Bohr model. Relativity and introductory concepts of wave mechanics. Laboratory devoted to wave propagation, geometrical optics, and polarization.

Text: at the level of Halliday and Resnick, *Fundamentals of Physics*.

## **PHYS 2131-2-3. Honors Physics I, II, III**

5-3-6 each. Prerequisites and corequisites: see listings for PHYS 2121-2-3.

Parallels PHYS 2121-2-3: the sequences may be intermixed. Some topics treated in more depth or more extensively. A rigorous physics foundation requiring demonstrated competence in mathematics.

## **PHYS 2750. Physics of the Weather**

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 and some elements of weather forecasting are analyzed. PHYS 2750 is the same as EAS 2750.

Text: at the level of Battan, *Fundamentals of Meteorology*.

## **PHYS 2801-2-3-4-5. Special Topics**

1-0-1 to 5-0-5 respectively.

Courses in special topics of current interest in physics are presented from time to time.

## **PHYS 2900-1-2. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

## **PHYS 3001. Introductory Modern Physics**

5-0-5. Prerequisite: PHYS 2123.

Survey of principles and phenomenology of modern physics, including atomic structure, nuclear phenomena, and the interaction of radiations with matter.

Text: at the level of Weidner and Sells, *Elementary Modern Physics*.

## **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 3043. Principles of Quantum Mechanics**

3-0-3. Prerequisite: PHYS 2123.

Historical development of quantum theory. General rules of quantum mechanics; probability interpretation of the wave function, average values, operators, uncertainty relations, Eigenvalue problems, Schroedinger equation.

**PHYS 3121. Classical Mechanics**

5-0-5. Prerequisite: PHYS 2123. Corequisite: MATH 3308.

Dynamics of particles including oscillations and planetary motion, rotation of rigid bodies, collisions.

Text: Barger and Olsson, *Classical Mechanics: A Modern Perspective*.

**PHYS 3122. Classical Electricity**

5-0-5. Prerequisite: PHYS 2123. Corequisite: MATH 3308.

Electric and magnetic fields, potentials, resistance, inductance and capacitance, polarization, magnetic materials, development of Maxwell's equations.

Text: Cheng, *Field and Wave Electromagnetics*.

**PHYS 3123. Classical Magnetism**

5-0-5. Prerequisite: PHYS 3122.

Applications of Maxwell's equations, including the propagation of electromagnetic waves; electrodynamics.

Text: Wangness, *Electromagnetic Fields*.

**PHYS 3141. Thermal Physics**

5-0-5. Prerequisites: PHYS 2123 and MATH 2508.

Thermodynamics and introduction to statistical mechanics. Heat, temperature, entropy. Reversible, irreversible and quasistatic processes. Thermodynamic potentials. Magnetic thermodynamics. Maxwell-Boltzmann distribution. Microcanonical and canonical ensembles.

Text: at the level of Callen, *Thermodynamics*.

**PHYS 3143. Quantum Mechanics I**

5-0-5. Prerequisites: PHYS 3121 and MATH 3308.

Historical approach to wave mechanics. Operator, eigenfunction—eigenvalue problem solutions to Schroedinger's equation, free particle, particle in a box, the square well, harmonic oscillator, rigid rotator and hydrogen atom.

Text: at the level of Eisberg, *Fundamentals of Modern Physics*.

**PHYS 3211. Electronics**

5-6-7. Prerequisite: PHYS 2123.

AC circuits; semiconductor devices; amplifiers, feedback, operational amplifiers, oscillators; introduction to digital circuits, combinatorial and sequential logic; representative experiments in the laboratory.

Text: Brophy, *Basic Electronics for Scientists*.

**PHYS 3223. Geometrical Optics**

3-0-3. Prerequisites: PHYS 2123 and MATH 2508.

Development of optical analysis of lenses and reflectors using ray tracing techniques. Coverage includes image formation, stops, aberrations, photometry, and analysis of typical optical systems.

Text: at the level of O'Shea, *Elements of Modern Optical Design*.

**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, nodal slides, microscopes, and telescopes.

**PHYS 3225. Fourier Optics**

3-0-3. Prerequisites: PHYS 2123 and MATH 2508.

A discussion of physical optics including diffraction and interference. Abbe theory of image formation. Coherence, polarization. Maxwell equations as the basis for physical optics.

Text: at the level of Hecht, *Optics*.

**PHYS 3226. Advanced Optical Physics Laboratory**

1-3-2. Corequisite: PHYS 3225.

Optional laboratory taken with PHYS 3225. A small number of experiments designed to exemplify the material presented in lecture course.

**PHYS 3230. Photographic Principles**

2-3-3. Prerequisite: PHYS 2013 or 2123.

Lectures and demonstration (laboratory) period. Relationship of photographic practice and scientific principles: photographic optics, photometry, perspective control, monochrome and color images and processing, image quality.

Text: at the level of Langford, *Basic Photography and Advanced Photography*.

**PHYS 3241. Elementary Biophysics I**

3-0-3. Prerequisite: PHYS 2123.

Overviews of traditional and modern biophysics. Discussion of important discoveries in biophysics.

Text: at the level of Stanford, *Foundations of Biophysics*.

**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 3265. Introduction to Acoustics**

3-0-3. Prerequisite: PHYS 2012 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 that underlie all acoustical phenomena.

Text: at the level of Kinsler, *Fundamentals of Acoustics*.

**PHYS 3266. Computational Physics I**

3-3-4. Prerequisite: PHYS 2123.

Computer solutions of realistic physics problems such as projectiles in a resistive medium, electromagnetic sources and fields, atomic scattering, and band-pass filters.

Text: at the level of DeVries, *A First Course in Computational Physics*.

**PHYS 3267. Computational Physics II**

3-3-4. Prerequisite: PHYS 2123.

Computational approaches to physics problems involving functional forms for discrete data and the connection of basic laws with complex experiments by simulation techniques.

Text: at the level of DeVries, *A First Course in Computational Physics*.

## **PHYS 3751. Laser Physics**

3-0-3. Prerequisite: PHYS 2123.

Principles of laser operations. Types of lasers. Survey lectures on the application of lasers to various fields. Course intended for both physics and nonphysics majors. PHYS 3751 is the same as EE 4751.

Text: at the level of O'Shea, Callen, and Rhodes, *Introduction to Lasers and Their Application*.

## **PHYS 3801-2-3-4-5. Special Topics**

1-0-1 to 5-0-5 respectively.

Courses in special topics of current interest in physics are presented from time to time.

## **PHYS 3900-1-2. Special Problems**

Credit to be arranged. Prerequisite: Consent of the School.

## **PHYS 4121. Classical Mechanics II**

3-0-3. Prerequisite: PHYS 3121.

Lagrangian and Hamiltonian dynamics, variational principles, rotating coordinate systems, coriolis forces, nonlinear and coupled oscillations, phase diagrams, dynamics of rigid bodies, inertia tensor, Euler's equations.

Text: at the level of Marion and Thornton, *Classical Dynamics*.

## **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 Park, *Introduction to Quantum Theory*.

## **PHYS 4146. Special Relativity**

5-0-5. Prerequisite: PHYS 3122.

Development of Einstein's special relativity. Four vector notation. Kinematics and dynamics of a particle. Transformation of electromagnetic fields. Transitions of a system, collisions. Successive Lorentz transformations. Spin dynamics.

Text: at the level of Sard, *Relativistic Mechanics*.

## **PHYS 4206. Interfacing Laboratory I**

3-3-4. Prerequisite: PHYS 3211 or equivalent.

Introduction to the interfacing of computers with scientific apparatus. A computer and a variety of interfacing logic are available for the laboratory.

## **PHYS 4211. Electronic Instruments for Scientific Research**

2-3-3. Prerequisite: PHYS 3211 or equivalent.

An intermediate course in electronic instruments and instrumentation as employed in research and general laboratory measurements.

Text: at the level of Littauer, *Pulse Electronics*.

## **PHYS 4216. Interfacing Laboratory II**

1-6-3. Prerequisite: PHYS 4206 or consent of the School.

A continuation of PHYS 4206. Emphasis on individual student design and construction of interfaces for on-line control of experiments.

## **PHYS 4220. Optical Design**

3-3-4. Prerequisite: PHYS 3223 or consent of the School.

Principles of optical design, ray tracing, and third-order aberrations; laboratory stresses optical testing using conventional resolution tests and modulation transfer function.

Text: at the level of O'Shea, *Elements of Modern Optical Design*.

## **PHYS 4222. Solid-state Devices**

3-0-3. Prerequisite: PHYS 3141, 3143.

Topics to be covered include electronic energy band structure of solids, p-n junctions, transistors, semiconductor superlattices, semiconductor lasers and detectors, charge-coupled devices, integrated optics.

## **PHYS 4251. Biophysics I**

3-0-3. Prerequisites: PHYS 2123, BIOL 1110 or equivalent.

Application of thermodynamics and other physical principles to analysis of macromolecular behavior in solution, bioenergetics, and membranes.

Text: at the level of Van Holde, *Physical Biochemistry*.

## **PHYS 4254. Biophysics-Biochemistry Laboratory**

0-6-2. Prerequisite: PHYS 4251 or consent of the School.

Selected experiments using biophysical and biochemical methods exemplifying studies on macromolecules and the principles of the techniques currently used in molecular biophysics and molecular biology. Offered jointly with BIOL 6640.

## **PHYS 4261. Atomic Physics**

5-0-5. Prerequisite: PHYS 3143 or equivalent.

The structure, spectra, and dynamics of simple atoms and molecules. Basic quantum theory of isolated and interacting systems. Atomic, ion, and molecular beams.

Text: at the level of Bransden and Joachain, *Physics of Atoms and Molecules*.

## **PHYS 4262. Solid-state Physics**

5-0-5. Prerequisites: PHYS 3143; PHYS 3141.

Introduction to basic concepts of the quantum theory of solids. Emphasizes simple physical models.

Text: at the level of Ashcroft and Mermin, *Solid-state Physics*.

## **PHYS 4263. Nuclear Physics**

5-0-5. Prerequisite: PHYS 3143.

Basic properties of nuclei, interactions of radiation with matter, accelerators, radioactivity, nuclear reactions, nuclear models, elementary particles.

Text: at the level of Evans, *The Atomic Nucleus*.

## **PHYS 4267 Introduction to Nonlinear Dynamics and Chaos**

3-0-3. Prerequisite: PHYS 3121.

An overview of nonlinear phenomena in physics, including nonlinear oscillations, entrainment, bifurcation's, routes to chaos, strange attractors, fractals, and control of chaos (with computational examples.)

Text: at the level of Strogatz, *Nonlinear Dynamics and Chaos, with Applications to Physics, Biology, Chemistry, and Engineering*.

**PHYS 4321-2-3. Advanced Laboratory I, II, III**

1-6-3 each. Prerequisite: PHYS 3143.

May be scheduled in any order. Experiments of classical and contemporary importance selected from various fields of physics. Experiments frequently deal 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 4601-2-3. Senior Student Seminar**

1-0-1. Prerequisite: Consent of the School.

Representative research programs in the School are described by advanced graduate students, post-doctorals, and faculty members.

**PHYS 4755. Introductory Diffraction Studies**

3-6-5. Prerequisite: Senior standing in physics or consent of the School.

Introductory theory and practice of X-ray and neutron diffraction techniques, mostly powder, e.g., identification, lattice parameters, texture, line breadth, thermal neutron, and crystal orientation.

**PHYS 4801-2-3-4-5. Special Topics**

1-0-1 to 5-0-5 respectively.

Courses in special topics of current interest in physics are presented from time to time.

**PHYS 4900-1-2. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

**PHYS 6005. Computer Facilities for Graduate Research in Physics**

1-6-3.

Introduction to the computational aspects of physics research and the characteristics of the computing systems available.

**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 6051-2-3. Research Group Seminar**

1-0-1.

Participation in the discussion meetings and seminars of the various research groups in the department.

**PHYS 6101. Classical Mechanics I**

4-0-4.

Newtonian mechanics, Hamilton's variational principle, Lagrangian and Hamiltonian mechanics, central forces, rigid body motion, and small oscillations.

Text: at the level of Goldstein, *Classical Mechanics*, 2nd Edition.

**PHYS 6102. Classical Mechanics II**

4-0-4.

Canonical transformations, Hamilton-Jacobi theory, canonical perturbation theory, and an introduction to the Lagrangian formulations for continuous systems and fields.

Text: at the level of Goldstein, *Classical Mechanics*, 2nd Edition.

**PHYS 6103. Electromagnetism I**

4-0-4.

Electrostatics, Poisson, and Laplace equations, boundary value problems, method of images, separation of variables, Green functions, dielectrics, magnetostatics, currents, induction, and Maxwell's equations.

Text: at the level of Jackson, *Classical Electrodynamics*, 2nd Edition.

**PHYS 6104. Electromagnetism II**

4-0-4.

Time-varying electromagnetic fields, wave propagation in free space and in wave guides, resonant cavities, radiation, scattering, diffraction, and multipole fields.

Text: at the level of Jackson, *Classical Electrodynamics*, 2nd Edition.

**PHYS 6105. Quantum Mechanics I**

4-0-4.

Formal development of nonrelativistic quantum theory, quantum dynamics, theory of angular momentum, and symmetry in quantum mechanics.

Text: at the level of Sakurai, *Modern Quantum Mechanics*.

**PHYS 6106. Quantum Mechanics II**

4-0-4.

Perturbation theory, identical particles, scattering theory, and applications to atomic and nuclear physics.

Text: at the level of Sakurai, *Modern Quantum Mechanics*.

**PHYS 6107. Statistical Mechanics I**

4-0-4.

Basic elements of equilibrium statistical mechanics covering both classical and quantum topics. Applications to various problems in condensed matter and astrophysics.

Text: at the level of Huang, *Statistical Mechanics*, 2nd Edition.

**PHYS 6110. Survey of Physics**

3-9-6.

Problem course reviewing classical mechanics, electricity and magnetism, statistical mechanics, thermodynamics, and quantum mechanics as a preparation for the doctoral qualifying exams.

**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 6210. Condensed Matter Physics I**

5-0-5. Prerequisite: PHYS 6101, 6103, 6105, and 6107, or equivalents.

Introduction to condensed matter physics. Crystal structure, electronic and thermal properties, response to external electric and magnetic fields. First of a three-course sequence.

**PHYS 6211. Condensed Matter Physics II**

3-0-3. Prerequisite: PHYS 6210.

Optical and many-electron properties of solids. Topics include one-photon absorption, Raman and Brillouin scattering, dielectric screening. Second of a three-course sequence.

## **PHYS 6212. Condensed Matter Physics III**

3-0-3. Prerequisite: PHYS 6211.

Collective phenomena in condensed matter systems. Topics include magnetism, superconductivity, and subjects of current interest. Third of a three-course sequence.

## **PHYS 6251. Diatomic Molecules**

3-0-3. Prerequisite: PHYS 4143 or equivalent.

Electronic structure, calculation of potential energy curves, absorption parameters, emission parameters, rotational line strengths, vibrational band strengths, and calculation of Franck-Condon factors.

## **PHYS 6263. An Introduction to Collision Theory**

3-0-3. Prerequisite: PHYS 4143 or equivalent.

Quantum theory of nonrelativistic elastic and inelastic scattering, rearrangement collisions, central, nonlocal, absorptive interactions, phase shift analysis, variational methods, semiclassical and impulse approximations, transition probabilities.

## **PHYS 6265. Atomic Physics**

4-0-4. Prerequisite: PHYS 4143 or equivalent.

The structure, spectra, and dynamics of simple atoms and molecules; basic quantum theory of isolated and interacting systems; atomic and molecular beams.

Text: at the level of Bransden and Joachain, *Physics of Atoms and Molecules*.

## **PHYS 6267. Atomic Collisions**

3-0-3.

A discussion of the techniques by which atomic collisions phenomena are studied, includes scattering of ions and electrons in gases and scattering from solid surfaces.

## **PHYS 6300. Graduate Laboratory**

1-6-3.

Students choose experiments from various fields of physics, including atomic, nuclear, solid-state, and classical physics of current interest.

## **PHYS 7000. Master's Thesis**

## **PHYS 7122. Electromagnetic Theory**

5-0-5. Prerequisite: PHYS 6104.

Discussion of relativistic electrodynamics, radiating systems, multipole expansions, scattering, and diffraction. Exposure to magnetohydrodynamics and plasmas. Use of Lagrangian and Hamiltonian formulations.

Text: at the level of Jackson, *Classical Electrodynamics*.

## **PHYS 7123. Statistical Mechanics II**

5-0-5. Prerequisite: PHYS 6107.

An advanced course in statistical mechanics, including problems of biological significance.

## **PHYS 7125. Introduction to Relativity**

5-0-5. Prerequisites: PHYS 6101, 6103.

Reference frames and transformations, tensor calculus, review of special relativity, electrodynamics, the principle of equivalence, general relativity and gravitation, cosmologies, and black holes.

## **PHYS 7141. Quantum Mechanics of Many-particle Systems**

5-0-5. Prerequisite: PHYS 6106.

Interacting systems of particles described quantum mechanically using the method of second quantization. Application to Fermi and Bose systems.

## **PHYS 7142. Relativistic Quantum Mechanics**

5-0-5. Prerequisite: PHYS 6106.

Relativistic quantum mechanics, Dirac theory, the Lorentz group, antiparticles, relativistic Hamiltonians, propagators, Feynman graphs.

Text: at the level of Bjorken and Drell, *Relativistic Quantum Mechanics*.

## **PHYS 7143. Group Theory and Quantum Mechanics**

5-0-5. Prerequisite: PHYS 6106 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 6106 or equivalent.

Dirac theory of radiation, Dirac equation, second quantization, Feynman diagrams, quantum electrodynamics.

Text: at the level of Greiner and Renhardt, *Quantum Electrodynamics*.

## **PHYS 7150. Quantum Logics**

5-0-5. Prerequisite: PHYS 6106.

Non-Boolean physical logics inherent in quantum theory from predicate algebra to set theory with applications to quantum cosmology and unified quantum theories.

## **PHYS 7220. Quantum Optics**

3-0-3. Prerequisite: PHYS 4143 or PHYS 6106 or EE 4350.

Classical and quantum coherence theory. Rate equations and Bloch equations for atoms interacting with radiation. Photodetection and photoelectron counting. Resonance fluorescence. The laser density matrix. Nonlinear optics, second harmonic generation, two photon absorption processes.

Text: Loudon, *The Quantum Theory of Light*.

## **PHYS 7224. Nonlinear Hamiltonian Dynamics and Chaos**

4-0-4. Prerequisite: PHYS 6101 or equivalent.

Introduction to nonlinear dynamics and chaos through reading selected original papers. A review of theoretical developments since Poincare. Experiments where available including conservative and dissipative chaos.

Text: at the level of Lichtenberg and Lieberman, *Regular and Stochastic Motion*, 2nd Edition.

## **PHYS 7999. Preparation for the Comprehensive Examination**

Audit only.

## **PHYS 8001-2-3. Graduate Student Seminar**

1-0-1.

Intended mainly for beginning graduate students. Representative research programs in the School are described by advanced graduate students, post-doctorals, and faculty members. The experimental basis of physics is illustrated through accounts of great experiments of importance to contemporary research.

**PHYS 8101-2-3-4-5. Special Topics**

1-0-1 to 5-0-5 respectively.

Courses in special topics of current interest in physics are presented from time to time.

**PHYS 8163. Special Topics in Atomic, Molecular, and Chemical Physics**

3-0-3. Prerequisite: PHYS 6265 or equivalent.

Courses in special topics of current interest in atomic, molecular, and chemical physics.

**PHYS 8501-2-3. Special Problems**

Credit to be arranged.

**PHYS 8511-2-3. Special Problems**

Credit to be arranged.

**PHYS 8521-2-3. Special Problems in Condensed Matter Physics**

Credit to be arranged.

Independent investigations, under the supervision of appropriate faculty members, in the area of condensed matter physics.

**PHYS 8531-2-3. Special Problems in Acoustics**

Credit to be arranged.

Independent investigations, under the supervision of appropriate faculty members, in the area of acoustics.

**PHYS 8541-2-3. Special Problems in Applied Optics**

Credit to be arranged.

Independent investigations, under the supervision of appropriate faculty members, in the area of applied optics.

**PHYS 8551-2-3. Special Problems in Physics Instrumentation**

Credit to be arranged.

Independent investigations, under the supervision of appropriate faculty members, in the instrumentation associated with experimental research in physics.

**PHYS 8561-2-3. Special Problems in Atomic, Molecular, and Chemical Physics**

Credit to be arranged.

Independent investigations, under the supervision of appropriate faculty members, in the area of atomic, molecular, and chemical physics.

**PHYS 8591-2-3. Practicum for M.S. in Applied Physics**

Credit to be arranged. Prerequisite: consent of the School.

Research project required to fulfill requirements of the M.S. in Applied Physics degree.

**PHYS 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: Consent of the School.

For graduate students holding graduate teaching assistantships.

**PHYS 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: Consent of the School.

For graduate students holding graduate research assistantships.

**PHYS 8999. Preparation for Doctoral Dissertation**

Audit only. Prerequisite: consent of the School.

**PHYS 9000. Doctoral Thesis**

## **School of Psychology**

**Established in 1959**

**Location: Skiles Building**

**Telephone: 404-894-2680/2683**

*Acting Director and Associate Professor—*

Gregory M. Corso; *Director and Professor*

*Emeritus—*Edward H. Loveland; *Professors—*

Albert N. Badre, Jack M. Feldman, Arthur D. Fisk, Christopher K. Hertzog, Terry L. Maple, M.

Jackson Marr, Nancy Nersessian, Stanley A.

Mulaik, M. Carr Payne, Jr. (emeritus), Nambury

Raju, Timothy A. Salthouse, Anderson D. Smith;

*Associate Professors—*Dorrit Billman, Freda

Blanchard-Fields, Elizabeth T. Davis, C. Michael

York, Craig M. Zimring; *Assistant Professors—*

Kristin Boyle, Susan Bovair, Richard Catrambone,

Todd A. Maurer, Tony Simon, Neff Walker;

*Instructors—*Lois A. James, O. Edmund Martin;

*Adjunct Professors—*Ronald C. Arkin, Theodore

J. Doll, Kurt Eiselt, Debra L. Forthman, Ashok K.

Goel, Joanne Green, Leonard Howell, Janet L.

Kolodner, Daryl Lawton, Denise C. Park, Leonard

W. Poon, Ashwin Ram, Wendy Rogers.

## **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, 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, social sciences, and management. The large number of elective courses enables the curriculum to fulfill a wide variety of educational and vocational needs.

## **Undergraduate Curriculum**

The curriculum is technically oriented and stresses quantitative and experimental approaches

to the study of behavior. Many graduates of this curriculum have continued their studies in psychology graduate programs, medical and law schools, as well as in other graduate programs leading to degrees in widely diverse fields such as business, education, history, labor relations, marketing, music, and religion. Other graduates have been employed upon graduation in a variety of positions including general management, personnel research, personnel services (e.g. personnel training and employment), personnel subsystems (including human factors engineering), engineering psychology research, and systems engineering. Graduates have been able to engage successfully in postgraduate study in many fields including business administration, history, industrial management, labor relations, law, medicine, music, psychology, and theology.

### Certificate Program in Psychology

The School of Psychology offers for nonpsychology majors five programs of study leading to certificates in biopsychology, engineering psychology, experimental psychology, industrial/organizational psychology, and social-personality psychology. Each program focuses upon a limited area of psychology that will be of interest and use to students who wish to investigate the psychological complexities inherent in their major fields or to those who simply wish to broaden their education in a systematic manner. Each certificate requires 18 hours of prescribed psychology courses.

### Bachelor of Science in Applied Psychology Curriculum (Suggested Schedule)

#### Freshman Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>CHEM 1101-1102</b>			
General Chemistry	4-3-5	4-3-5	.....
<b>ENGL 1001-2 (1)</b>			
Analysis of Literature and Language I, II	3-0-3	3-0-3	.....
<b>English Elective (1)</b>	.....	.....	3-0-3
<b>MATH 1507-8-9</b>			
Calculus I, II, III	5-0-5	5-0-5	5-0-5
<b>CS 1501</b>			
Intro. to Computing	.....	.....	3-3-4
<b>HPS 1040</b>			

Health Education or <b>HPS 1061</b> Fitness: Theory, Evaluation, and Conditioning	3-0-3	.....	.....
<b>HIST 1001 (2)</b> History of the U.S. to 1865 or <b>HIST 1002 (2)</b> History of the U.S. from 1865 to the present	2-2-3	.....	.....
<b>POL 1251</b> American Government	.....	3-0-3	.....
<b>Free Elective</b>	2-0-2	.....	3-0-3
<b>TOTALS</b>	17-2-18 or 16-5-18	15-3-16	17-3-18

#### Sophomore Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>MATH 2506 and 2507</b> Calculus IV and V or <b>MATH 2501 and 2502</b> Calculus & Linear Algebra and Elementary Difference and Differential Equations	3-0-3	3-0-3	.....
<b>MATH 3720</b> Statistics and Applications	.....	.....	3-0-3
<b>BIOL 1110-1-2</b> General Biology	3-3-4	3-3-4	3-3-4
<b>PSY 3303-4 (2)</b> General Psychology I, II	3-0-3	3-0-3	.....
<b>PSY 4401</b> Industrial Psychology	.....	.....	3-0-3
<b>PSY 4410 (2)</b> Social Psychology	.....	.....	3-0-3
<b>English Electives (1)</b>	3-0-3	3-0-3	3-0-3
<b>Free Electives</b>	3-0-3	3-0-3	.....
<b>TOTALS</b>	15-3-16	15-3-16	15-3-16

#### Junior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>PSY 4406</b> Psychology Statistics	2-3-3	.....	.....
<b>PSY 4510</b> Research Methods and Experimental Design	2-3-3	.....	.....
<b>PSY 4500 (2)</b> Developmental Psychology	.....	3-0-3	.....
<b>PSY 3502</b> Individual Differences	.....	3-0-3	.....
<b>PSY 4511</b> Experimental Analysis of Behavior	.....	.....	3-3-4
<b>PSY 4503</b> Cognition: Attention and Memory	.....	.....	3-0-3
<b>PHYS 2121-2-3</b> Physics	4-3-5	4-3-5	4-3-5

<b>Applied Psychology</b>			
<b>Specialty Electives (3)</b>	.....	.....	3-0-3
<b>Free Electives</b>	6-0-6	3-0-3	3-0-3
<b>TOTALS</b>	14-9-17	16-3-17	16-6-18

### Senior Year

<i>Course</i>	<i>1st Q.</i>	<i>2nd Q.</i>	<i>3rd Q.</i>
<b>PSY 4501</b>			
Sensation and Perception	3-0-3	.....	.....
<b>PSY 4512</b>			
Cognition: Language and Thought	2-3-3	.....	.....
<b>PSY 4413</b>			
Applied Experimental Psychology	.....	3-3-4	.....
<b>PSY 4600-1</b>			
Senior Thesis/Practicum I, II	.....	1-3-2	3-3-4
<b>ENGL 3015</b>			
Public Speaking	.....	.....	3-0-3
<b>Applied Psychology</b>			
<b>Specialty Electives (3)</b>	6-0-6	3-0-3	.....
<b>Free Electives</b>	3-0-3	6-0-6	9-0-9
<b>TOTALS</b>	14-3-15	13-6-15	15-3-16

**Total Credit Hours Required for Graduation = 198**

### Notes:

- (1) A total of 18 hours of humanities credit is required. Those courses denoted (1) are already designated, or recommended to be taken for humanities credit (see catalog for list).
- (2) A total of 18 hours of social sciences credit is required. Those courses denoted (2) are already designated, or are recommended to be taken for social science credit.
- (3) A total of at least 9 hours of additional psychology courses at the 4000 level or above are required in the junior and senior years along with an additional course either within or outside the department for a total of 12 hours. These four courses must be arranged as an applied specialty area, for example:

Industrial/Organizational  
Applied Experimental/Engineering  
Instructional Technology  
Human-Computer Interaction  
Preclinical  
Premedical

An example of an applied course sequence for a pre-med student would be PSY 4421 (Physiological Psychology), PSY 4426 (Behavioral Pharmacology) PSY 4425 (The Psychology of Aging), and an advanced course in biology or chemistry. An example of an applied course sequence in instructional technology would be

PSY 4403 (Introduction to Psychological Testing), PSY 4423 (Introduction to Psycholinguistics), PSY 4753 (Human Factors in Software Development), and a course in instructional technology in computer science. In applied experimental /engineering psychology a sequence might include PSY 4409 (Introduction to Engineering Psychology), PSY 4751 (Psychology and Environmental Design), PSY 4753 (Human Factors in Software Development), and a course in ISYE. There are many other possibilities.

The program of study will be worked out with the student's adviser and approved by the director or associate director of the School of Psychology.

Overall, the curriculum requires 18 hours of social science, 18 hours of humanities, 61 hours of basic science and mathematics, at least 58 hours of psychology, and up to 42 hours of free electives. The total hours required for graduation is 198.

## Graduate Curricula

Doctoral and master's candidates share a core curriculum in general psychology and quantitative methods. The School may grant permission to substitute another course for a required course if the student can pass a written examination. Doctoral candidates will complete all requirements for the master's degree, which includes writing a thesis.

Master's programs prepare the student for continuation of graduate work toward the Ph.D. and/or for employment in business, industry, government, or education. Most students require a minimum of two calendar years to complete the master's degree, which includes writing a thesis.

The doctoral program provides the student with an opportunity for advanced study in general-experimental (focus areas in cognitive science, cognitive aging, and animal behavior), industrial-organizational, or engineering psychology. Each of these curricula consists of additional courses and programs of individual study and research beyond the core curriculum, which contribute to a strong background in general experimental psychology, quantitative methodology, and the student's area of specialization. The doctoral program will ordinarily require at least 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, as well as psychological statistics. Supplementary education in areas such as biology, chemistry, physics, engineering, foreign languages, and particularly mathematics is also advised. Students who have considerable undergraduate preparation in one or more of these areas may, with the approval of the School of Psychology, exempt some of the required psychology courses. All applicants should submit scores on the Graduate Record Examination.

The psychology faculty encourages competent students in subjects other than psychology to apply for admission.

### **Graphics, Visualization and Usability (GVU) Center's Suggested Courses for Graduate Minor**

To fulfill their graduate minor requirements, psychology graduate students may take an interdisciplinary sequence of courses suggested by the Graphics, Visualization, and Usability Center. There are three different tracks of study designed to provide a systematic overview of a given area---one specializing in graphics, another in visualization, and a third in usability. Courses for these three tracks are specified in the College of Computing section of this catalog.

### **Graduate Certificate in Cognitive Science**

Cognitive science is an interdisciplinary research area spanning psychology, computer science, linguistics, and philosophy. The certificate in cognitive science provides students with a structured set of courses from related disciplines. Psychology students usually sample artificial intelligence courses (from computer science) and human systems engineering (from industrial and systems engineering). There are two interactive courses specifically designed to give students a systematic exposure to this new and very active area. The courses for the certificate can also function as the student's graduate minor. An extended description of the program can be found in the catalog section for the College of Computing.

## **Courses of Instruction**

### **PSY 1010. Adjustment to College Life**

2-1-2.

Discussion of topics relevant to personal adjustment to college life. The course considers psychological principles important in understanding the basis of adjustment. Such topics as study skills, career development, human relations, and ethical development will be considered.

### **PSY 3300. Psychology and Contemporary Issues in Society**

3-0-3.

Contributions of psychology to an appreciation of selected contemporary issues. Topics may vary from quarter to quarter.

### **PSY 3303. General Psychology I**

3-0-3.

An intensive coverage of the methods and findings of contemporary psychology. Includes topics such as psychological development, learning, conditioning, and biological bases of behavior.

### **PSY 3304. General Psychology II**

3-0-3. Prerequisite: PSY 3303.

A continuation of PSY 3303. Topics such as individual differences, perception, personality, and social psychology will be discussed.

### **PSY 3402. Abnormal Psychology**

3-0-3. Prerequisite: PSY 3303.

Considerations of characteristics and etiology of typical and atypical human behavior. A principal objective is an increased understanding of self and others.

### **PSY 3502. Human Individual Differences**

3-0-3. Prerequisites: PSY 3303 and 3304.

Addresses human abilities and temperament, group differences (e.g., gender), and controversies such as heredity versus environment, and person versus situational influences on behavior.

### **PSY 4401. Industrial Psychology**

3-0-3.

A survey of methods and findings in the scientific study of humans at work. Considered are topics such as selection, training, motivation, accidents, and environmental effects.

### **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 or 4401.

An analysis of psychological principles and techniques that 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 School.

Application of statistical techniques to the design and analysis of psychological studies.

**PSY 4409. Introduction to Engineering Psychology**  
3-0-3.

Engineering psychology is presented as an integral component in the design and evaluation of human/machine systems. Applied problems and general methodological questions are examined.

**PSY 4410. Social Psychology**

3-0-3. Prerequisite: PSY 3303.

Consideration of the behavior of the individual in relation to other individuals and groups.

**PSY 4413. Applied Experimental Psychology**

3-3-4. Prerequisites: PSY 4406, 4412, and consent of the School.

Consideration of the applications of the methods and data of experimental psychology.

**PSY 4421. Physiological Psychology**

3-0-3. Prerequisites: PSY 3304, BIOL 1110, 1111, and 1112.

Neurophysiological, endocrinological, and biochemical basis of sensory and motor functioning, learning, memory, motivation, and behavior disorders.

**PSY 4422. Comparative Psychology**

2-2-3. Prerequisites: BIOL 1110, 1111, and 1112, PSY 3304, and consent of the School.

Consideration of principles and research methods of animal psychology and ethology. Literature reviews and reports, field trips, and laboratory studies.

**PSY 4423. Introduction to Psycholinguistics**

3-0-3. Prerequisite: consent of the School.

A critical examination of current psychological research and theory in language development and behavior.

**PSY 4424. Introduction to Personality**

3-0-3. Prerequisites: PSY 3304 or 4410.

Introduction to and survey of major theories of personality.

**PSY 4425. The Psychology of Aging**

3-0-3. Prerequisites: senior or graduate standing, PSY 3303 and 3304 or equivalent.

Current research findings and their theoretical and practical implications will be discussed. Interactions between adult age and a variety of psychological processes will be discussed: perception, memory, learning, cognition, personality, psychomotor skill, and psychophysiological processes.

**PSY 4426. Behavioral Pharmacology**

3-0-3. Prerequisites: BIOL 1110, 1111, 1112, PSY 3304, and consent of the instructor.

An introduction to the study of drug-behavior interactions. Among the topics to be treated are the pharmacology of behaviorally active drugs, the influence of drugs on schedule-controlled behavior and stimulus control, the role of drugs as stimuli, and the use of drugs for the analysis of behavior.

**PSY 4491-2-3-4. Field Study of Animal Behavior I, II, III, IV**

1-6-3 each. Prerequisites: anthropology, biology, or psychology background; demonstrated interest in animal behavior; consent of the instructor.

This course takes place in Kenya, East Africa, and is limited to 15 qualified students. Lectures by the instructor and resident scientists will provide the in-class portion of the course. Visits to national parks, game preserves, and lengthy in-field observation will introduce the students to the natural habitats of African animals.

**PSY 4500. Developmental Psychology**

3-0-3. Prerequisite: PSY 3303.

A comprehensive study of human behavior and psychological development from infancy through older adulthood.

**PSY 4501. Sensation and Perception**

3-0-3. Prerequisites: PSY 3303 and 3304, BIOL 1111, and PHYS 2123.

Examines how we process sensations and perceptions of our environment to determine what something is and where it is located. Vision and audition are emphasized.

**PSY 4503. Cognition: Attention and Memory**

3-0-3. Prerequisites: PSY 3303 and 3304.

Experimental study of human attention and memory from the cognitive perspective. Key phenomena, theories explaining the phenomena, and experimental methods used in investigation are studied.

**PSY 4510. Research Methods and Experimental Design**

2-3-3. Prerequisite: PSY 3303, psychology major or psychology certificate student or permission of the instructor.

An introduction to research methods used in psychology. The course will focus on experimental methods and design. The laboratory will introduce students to the use of statistical packages for data analyses.

**PSY 4511. The Experimental Analysis of Behavior**

3-3-4. Prerequisites: PSY 3304, 4406, 4510.

The history, theory, and methodology of behavior analysis will be studied. Among the topics treated are shaping of behavior, stimulus-stimulus and response-consequence contingencies, stimulus control, and choice.

**PSY 4512. Cognition: Language and Thought**

2-3-3. Prerequisites: PSY 3303 and 3304.

Experimental study of human language and thought from the cognitive perspective. Key phenomena, theories explaining the phenomena, and experimental methods used in investigation are studied.

**PSY 4550. Gender Roles: Their Development and Cultural Influence**

3-0-3. Prerequisite: PSY 3304.

Theoretical, empirical, and socio-cultural issues in gender role development of women and men from infancy through older adulthood.

**PSY 4600. Senior Thesis/Practicum I**

1-3-2. Prerequisites: consent of the School and senior standing.

This is the first of a two-course sequence. The student will, under the direction of a faculty member, develop a senior

research or practicum project. Students must make arrangements with a faculty member prior to registration.

## **PSY 4601. Senior Thesis/Practicum II**

3-3-4. Prerequisite: consent of the School.

This is the second of a two-course sequence. The student will, under the direction of a faculty member, carry out project developed in the first senior thesis/practicum course. Students must make arrangements with faculty member prior to registration.

## **PSY 4750. Social Psychology-Sociology Measurement Seminar**

3-0-3. Prerequisite: PSY 4410 or equivalent and consent of the School.

Problems, implications, and methodologies relating to the measurement of individual and group behavior in social situations. Students will receive supervised project experience. Also taught as SOC 4750.

## **PSY 4751. Psychology and Environmental Design I**

3-3-4. Prerequisite: consent of the School.

Introduction to psychological concepts relevant to environmental design. Survey of selected methods for assessing human-made environment. Taught jointly by psychology and architecture faculty. Cross-listed as ARCH 4751.

## **PSY 4752. Psychology and Environmental Design II**

3-3-4. Prerequisites: PSY 4751 and consent of the School.

Continuation of PSY 4751, with greater emphasis on independent research and development of design solutions to selected problems. Taught jointly by psychology and architecture faculty. Also taught as ARCH 4752.

## **PSY 4753. Human Factors in Software Development**

3-0-3. Prerequisites: PSY 3304, CS 1501 or equivalent.

Examines human factors in the software design and application process from initial requirements to testing and implementation, with emphasis on designing the user interface. Also listed as CS 4753.

## **PSY 4754. Models of Human Information Processing**

3-0-3. Prerequisites: PSY 3303, 3304, and CS 1501, or equivalent.

General and unified approaches to psychological and computer modeling of human information processes. Emphasis on neural, sensory memory, semantic, and conceptual processing. Also listed as CS 4754.

## **PSY 4800. Special Topics**

1-3-2. Prerequisites: PSY 3304, 4407, and consent of the School.

Guided independent study in an area of psychology not represented in the School's course offerings.

## **PSY 4802-3-4. Special Topics**

2-0-2 through 4-0-4 respectively. Prerequisite: consent of the School.

Special topics of current interest.

## **PSY 4900-1-2-3. Special Problems**

Credit to be arranged. Prerequisite: consent of the School.

Students engage in individual and group projects under the direction of a faculty member.

## **PSY 4953. Special Problems in Psychological Aspects of Environmental Design**

Credit to be arranged. Prerequisites: PSY 4751, 4752, and consent of the School.

Supervised individual study of problems relating to the interaction of environmental design and behavior.

## **PSY 6011. Conditioning and Learning**

3-0-3. Prerequisites: graduate standing and consent of the School.

Conceptual and methodological issues in the experimental analysis of behavior with special emphasis on classical and operant conditioning.

## **PSY 6012. Cognitive Psychology**

3-0-3. Prerequisites: graduate standing and consent of the School.

A survey of the core areas of human cognition: attention, memory, language, representation of knowledge, thinking, reasoning, problem solving, decision making. History, theoretical issues, and methods are also addressed.

## **PSY 6013. Developmental Psychology**

3-0-3. Prerequisites: graduate standing and consent of the School.

Overview of major concepts, assumptions, methods, theories, and research findings in human development across the life span. Special emphasis will be given to cognitive development. An examination of the issues of how behavior development occurs, what it is that develops, and what initial capabilities exist.

## **PSY 6014. Sensation and Perception**

3-0-3. Prerequisites: graduate standing and consent of the School.

An examination of human experience which results from stimulation of the senses. Topics treated include psychophysics, sensory processes, and how we perceive "that out there."

## **PSY 6015. Physiological Psychology**

3-0-3. Prerequisites: graduate standing and consent of the School.

Basic neural mechanisms and their relation to sensory functions, motivational variables, learning processes, and memory.

## **PSY 6016. Comparative Psychology**

3-0-3. Prerequisites: graduate standing and consent of the School.

An advanced overview of the field of comparative psychology (animal behavior) with an emphasis on the contributions of ethology and field research.

## **PSY 6017. Individual Differences**

3-0-3. Prerequisites: graduate standing and consent of the School.

A survey of the theory and methods employed in the study of human differences. The course covers issues involved in the construction of taxonomic systems for the measurement and description of human differences, such as intelligence, creativity, and values.

**PSY 6018. Social Psychology**

3-0-3. Prerequisites: graduate standing and consent of the School.

Fundamental theory and research in social behavior, including social perception/cognition, attitude formation and change, social influence, and group process.

**PSY 6019. Personality**

3-0-3. Prerequisites: graduate standing and consent of the School.

A survey of theories, methods, and current research findings in the study of personality.

**PSY 6601. Advanced Industrial Psychology**

3-0-3. Prerequisite: PSY 4401.

A survey of theoretical and pragmatic issues in industrial psychology. Recent developments and experimental findings will be discussed.

**PSY 6608. Human Motivation**

3-0-3. Prerequisites: graduate standing and consent of the School.

Examines theoretical and pragmatic issues in the description and prediction of motivated behavior. Includes measurement problems, implications, and applications in a range of settings.

**PSY 6609. Social Psychology of Organizations**

3-0-3. Prerequisites: PSY 4410 or equivalent and consent of the School.

Selected topics from social psychology that are of particular significance to an understanding of individual behavior in an organizational context. Supervised readings and discussion.

**PSY 6610. Psychoacoustics**

3-0-3. Prerequisites: PSY 3304 or equivalent and consent of the School.

A comprehensive coverage of physiological and psychological acoustics, including analyses of auditory and extra-auditory response mechanisms and evaluation of research and theories in hearing.

**PSY 6611. Quantitative Methods in Psychology I**

4-6-6. Prerequisites: graduate standing and consent of the School.

A survey of quantitative methods in psychology used in the design of psychological experiments and studies and used in the analysis of psychological data.

**PSY 6612. Quantitative Methods in Psychology II**

4-6-6. Prerequisites: graduate standing and consent of the School.

A coverage of the theoretical and applied aspects of regression/correlation procedures in the analysis of psychological data.

**PSY 6613. Quantitative Methods in Psychology III**

4-6-6. Prerequisites: graduate standing and consent of the School.

Coverage of experimental design and the use of analysis of variance procedures in the analysis of experimental data in psychology.

**PSY 6621-2. Foundations of Psychology I, II**

3-0-3 each. Prerequisites: graduate standing and consent of

the School.

A sequence involving historical and current points of view in psychology, emphasizing issues important for psychological theory.

**PSY 6626. Response Evaluation**

3-0-3. Prerequisites: graduate standing, PSY 4406 or equivalent, and consent of the School.

Intensive consideration of theoretical and pragmatic problems in the description and evaluation of human responses in areas such as task analysis and performance measurement.

**PSY 6627. Human Learning**

3-0-3. Prerequisites: graduate standing, PSY 3303 or equivalent, and consent of the School.

A comprehensive consideration of principles, problems, methods, and experimental data in the study of human learning, including discussion of applications of theory and experimental findings.

**PSY 6629. Psychomotor Skill Learning and Performance**

3-0-3. Prerequisites: PSY 4406, and consent of the School.

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. Prerequisites: PSY 4403, 6611, 6612, 6613, or equivalent.

Preparation of students in statistical theory and techniques relevant to becoming professionally involved in construction, analysis, and evaluation of psychological and personnel tests.

**PSY 6631. Personality and Social Development**

3-0-3. Prerequisite: consent of the School.

The developmental aspects of personality and socialization in children are examined. Particular attention will be given to empirically derived data, assessment techniques, and theoretical explanations.

**PSY 6632. Perceptual Development**

3-0-3. Prerequisite: consent of the School.

Perceptual capabilities and experience are examined as they change across the life span. Special attention will be given to early development (infancy and childhood).

**PSY 6640. Engineering Psychology I: Methods**

3-0-3. Prerequisite: Graduate standing or permission of the School.

This course covers the basic methods used to study human-machine systems. These methods include both system analysis techniques and human performance evaluation techniques. Students are required to apply these methods to specific systems.

**PSY 6641. Engineering Psychology II: Displays, Controls, and Work Space Layout**

3-0-3. Prerequisite: PSY 6640 or equivalent.

Basic principles of human factors for design and evaluation of displays, controls, and workspace layouts. New control and display technologies and associated human factors problems are also included.

## **PSY 6642. Engineering Psychology III: Stressors and Human Performance**

3-0-3. Prerequisite: PSY 6641 or equivalent.

This course covers the effects of environmental stressors on human performance and behavior, including noise, vibration, light, color, weightlessness, extreme temperatures, work/rest cycles, atmospheric pollutants, and drugs. Arousal and fatigue effects will be discussed, as will sustained attention and sensory deprivation.

## **PSY 6751. Human-Computer Interface**

3-3-4.

Human-computer interface is considered in terms of user-system compatibility. Concepts in human factors and interface design are covered in relation to capabilities of both humans and computers. Also listed as CS 6751.

## **PSY 6752. Human-Computer Interface II**

3-0-3. Prerequisite: PSY/CS 6751.

The design process and application of design principles to the design process. Additional design topics, such as help systems, interaction styles, visual design principles, user interface prototyping, and development tools. Also listed as CS 6752.

## **PSY 6799. Quasiexperimental Design**

3-0-3. Prerequisites: ISYE 6400 or 6401 or PSY 6611, 6612, and 6613.

Design, application, statistical analysis, and critical evaluation of quasi-experiments (i.e., extension of experimental design concepts into field settings that preclude ideal, randomized experiments).

## **PSY 7000. Master's Thesis**

## **PSY 7010. Seminar in Industrial Psychology**

3-0-3. Prerequisites: PSY 6601 and consent of the School.

Critical and comprehensive examination of current problems in a selected area of industrial psychology. The area to be covered may vary from year to year.

## **PSY 7011. Seminar in Experimental Psychology**

3-0-3. Prerequisite: consent of the School.

Critical examination of current problems in a selected area of general experimental psychology. Area to be discussed may vary each time the course is offered.

## **PSY 7012. Seminar in Engineering Psychology**

3-0-3. Prerequisites: PSY 6602 and consent of the School.

Critical examination of current problems in a selected area of engineering psychology. The area to be discussed may vary each time the course is offered.

## **PSY 7020. Advanced Learning**

3-0-3. Prerequisites: graduate standing and consent of the School.

An advanced and systematic examination of selected topics dealing with the experimental psychology of learning and memory. Theoretical approaches to learning, transfer, and retention will be discussed.

## **PSY 7021. Sensation and Perception**

4-0-4. Prerequisite: consent of the School.

An examination of human interpretation of physical stimulation. The student studies in some detail the nature of perceptual processes, including human sensory processes.

## **PSY 7022. Vision**

3-0-3. Prerequisite: consent of the School.

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: consent of the School.

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 7024. Primate Behavior**

3-0-3. Prerequisites: graduate standing and consent of the School.

A survey of research relating to primate behavior. A content course in which the major findings and theories of primate behavior will be considered; students will also discuss the methods employed in primate research and observe selected species at the Yerkes Primate Research Center and Atlanta Zoological Park.

## **PSY 7025. Seminar in Cognitive Aging**

3-0-3. Prerequisites: PSY 6012 and consent of School.

Advanced examination of research in a selected topic in the cognitive psychology of aging. The topic to be discussed can vary each time the course is offered.

## **PSY 7050. Professional Problems**

2-0-2. Prerequisites: graduate standing and consent of the School.

Introduces the student to professional problems that he or she may face as a psychologist, including teaching, professional practice, and research. Ethical issues in all of these areas will be examined.

## **PSY 7051. Teaching Practicum**

1-3-2. Prerequisite: PSY 7050.

Supervised college teaching for advanced graduate students in psychology. Discussion of teaching techniques, course and curriculum design in psychology, and student evaluation is included in the course. Students will prepare and present lectures on selected topics in psychology courses. Direct observation and television taping will be used as a basis for class discussions.

## **PSY 7101. Introduction to Multivariate Analysis in the Behavioral Sciences**

3-0-3. Prerequisites: PSY 6611, PSY 6612, PSY 6613, or equivalent.

This course provides the foundations for multivariate analysis in the behavioral sciences. Topics include matrix algebra, the properties of linear composite variables, multiple regression, multiple correlation, partial correlation, MANOVA, multiple discriminant analysis, canonical correlation, and cluster analysis.

## **PSY 7102. Introduction to Factor Analysis**

3-0-3. Prerequisite: PSY 7101 or equivalent.

This course provides the theoretical foundations for the use of factor analysis in the behavioral sciences. Multiple discriminant analysis, principal components analysis, common factor analysis, and confirmatory factor analysis will all be covered.

**PSY 7103. Linear Causal Modeling in the Behavioral Sciences**

3-0-3. Prerequisite: PSY 7102 or equivalent.

A description of linear causal modeling as a methodology for the study of causal relations. The course topics include the examination of the concept of causality, methods for establishing causality, fundamentals of linear structural equation modeling with latent variables, and practical experience of fitting models with data sets.

**PSY 7750. Seminar on Psychology and Management**

3-0-3. Prerequisites: PSY 6601, 6609, MGT 6150 or 6105 and consent of the School.

Selected management problems involving psychological complexities, individual behavior in an organizational setting. Also listed as MGT 7750.

**PSY 8504. Special Problems in Industrial Psychology**

Credit to be arranged. Prerequisites: PSY 6601 or 6018 and consent of the School.

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 School.

Students conduct research under direction of a faculty member on problems in the general area of experimental psychology.

**PSY 8506. Special Problems in Engineering Psychology**

Credit to be arranged. Prerequisites: PSY 6640 or equivalent and consent of the School.

Students conduct research under direction of a faculty member on problems in the area of engineering psychology.

**PSY 8997. Teaching Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

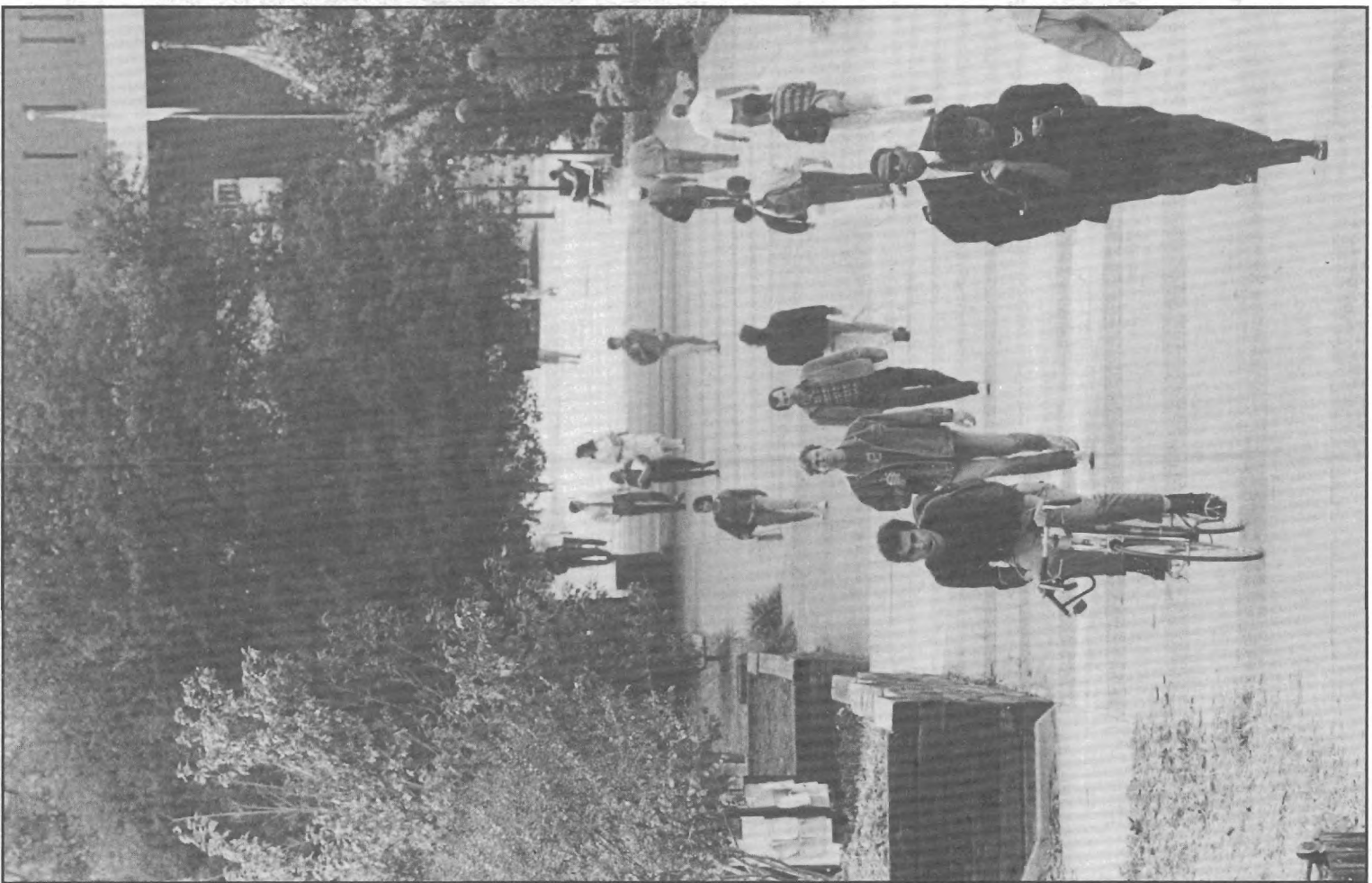
For graduate students holding graduate teaching assistantships.

**PSY 8998. Research Assistantship**

Credit to be arranged. Audit basis only. Prerequisite: consent of the School.

For graduate students holding graduate research assistantships.

**PSY 9000. Doctoral Thesis**



# RULES AND REGULATIONS

## Student Rules and Regulations

Originally approved by the faculty May 24, 1949.  
Revised printings: 1952, 1957, 1960, 1965, 1968,  
1971, 1973. Revised annually since 1973.

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### I. Purpose

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 and Change of Address

#### A. Notices

All students will be required to have a box in the post office of the Georgia Institute of Technology, which will be their official school address, and they are expected to check this box each school day. Students are also expected to be aware of the contents of individual notices placed in the post office box and that appear on the Student Access System on electronic mail, as well as general notices that appear in *The Technique*. It is the student's responsibility to check the Student Access System during the



drop/add period of registration and during the quarter to verify the accuracy of his/her schedule and for notices. Schedules should be verified at least once during the first five weeks of the quarter and once after mid-term.

### **B. Change of Address**

Students are responsible for reporting all changes within one week to the Office of the Registrar or on the Student Access System.

### **C. Unclaimed Mail**

Students are responsible for returning to the front window of the Post Office all mail in their post office boxes that is unclaimed after three days.

## **III. Attendance**

### **A. General**

1. Each quarter a course listing is published showing the time period for each class. Classes begin five minutes after the published starting time.
2. If an instructor should be late in meeting the class, the students shall wait 20 minutes after the published starting time. If the instructor has not arrived by that time, the students may leave unless specifically notified to await the instructor's arrival.

### **B. Class Attendance**

1. 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; students should, therefore, maintain regular attendance if they are to attain maximum success in the pursuit of their studies.
2. All students are responsible for obtaining an understanding of each instructor's policy regarding absences; all students are expected to attend announced quizzes, laboratory periods, and final examinations. Although it is recognized that occasionally it may be necessary for students to be absent from scheduled classes or laboratories for personal reasons, students are responsible for all material covered in their absences, and they are responsible for the academic consequences of their absences. Work missed may be made up if

the reasons for absences are acceptable to the instructors.

3. 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 Student Academic and Financial Affairs Committee of the Academic Senate, and statements of the approved absence may be obtained from the Office of the Registrar.

## **IV. Grades and Scholastic Average**

### **A. Grades**

1. The letter grades for completed courses used in the calculation of scholastic average are the following:

*A* — excellent (four quality points)

*B* — good (three quality points)

*C* — satisfactory (two quality points)

*D* — passing (one quality point)

*F* — failure, must be repeated if in a required course (no quality points)

2. The following grades will be used in the cases indicated and will not be included in the calculation of scholastic average:

*S* — passing of a course taken under pass/fail or completion of a course in which no letter grade may be assigned;

*U* — unsatisfactory in a course taken under pass/fail or unsatisfactory performance in a course for which no letter grade may be assigned;

*V* — assigned when the course has been audited; no credit given; and implies no academic achievement on the part of the student.

3. The following grades will be used in the cases indicated:

*I* — incomplete. Assigned when a student was doing satisfactory work, but for nonacademic reasons beyond his/her control and deemed acceptable by the instructor, was unable to meet the full requirements of the course. If the student's performance was so poor as to preclude his/her passing, the instructor shall assign the grade of *F*. (Note: To remove the incomplete, the student should consult with the instructor as soon as possible into the next quarter of residence and complete whatever work is outlined by the instructor. A student is not required to be enrolled

to remove an incomplete; however, once the student enrolls with an outstanding *I*, the work must be completed before the end of that quarter.)

**W**— out before the end of the fifth week. This symbol indicates that a student was permitted to withdraw without penalty. Withdrawals without penalty will not be permitted after the fifth week except in cases of hardship as determined by the registrar. Ordinarily, students who withdraw from school and receive all grades of **W** will not be permitted to re-enroll the next succeeding quarter.

**NR** — not reported. Assigned when an instructor fails to submit grades by the published deadline, through no fault of the student.

4. Final grades are reported to the registrar at the end of each term.

5. If a final course grade is believed to be in error, the student should contact the professor as soon as possible. In general, no change of grade will be made after the end of the student's next quarter in residence.

## B. Scholastic Average

The scholastic average is calculated as the ratio of the total number of quality points earned to the total number of quarter credit hours in which a final letter grade has been assigned.

# V. Scholastic Regulations

## A. Classification of Students

1. Undergraduate students with the exception of nondegree seeking students shall be classified at the end of each quarter by the Office of the Registrar on the basis of the total number of quarter credit hours for which they have credit in accordance with the following schedule:

Freshman	0—44	credit hours
Sophomore	45—89	credit hours
Junior	90—134	credit hours
Senior	135 +	credit hours

Students who have completed all requirements for a particular classification as defined by their major department may petition for reclassification through their major department.

2. Students scheduled for 12 credit hours or more are classified as full-time students.

## B. Eligibility for Class Rings

A student may purchase a class ring any time after receiving credit for 106 quarter credit hours.

## C. Scholastic Standing

1. The minimum satisfactory scholastic average is 1.7 for freshmen, 1.9 for sophomores, 2.0 for juniors and seniors, and 2.7 for graduate students.

### 2. Good academic standing

a. Students not on academic probation are in good academic standing.

b. Undergraduate students in good academic standing may schedule up to 23 credit hours with the approval of their school.

c. Graduate students in good academic standing may schedule up to 21 credit hours with the approval of their school.

### 3. Academic warning

a. 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.

b. An undergraduate student on academic warning shall be limited to a maximum schedule load of 16 credit hours.

### 4. Academic probation

a. A student on academic warning whose scholastic average is below the minimum satisfactory scholarship requirement for any quarter shall be placed on academic probation. Also see 6.b and 6.c.

b. An undergraduate student on academic probation shall be limited to a maximum load of 14 credit hours.

### 5. Academic honors

The Institute encourages excellence in scholarship and gives official recognition to undergraduate students whose work is superior in any given quarter.

a. Dean's List - includes all undergraduates who, during the preceding quarter, made an academic average of 3.0 or higher, completed a schedule of at least 12 hours or higher of course work on a letter grade basis, and are not on academic warning or probation or subject to any disciplinary action. (All grades must be reported.)

b. Faculty honors - includes all undergraduates who during the preceding quarter made an academic average of 4.0, completed a schedule load of at least 12 hours of course work on a letter grade basis, with no **W** grades, and are not

on academic warning or probation or subject to any disciplinary action. (All grades must be reported.)

**6. Dismissal for unsatisfactory scholarship**

a. The Institute may drop from the rolls at any time a student whose record in scholarship is unsatisfactory.

b. An undergraduate student whose scholastic average for any quarter is 1.0 or below may be referred to the Undergraduate Curriculum Committee, which may place the student on academic probation or drop, regardless of the student's previous record, if such action is deemed advisable.

c. A graduate student whose scholastic average for any quarter is 2.0 or below may be placed on academic probation or drop, regardless of the student's previous record.

d. 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 dropped from the rolls for unsatisfactory scholarship.

e. The record of a student on academic probation whose overall scholastic record is satisfactory but whose quarter average is unsatisfactory may be reviewed by the Undergraduate Curriculum Committee or the Graduate Committee, as appropriate. The student may be dropped or may be continued on academic probation.

**7. 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 that makes the student ineligible for registration. If no acceptable explanation is given within a reasonable time, the standing is changed to drop.

8. The scholastic standing regulations given above for graduate students do not preclude a school from having more rigorous requirements.

**9. Part-time students**

a. These regulations do not necessarily apply to students scheduling fewer than 12 credit hours.

b. The scholastic standing of these students may be determined by either the Undergraduate Curriculum Committee or the Graduate

Committee, as appropriate, with the decision based on individual merit in each case.

**D. Change of Major**

1. Undergraduate students, by filing the required form, will be permitted one unrestricted transfer between majors (including undecided) until they have accumulated credit for 90 hours. After 90 hours or upon subsequent request for transfer, the transfer will be permitted at the discretion of the school that the student is seeking to enter. (Note: Certain majors, because of high enrollment, have been granted a waiver of the one unrestricted transfer regulation. Students should consult with the individual school concerning its current transfer policy.)

2. Graduate students, by filing the required form, may transfer with the concurrence of the schools involved and the Graduate Dean.

**E. Exceptions**

Exceptions to these scholastic regulations may be made by the Undergraduate Curriculum Committee or the Graduate Committee, as appropriate, whenever a consideration of the student's complete record indicates that the application of a specific regulation will result in injustice.

**VI. Deficiencies**

**A. General**

1. A student who has received a grade of *I*, *F*, or *U* in a course has a deficiency in the course.

2. A student whose final grade is *F* or *U* has a failure in that course. The student must repeat and pass the course in class before credit will be allowed. (See B.4).

**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 the 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 the grade is received, nor in any quarter immediately following in which the student 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 be changed to an *F* on the student's permanent record and will count thereafter as an *F* in the computation of point average. (Note:

Registering and repeating a course in which an *I* grade has previously been assigned will not remove the outstanding *I* grade.)

3. A student who has a failure in a required course must schedule that course the next time it is offered while the student is in residence.

4. A degree candidate who has a single course deficiency for graduation will be permitted one re-examination 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 commencement exercises. This re-examination must be authorized by the registrar before being scheduled. The examination will be graded *S* or *U* and grade so recorded. The previously assigned *F* or *U* will remain a part of the record.

5. A degree candidate who has otherwise completed all requirements for graduation and who has an incomplete in laboratory work taken during his or her final quarter in residence may remove the incomplete at the convenience of the department of instruction concerned.

## VII. Withdrawal from School

### A. General

1. A student 18 years of age or older may withdraw from school upon the submission of a formal resignation during the first five weeks of the quarter.

2. A student under 18 years of age must include written permission from parents or guardian along with a formal resignation in order to withdraw from school before the official close of a quarter.

3. The proper forms for withdrawal are available from the Office of the Registrar. Students who withdraw without proper notification will receive grades of *F*, *U*, or *I* for the courses in which they were registered that quarter.

4. Permission and/or formal resignation are not required when a student has completed an official school quarter and does not register for the succeeding quarter.

5. See Section IV.A.3 for further information on withdrawal.

### B. Readmission

See Section VIII for the regulations concerning readmission.

## VIII. Readmission

### A. General

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 all pertinent supporting information (except possibly another college transcript—see 2 below), must be submitted to the Registrar before the deadline for the quarter for which readmission is requested, as listed below:

**Fall—August 1                      Spring—March 1**  
**Winter—December 1      Summer—June 1**

Applications received after these deadlines will not be accepted.

2. Students who have attended other colleges should plan their readmission so as to allow ample time for official transcripts from those colleges to be sent to the Georgia Institute of Technology. If official transcripts have not been received prior to the last day of registration, the student seeking readmission will not be allowed to complete registration.

### B. Readmission

1. A student who has been dropped once for unsatisfactory scholarship will ordinarily not be readmitted. A student who seeks an exception to this rule must have been out of the Institute for at least one quarter of the academic year and have had a conference with the major school concerning the readmission prior to the appropriate date listed in VIII.A.1 above. Because the summer quarter is not included in the academic year, students who are dropped at the end of the spring quarter will not be eligible for readmission until the beginning of the following winter quarter.

2. A student who is dropped a second time for unsatisfactory scholarship will not be readmitted to the Institute.

### C. Transfer Credit

1. Course work pursued at another institution after dismissal from Georgia Tech for unsatisfactory scholarship may be considered as evidence for readmission.

2. If readmitted, a student will not necessarily be given transfer credit for work taken at another institution after dismissal from Georgia Tech.

3. In no case will credit be allowed (except by examination) for courses completed at another institution that have previously been failed at Georgia Tech.

## IX. Scheduling

### A. General

1. All previously scheduled course work takes precedence over newly scheduled material. Therefore, all work which is incomplete from a previous quarter should be completed or arrangements to complete should be made prior to placing emphasis on new course work.

2. Students must follow the approved curriculum of the academic school in which they are registered. Students who do not follow the approved curriculum may be denied registration privileges.

3. Each student is strongly advised each quarter to schedule all prerequisite courses possible and should schedule all back courses before scheduling any advanced courses.

4. The completion of incomplete work from a previous quarter and the scheduling of out of sequence courses are the responsibility of the student, and they will be consequently held accountable.

5. Students may not repeat courses on a letter grade basis in which the grade of *B* or higher has been earned previously.

6. Subject to approval by a faculty adviser, a course may be taken more than once for academic credit. All grades will count in determining the scholastic average, but the course will be counted only once for credit toward a degree.

7. See Sec. X for Institute rules for courses taken on a pass/fail basis.

### B. Academic Load

1. The normal load scheduled by an undergraduate student in good standing should not exceed 21 credit hours. However, in exceptional cases, a total of 23 credit hours may be scheduled with the approval of the school.

2. Maximum credit hour loads are given in Sec. V.C.2, C.3, and C.4. Any hours above these limits must have prior approval of the Undergraduate Curriculum Committee or the Graduate Committee, as appropriate.

3. Graduate students must maintain a minimum of three credit hours each quarter of enrollment.

## C. Auditing of Courses

1. Auditing of courses will be permitted to regularly enrolled students who have obtained the approval of their adviser and the departments concerned. Such courses count at full value in computing the student's load.

2. The grade for auditing is *V* (visitor), and this grade will have no effect on the student's grade point average.

3. No academic credit is granted for audit participation in a course.

4. Students are not permitted to change to and from an auditing status except through the regular procedures for schedule change or withdrawal.

## X. Pass/Fail System

### A. General

1. At the option of the student's major school, credit toward a bachelor's degree may be allowed for courses taken under the pass/fail system and completed with a grade of pass.

2. The major school must approve all pass/fail courses included in the final program of study, and students should become aware of school requirements.

3. In graduate programs, thesis research hours will be evaluated on a pass/fail basis.

4. Pass/fail enrollment in any course may be restricted by the school or department offering the course.

5. Students who are permitted to register under the pass/fail system will be so designated on the official class rolls; the grades recorded will be *S* for satisfactory or *U* for unsatisfactory. These grades will not be included in the calculation of the grade point average and cannot be changed to a grade that will count in the average.

6. Withdrawals from courses taken on a pass/fail basis will follow the same rules that govern withdrawals from courses included in the scholastic average.

### B. Credit Hours Permitted

1. The maximum number of pass/fail hours permitted in an undergraduate program of study depends upon the number of credit hours that will be completed at Georgia Tech, as follows:

<i>Hours included</i>	<i>Hours allowed</i>
in program of study	on pass/fail basis
50 to 89 credit hours .....	3 credit hours
90 to 134 credit hours .....	6 credit hours

- 135 to 179 credit hours ..... 9 credit hours  
 180 or more credit hours ..... 12 credit hours
2. For a second undergraduate degree, these limitations apply to the credit hours approved for the program of study for that second degree.
  3. A master's degree program of study may include up to six course credit hours on a pass/fail basis.

## **XI. Cross Enrollment - University Center in Georgia**

### **A. General**

1. With the approval of the student's major school, a student may schedule courses at any one of the colleges or universities comprising the University Center in Georgia if such courses are not available in a particular quarter at Georgia Tech. (Member institutions—Agnes Scott College, Atlanta College of Art, Atlanta University Center, Columbia Theological Seminary, Emory University, Georgia Institute of Technology, Georgia State University, Interdenominational Theological Center, Kennesaw State College, Mercer University Atlanta, Oglethorpe University, Southern College of Technology, University of Georgia.)
2. All registration activities are performed at Georgia Tech.
3. Copies of the Guidelines for Cross Registration among University Center Member Institutions are available in the Office of the Registrar.

### **B. Eligibility**

1. Cross enrollment is available only to degree-seeking juniors, seniors, and graduate students.
2. To participate in cross enrollment, a student must be in good standing during the quarter when the application is processed.
3. During the quarter of cross enrollment, the student must be carrying three or more credit hours at Georgia Tech and be in good standing. The total academic load carried may not exceed 21 hours.
4. Credits earned under cross enrollment will be handled as transfer credit but will count as resident credit toward a degree. Grades received in cross enrollment courses will not be included in the calculation of the grade point average.

## **XII. Examinations**

### **A. General**

1. All re-examinations, examinations for advanced standing, and special examinations must be

authorized by the registrar before being scheduled.

2. If the instructor considers it necessary during an examination, students may be required to present their student identification card to the instructor or an authorized representative.

### **B. Examinations for Advanced Standing**

1. Students who offer satisfactory evidence that they are 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 require the recommendation of the department of instruction in which the course is offered, payment of the appropriate fee, and authorization by the registrar.
3. Examinations for advanced standing will ordinarily be offered during the week of final examinations.
4. A student will not be allowed to take an examination for advanced standing in a given course more than twice.
5. 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.

### **C. Final Examinations for Degree Candidates**

A degree candidate will be exempted from examinations during final examination week in the quarter of graduation.

### **D. Regulations Covering Final Examinations**

A student reporting to a final examination room more than 15 minutes after the scheduled starting time shall not be allowed to take the examination unless a satisfactory explanation is presented to the instructor conducting the examination.

## **XIII. Undergraduate Degrees**

### **A. General**

1. To be considered for admission to candidacy for a degree, a student must have passed the Regents' Test and must make a formal petition for the degree during the quarter preceding the final quarter in residence. A petition for degree will not be accepted until the Regents' Test has been passed.
2. Students desiring to withdraw their name from the rolls of degree candidates must formally withdraw the petition for degree before the end of the eighth week of the quarter.

3. A degree program may include a maximum of six hours of basic ROTC and a maximum of nine hours of advanced ROTC.

4. The diploma of a candidate for a degree shall bear the date of the commencement at which the degree is awarded.

5. All requirements for the degree must be completed and certified by the Registrar at least 72 hours prior to commencement. If a candidate for a degree is not certified at least 72 hours prior to commencement, the candidate will be graduated at the next scheduled commencement. The diploma will bear the date of the commencement at which the degree is awarded.

## **B. Fifty-hour Rule**

1. 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.

## **C. Ten-year Rule**

1. Work which was completed more than ten years prior to commencement must be validated by special examinations before it can be counted toward a degree.

## **D. Requirements for a Degree**

1. To be a candidate for a degree, undergraduate students must have passed all courses required for the degree, must have a scholastic average for their entire academic program of at least 2.0, and must have done creditable work in their departmental courses so as to merit the recommendation for the degree by the director and faculty of their school.

2. Students, with the approval of their school or 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 their enrollment in the Institute or during their last two years (prior to their enrollment at Georgia Tech) in the program at one of the eight RETP schools. A catalog is in effect for a 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.

3. Constitution and history examinations

a. 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.

b. Courses that may be substituted for the United States and Georgia constitution and history examinations are listed in this catalog in the section for the School of Social Sciences.

## **4. Regents' testing program**

All students completing requirements for baccalaureate degrees are required by the University System of Georgia to pass an examination designed to measure proficiency in reading and English composition. This examination is known as the Regents' Test. It must be passed before a petition for graduation will be accepted. Students should obtain further information from the registrar.

## **5. Physical education requirement**

a. Unless medically disqualified, all students are required to complete HPS 1040 or 1061 before graduation.

b. See Sec. XV for a complete description of the physical education requirements at Georgia Tech.

## **E. Graduation with Academic Distinction**

1. 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.

2. A student must have earned at least 100 credit hours (excluding remedial course work) at Georgia Tech to graduate with highest honor, with high honor, or with honor.

3. In order to qualify for graduation with honors, all grades or grade corrections affecting the honors designation must be received and certified by the registrar at least 72 hours prior to commencement. Grades or grade corrections received after that time will have no bearing on the honors designation.

## **F. Second Undergraduate Degree**

1. A student enrolled for a second undergraduate degree shall be classified an undergraduate student. A graduate student wishing to pursue a second undergraduate degree will remain classified as a graduate student. A graduate

student, with approval of the major school, may work toward a second undergraduate degree while pursuing a graduate program.

2. To be a candidate for a second undergraduate degree, a student must have the recommendation of the director of the school concerned and the approval of the Undergraduate Curriculum Committee.

3. To obtain a second undergraduate degree, a student must complete all major required courses for the degree and earn credit for a total of at least 50 credit hours in excess of the requirement for any previous degrees earned.

4. All regulations in Section XIII apply to students completing second undergraduate degrees.

## **XIV. Graduate Degrees**

A complete description of Institute requirements for the master's and doctor's degrees is given in this catalog in the section titled "Information for Graduate Students." Also see Section XIII.A.2 for a regulation concerning withdrawal of a petition for degree.

## **XV. Health Sciences**

### **A. General**

1. All students entering Georgia Tech are required to complete satisfactorily three credit hours in physical education courses, either HPS 1040 or 1061.

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

### **B. Medical Exemptions**

1. The Health Information Record on file with the director of Health Services will be used to determine any medical exemptions from physical education courses. All certificates of disability from personal physicians must be endorsed by the Student Health Services before they will be accepted by the Department of Health and Performance Sciences.

## **XVI. Student Motor Vehicles**

Students desiring to operate motor vehicles on campus are subject to all rules set forth by the Georgia Tech motor vehicle regulations.

## **XVII. Medical Regulations**

### **A. General**

1. 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 immediately reporting such illness to the infirmary.

2. A current Health Information Record and a consent-for-treatment form must be on file with the director of Health Services.

### **B. Infirmary Regulations**

Students must conform to infirmary regulations, as posted in the infirmary, while confined as patients in the infirmary.

## **XVIII. Extracurricular Activities**

### **A. Participation**

1. In order to be eligible for participation in extracurricular activities, a student must satisfy the following requirements:

a. be enrolled in a degree program;

b. maintain a schedule with at least six credit hours on a credit basis or be a student in the Cooperative Division on work quarter;

c. not be on academic or disciplinary probation.

2. Participation also requires satisfaction of any additional requirements established by the Student Activities Committee of the Academic Senate.

### **B. Scheduling of Events**

1. During the first week of each quarter, a schedule of public performances to be sponsored by each student organization must be submitted to the Division of Student Services for approval by the Student Academic and Financial Affairs Committee of the Academic Senate.

2. All student organizations must make written application to, and receive permission from, the Division of Student Services to hold a social function. The request must be submitted at least one week before the date of the activity, and the permission must be received before making any agreements in connection with the function.

3. In each quarter, the weekend before final examinations is closed to student-sponsored extracurricular events.

### **C. Student Organizations**

Requirements and standards for chartering a student organization are established by the Student Activities Committee of the Academic Senate and are available from the Division of Student Services.

### **D. Fraternity and Sorority Regulations**



1. To be eligible for initiation, a student must be a full-time student not on academic or disciplinary probation.

2. The initiation of any individual must be registered with and approved by the Division of Student Services prior to the initiation.

3. The individual must meet all Georgia Tech Interfraternity Council (I.F.C.) or Panhellenic requirements concerning initiation.

4. All fraternities and sororities are subject to the rules established by the Georgia Tech I.F.C./Panhellenic.

## **E. Intercollegiate Athletic Regulations**

1. To be eligible for intercollegiate athletic competition, a student must be enrolled in a degree program, be carrying a workload of at least 12 credit hours, and not be on academic or disciplinary probation. In addition, he or she must be making satisfactory progress toward a degree and meet any further requirements of the NCAA or other governing organization; see the athletic director for details.

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 Division of Student Services. Being manager or assistant manager is counted as participation within the meaning of this rule.

## **XIX. Student Conduct Code**

### **A. General**

A student enrolling in the Georgia Institute of Technology assumes an obligation to conduct himself or herself in a manner compatible with the Institute's function as an educational institution. Actions considered inimical to the Institute and subject to discipline fall into the categories of academic and nonacademic misconduct.

### **B. Academic Misconduct**

Academic misconduct is any act that does or could improperly distort student grades or other student academic records. Such acts include but need not be limited to the following:

1. Possessing, using, or exchanging improperly acquired written or verbal information in the preparation of any essay, laboratory report, examination, or other assignment included in an academic course;

2. Substitution for, or unauthorized collaboration with, a student in the commission of academic requirements;

3. Submission of material that is wholly or substantially identical to that created or published by another person or persons, without adequate credit notations indicating the authorship (plagiarism);

4. False claims of performance for work that has been submitted by the claimant;

5. Alteration or insertion of any academic grade or rating so as to obtain unearned academic credit;

6. Deliberate falsification of a written or verbal statement of fact to a member of the faculty so as to obtain unearned academic credit;

7. Forgery, alteration, or misuse of any Institute document relating to the academic status of the student.

### **C. Nonacademic Misconduct**

Nonacademic misconduct includes the following specifically prohibited acts whenever, unless otherwise stated, such acts occur on Institute owned or controlled property or Institute-related premises:

1. Alcohol abuse, including

a. conspicuous or flagrant possession of alcoholic beverage;

b. intoxication made manifest by boisterousness, rowdiness, obscene or indecent conduct or appearance, or vulgar, profane, lewd, or unbecoming language;

c. disorderly conduct associated with the use of alcoholic beverages.

2. Pushing, unjustifiably striking or physically assaulting, or otherwise intentionally threatening or endangering the person of any member of the faculty, administration, staff, or student body, or any visitor to the campus.

3. Disorderly conduct, including

a. breach of the peace or obstruction or disruption of teaching, research, administration, disciplinary procedure, or other Institute activities, including its public service functions or other authorized activities;

b. 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 persons are acting in the performance of their duties;

c. lewd, indecent or obscene conduct or expression;

d. 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.

4. Drug abuse, including the use or possession (without valid medical or dental prescriptions), manufacture, furnishing, sale, or any distribution of any narcotic or dangerous drug controlled by law; this provision is not intended to regulate alcoholic beverages, which are covered in Section 1 above.

5. Unauthorized use of college facilities including  
a. unauthorized entry into any Institute building, office, or other facility or remaining in any building after normal closing hours;

b. unauthorized use of any Institute telephone facility or of any other Institute facilities;

c. possessing, using, making, or causing to be made any key for any Institute facility without proper authorization;

d. unauthorized use of another student or faculty member's password to gain access to the computer or computer output. This includes but is not limited to any knowing and willing use of fraudulent means to process computer programs and access computer files.

6. Furnishing false information to any Institute official or offering false statement in any Institute disciplinary hearing.

7. Forgery, alteration, or misuse of any Institute document, record, or identification.

8. Any hazing action that tends to cause 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.

9. Safety violations, including

a. intentional false reporting of a fire or that any explosive device has been placed on Institute property;

b. tampering with fire-fighting equipment, safety devices, or other emergency or safety equipment;

c. setting an unauthorized fire;

d. possession of unauthorized fireworks, firearms, ammunition, or dangerous weapons or materials;

e. unauthorized sale, possession, furnishing, or use of any incendiary device or bomb;

f. 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.

10. Theft and/or unauthorized possession of Institute property or property of a member of the Institute community or campus visitor.

11. Malicious or unauthorized damage or destruction to Institute property or property belonging to any member of the Institute community or campus visitor.

12. Violation of rules governing residence in Institute owned or controlled property such as dormitories, family housing, fraternities, and organization housing.

13. Playing of games of skill or chance for money or other items of value.

14. Failure to remit, return, or submit financial obligations, property or records of the Institute, within the time prescribed by the Institute.

15. Knowingly acting in concert with any other person to perform an unlawful act or to violate an Institute regulation or policy.

16. Violations of the Georgia Tech Motor Vehicle Regulations.

17. Violation of the Regents' Statement on Disruptive Behavior, the full text of which is given in Section XX.

18. Repeated violations of the published rules and regulations of the Institute, which cumulatively indicate an unwillingness or inability to conform to the Institute standards for student life.

19. Violation of the conduct code, wherever it may occur, violation of the laws of any city, county, state, or the United States, where the violation creates a clear and present danger of material interference with the normal or orderly processes of the Institute or its requirements of appropriate discipline.

## **XX. 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 fully support freedom of expression by each member of the

academic community and to preserve and protect the rights and freedom of its faculty members and students to engage in debate, discussion, peaceful and nondisruptive protests, and dissent. The following statement relates specifically to the problem described below. It does not change or in any way infringe upon the Board's existing policies and practices in support of freedom of expression and action. Rather, it is considered necessary to combat the ultimate effect of irresponsible disruptive and obstructive actions by students and faculty that 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 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, disrupts, or attempts to obstruct or disrupt any teaching, research, administrative, disciplinary, public service activity, or any other activity authorized to be discharged or held on any campus of the University System of Georgia is considered by the Board to have committed an act of gross irresponsibility and shall be subject to disciplinary procedures, possibly resulting in dismissal or termination of employment.

The Board reaffirms its belief that all segments of the academic community are under a strong obligation and have a mutual responsibility to protect the campus community from disorderly, disruptive, or obstructive actions, which interfere with academic pursuits of teaching, learning, and other campus activities.

The Board of Regents understands that this policy is consistent with resolutions adopted by the American Association of University Professors in April 1968, by the Association of American Colleges in January 1968, and by the executive committee of the Association for Higher Education in March 1968, condemning actions taken to disrupt the operations of institutions of higher education.

## **XXI. Disciplinary Administration**

### **A. Disciplinary Procedures**

1. All acts of misconduct (excepting violations of motor vehicle regulations) on the part of students shall be reported to the vice president for Student Services, who is designated the principal administrator to enforce Institute disciplinary measures as they pertain to student academic or nonacademic misconduct.
2. The vice president for Student Services shall

investigate alleged acts of student misconduct. If the investigation indicates that further action is necessary, the vice president for Student Services shall notify the accused in writing. This written notification shall contain a statement of the nature of the alleged or suspected misconduct and state the sections of the conduct code the student is alleged to have violated.

3. The vice president for Student Services or the authorized representative will normally confer with the accused student, and at this conference, the student may admit or deny the alleged violation, the student may waive further hearing and appeal(s) in writing and request that the vice president for Student Affairs take appropriate action, or may request a hearing as specified in 4, 5, or 6 below.

4. Cases of academic misconduct will normally be referred to the Student Honor Committee, which shall hear and try cases involving academic misconduct on the part of any student.

5. Cases of serious nonacademic misconduct that 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 agencies in those cases of nonacademic misconduct in violation of federal, state, or local law.

6. If the case does not involve possible suspension or expulsion, the vice president for Student Services ordinarily shall make full disposition of the case except that he or she, at the request of the accused or for good cause, may refer any case of nonacademic misconduct to the Graduate Judiciary or Undergraduate Judiciary Cabinet.

7. Students accused of an act of academic misconduct or nonacademic misconduct are encouraged to notify their parents or guardian of the charges. Parents or guardian will, if requested, be granted a conference with the vice president for Student Services prior to the hearing.

8. An accused student 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 vice president for Student Services may impose

temporary protective measures, including interim suspension, pending the hearing; such protective measures, if applied, will be without reasonably avoidable prejudice to the student.

### **B. Student Honor Committee**

1. The Student Honor Committee shall consist of four members of the corps of instruction elected from the Academic Senate and two undergraduate students with at least junior standing elected by the Student Council and one graduate student elected by the Graduate Student Senate. Student members must have good academic standing and must not be on disciplinary probation. The chairman shall be elected annually by the committee from among the Academic Senate members. The secretary shall be appointed by the chairman.

2. The committee shall hear and try all cases referred to it involving alleged dishonesty in academic matters on the part of students. The decision in the case shall be transmitted to the office or offices responsible for recording it, for notifying the student officially, and for implementing the action.

3. In its distributed minutes and in the annual report of its activities and findings, the committee shall preserve the anonymity of individuals by generalizing the issues involved and the actions taken.

### **C. Student Judiciary**

1. The Graduate Judiciary shall consist of a graduate student chairman and six graduate student justices. The graduate student justices and chairman shall be currently enrolled, full-time graduate students in good academic standing and not on disciplinary probation. They are appointed by the graduate student body president and approved by the Graduate Student Senate. The Graduate Judiciary shall normally hear all cases of graduate student nonacademic misconduct in which there is the possibility of suspension or expulsion of the accused student.

2. The Undergraduate Judiciary Cabinet shall consist of an undergraduate student chairman and ten undergraduate student justices. The undergraduate student justices and chairman will be currently enrolled, full-time undergraduate students in good academic standing and not on disciplinary probation. They are appointed by the student body president and approved by the Student Council. The Undergraduate Judiciary Cabinet shall normally hear all cases of

undergraduate student nonacademic misconduct in which there is a possibility of suspension or expulsion of the accused student.

## **D. Procedural Rights of the Accused**

Students accused of an act of misconduct and summoned to a hearing before the Student Honor Committee, Graduate Judiciary, or Undergraduate Judiciary Cabinet have the right to

1. be accompanied by an adviser of their choice;
2. remain silent with no inference of guilt drawn therefrom;
3. question the complainant;
4. present evidence in their behalf;
5. call pertinent witnesses in their behalf;
6. cross examine witnesses;
7. challenge and unseat as many as four student justices in Undergraduate Judiciary Cabinet hearings (the chairman cannot be struck; a quorum of six student justices and the chairman must remain);
8. appeal.

## **E. Hearing Procedures**

1. The chairman of the appropriate hearing body shall set the date, time, and place of the hearing, shall notify the members of the hearing body, and shall summon all principals in the case (defendants and witnesses).

2. The chairman of the appropriate hearing body shall notify the accused student in writing at least three days in advance of the scheduled hearing. The written notification should, if reasonably possible, be hand delivered; if not reasonably possible, notification should be by registered mail to the student's local address. The written notification should specify

- a. the date, time, and place for the hearing;
  - b. the nature of the alleged or suspected misconduct with which the student is accused, with sufficient particularity to ensure opportunity to prepare for the hearing; and
  - c. names of witnesses scheduled to appear.
3. Decisions for the hearing body shall be by majority vote. A quorum for the Student Honor Committee shall consist of five members, three faculty members, and two students. A quorum for the Undergraduate Judiciary Cabinet shall consist of the chairman and six justices. A quorum for the Graduate Judiciary shall consist of the chairman and four justices.
4. Members of the hearing body shall disqualify

themselves if their personal involvement in the hearing is of such a nature as to prejudice the case.

5. The hearings of the Student Honor Committee, Graduate Judiciary, and Undergraduate Judiciary Cabinet shall ordinarily be closed except for the accused, the accused's adviser, and those directly involved; exceptions may be made at the discretion of the chairman. The hearing body may exclude any person who may be reasonably expected to interfere materially with the hearing or who does interfere materially with the hearing. Hearing body deliberations are closed to all but the hearing body members.

6. The hearing body shall make a tape recording and/or summary transcription of the proceedings.

7. The hearing body shall provide a brief written summary of each case with recommendations for appropriate disciplinary action to the vice president for Student Affairs and to the student involved.

8. The vice president for Student Affairs will review the case and recommendations and implement disciplinary action.

## **F. Disciplinary Measures**

For violations of Institute rules and regulations or for acts of student misconduct, academic or nonacademic, the following disciplinary measures may be taken. This list is not exhaustive and may be modified to meet particular circumstances in any case.

1. Expulsion—permanent severance of the student's relationship with the Institute.
2. Disciplinary suspension—temporary severance of the student's relationship with the Institute for a specific period of time, though not less than one quarter.

A student expelled or suspended shall leave the campus and not visit the campus during the period of suspension or expulsion, except when on official school business. To violate this stipulation would adversely affect the student's chances for readmission.

3. Reprimand—an oral and/or written statement of disapproval issued to the student.
4. Restriction—exclusion from participation in social activities and loss of identification card privileges.
5. Disciplinary probation—notice to the student that any further major disciplinary violation may

result in suspension or expulsion; may include setting of restrictions and/or issuing a reprimand. A student on disciplinary probation is not in good standing and may not participate in extracurricular activities.

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—withdrawal from the academic course within which the offense occurred without credit for the course.

9. Change in grade—grade change for the course in which the offense occurred.

### **G. Appeal Procedures**

1. If accused students or accusers are dissatisfied with the action taken by the vice-president for Student Services, they may appeal the case in writing to the president of Georgia Tech within five days after the action about which there is a complaint. Such appeal shall recite all reasons for dissatisfaction with the previous decision.

2. The president, within five days, shall refer the appeal to the Student Grievance and Appeal Committee. This committee shall review all facts and circumstances connected with the case and within five days shall make its findings and report thereon to the president. After consideration of the committee's report, the president within five days shall make a decision that will be final so far as the Institute is concerned.

3. The Student Grievance and Appeal Committee shall consist of three members of the corps of instruction elected from the Academic Senate and two students with at least junior standing elected jointly by the Student Council and the Graduate Senate. The chairman shall be elected annually by the committee from among the elected Academic Senate members. The secretary shall be appointed by the chairman.

4. The Board of Regents of the University System of Georgia is the final appellate authority for all cases involving students who have been suspended or expelled. Should aggrieved persons be dissatisfied with the decision of the president, they may apply to the Board of Regents, without prejudice to their position, for a review of the decision. The application for review shall be submitted in writing to the executive secretary of the Board within a period of 20 days following the

decision of the president. This application for review shall state the decision complained of and the redress desired. A review of the Board is not a matter of right but is within the sound discretion of the Board. If the application for review is granted, the Board, or a committee of the Board shall investigate the matter thoroughly and render its decision thereon within 60 days from the filing date of the application for review or from the date of any hearing that may be held thereon. The decision of the Board shall be final and binding for all purposes.

## **XXII. Student Academic Grievance Procedures**

The procedures set forth here are intended to provide students at Georgia Institute of Technology a means for setting forth grievances relating to academic matters and grade disputes, when the student believes that an instructor has acted unfairly or improperly in assignment of grades. It is not the intention to provide a forum for questioning the judgement or grading policies of faculty.

### **A. Applicability of the Grievance Procedures**

1. Subject Matter: These procedures apply to the review of grievances concerning academic matters and grade disputes.

2. Grievant: These procedures shall be the appellate procedures for students at the Georgia Institute of Technology.

Students who have pursued a formal grievance procedure or who have pursued informally the resolution of a grievance in their own school, college, or unit and have had that appeal dismissed, may submit the grievance for review under these procedures.

### **B. Overview of Grievance Process**

1. Informal resolution attempted at the school, department, or unit level.

2. Formal resolution sought at the school, department, or unit level.

3. Formal resolution sought at the Institute level: appeal reviewed and, if so determined, heard by the Student Grievance and Appeal Committee.

### **C. Steps in the Grievance Process (to be followed in the order presented).**

1. The student shall attempt to resolve the grievance with the individual faculty member, the department, or the unit involved.

2. If the grievance is not resolved in step C.1. and

the student elects to continue the grievance process, the student may request a formal hearing setting forth in writing the complaint and the remedy sought, at the school, college, or unit level. Upon receipt of such appeal, the unit director will acknowledge the appeal in writing within seven calendar days, and will expeditiously proceed to constitute an ad hoc appeal committee. The unit director will serve as a non-voting member of the committee. In addition, the following four committee members will be selected:

- one tenured faculty member from within the unit, selected by the unit director.
- one member of the academic faculty, selected by the student. The student may elect not to select a faculty member; in that case, the committee will consist of three members.
- One member from outside the unit, selected by the Student Grievance and Appeal Committee in consultation with the unit director.
- One member of the academic faculty selected by the faculty member whose action is in question.

This committee will proceed with due haste to examine the merits of the complaint and to render a decision within 30 days. During the proceedings, the student may present any and all evidence that the student deems necessary to support the complaint, except that the committee must agree that the evidence is in some way relevant. Such evidence may consist of documentation and/or testimony, within reason. Both complainant and respondent may be accompanied by advisers; the role of adviser must, however, be restricted to advice. Complainant and respondent must make their own cases before the committee.

Following a hearing and a written decision at the school, college, or unit level, the grievance is presumed to be resolved unless the grievant appeals.

3. The grievant may appeal the decision that has been rendered by the school, college, or unit to the Student Grievance and Appeal Committee.

a. If the Committee, or subset thereof appointed by the chairperson, rules that the procedures are not applicable or that based on the facts stated by the grievant viewed in the light most favorable to the grievant, there is no basis for relief, then the appeal is denied.

b. If the Committee rules that the Institute

procedural rules are applicable and that a hearing of the appeal is warranted, the Committee shall initiate a hearing process.

c. If a student wishes to have a grievance outcome reviewed by the Student Grievance and Appeal Committee with a view to a formal hearing, the student shall observe the following requirements:

c.1 The appeal must be in writing. It must state the basis for the grievance and the facts which support it, including a summary of the steps which have already been taken to resolve the grievance, reasons why the student finds the resolutions unfair or unsatisfactory, and a statement of the desired remedy.

c.2 The written appeal must be presented to the chairperson of the Student Grievance and Appeal Committee within 30 days after the student has received notice of a decision from a school, college, or unit.

c.3 The decision as to whether a formal hearing is warranted shall be made available, in writing, to the parties concerned within 30 days after the Committee has received notice of appeal.

c.4 The Committee may alter a deadline specified in these procedures on written timely petition of either party showing a meritorious reason for delay; if the Committee itself needs to extend a deadline, it may do so on its own authority for periods up to 14 calendar days; for longer delays, the Committee must request an extension from the Executive Board of the Institute.

c.5 The determination of the Committee as to whether a hearing is warranted is final.

c.6 The Committee shall develop and, with the approval of the Academic Senate, establish and publish its own rules of procedure for the conduct of formal hearings.

c.7 After receiving testimony and the relevant documents, the Committee shall make a decision within 30 days on the basis of the received material.

c.8 The Committee's decision shall contain finding of fact, the decision arrived at, reasons for the decision, and the criteria or policy applied in reaching the decision.

## **D. Remedies**

1. General: If the Committee finds, after a formal hearing, that a faculty member, a departmental committee, or an administrator of a unit has not acted fairly or properly, it will recommend a remedy. It will seek to find a remedy that can be

implemented by those whose cooperation is needed. In the matter of a grade dispute, this must include the faculty member involved in the dispute.

## 2. Enforcement

a. If any party does not comply with the decision of the Committee, the Committee shall, upon request of any party, seek full compliance through the administrative offices of the Institute through the Executive Vice President and the President.

b. The merits of the dispute shall not be subject to review in the process of enforcement. There shall be strong presumption in favor of the remedy selected by the Committee.

3. Report of a Final Decision: After a final decision has been made in a case, the Committee shall prepare a report setting forth its findings and recommendations for action and present the report to the chief academic officer (CAO) of the Institute. A copy of the report shall be presented to the parties concerned and to those persons involved in implementing the Committee's recommendations. All such communications shall be effected in person or by certified mail with a return receipt requested; such receipt will become part of the Institute records of the case. Grade Changes: In decisions that would result in the changing of a posted grade, the CAO will instruct the unit director to ask the involved faculty member to effect the prescribed grade change, or, if cooperation is not forthcoming, to effect the grade change directly by action of the unit director. Such action shall not be construed as restrictive of the recourses of the faculty member through the usual appeal procedure of the Institute.

Care will be given that no incomplete or inaccurate information pertaining to the grievance is placed in any file; and that all evidence obtained at any stage of the process and all deliberations and proceedings be kept confidential. At the conclusion of each case, the Student Grievance and Appeal Committee shall transmit original or true copies of documents related to the case to the appropriate office of the Vice President for Student Services, who shall keep such records securely as Institute records for a period of time specified by Institute statutes.

4. Final Appeal. Appeal of the decision of the Committee to the CAO shall be permitted only for the purposes of procedural review. Such appeal shall be submitted in writing, with copies to the

Committee. The CAO will review the findings of the Committee, and, upon judgement that the Committee has failed to follow these procedures or has failed to follow the procedures approved by the Academic Senate for the operation of the Student Grievance and Appeal Committee (C.3.c.c6), return the case to the Committee for reconsideration, along with description of the perceived error in procedure and a recommendation for its correction.

## XXIII. Exceptions

Where appeals are not otherwise specified, exceptions to these regulations may be made by the appropriate faculty committee upon petition by the student and recommendation of the student's school or department. Blanket exceptions that have the effect of amending these regulations shall be referred to the Academic Senate for approval.

## Student Bill of Rights

1. The right to attend classes during their regularly scheduled time without deviation from such time and without penalty if the student cannot attend instructional hour not institutionally scheduled.
2. The right to consult with an assigned adviser for a reasonable amount of time each quarter.
3. The right to transfer core curriculum within the University System.
4. The right to consult with faculty outside the classroom time during regularly scheduled office hours by appointment.
5. The right to reasonable access to campus facilities of which use is required to complete course assignments and objectives.
6. The right to receive each quarter for each course, a syllabus which outlines course objectives and requirements and to be informed of any changes in these syllabi at the beginning of each quarter.
7. The right of timely review of lecture and/or reading material before a major examination is administered.
8. The right of each student to receive access to any of his/her records kept by the institution.
9. The right to reasonable access to grading instruments and/or evaluation materials.
10. The right to be informed of the grade appeals process.

(Adopted by the University System of Georgia Board of Regents.)



# ADMINISTRATION, FACULTY, AND STAFF

## Administration

### Board of Regents

The Georgia Institute of Technology is one of the educational institutions constituting the University System of Georgia. The university system is governed by a 16-member 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 listed below.

John H. Anderson, Jr., Hawkinsville .....	State-at-Large
J. Tom Coleman, Jr., Savannah .....	State-at-Large
Suzanne G. Elson, Atlanta .....	State-at-Large
Donald M. Leebern, Jr., Atlanta .....	State-at-Large
Charles H. Jones, Macon .....	State-at-Large
S. William Clark, Jr., Waycross .....	First District
Elsie P. Hand, Pelham .....	Second District
William B. Turner, Columbus .....	Third District
Dwight H. Evans, Atlanta .....	Fourth District
Elridge W. McMillan, Atlanta .....	Fifth District
Kenneth W. Cannestra, Atlanta .....	Sixth District
Edgar L. Rhodes, Bremen .....	Seventh District
John Howard Clark, Moultrie .....	Eighth District
Edgar L. Jenkins, Jasper .....	Ninth District
Thomas F. Allgood, Sr., Augusta .....	Tenth District
Juanita Powell Baranco, Decatur .....	Eleventh District

### Chancellor of the University System and the Administrative Staff

Chancellor Stephen R. Portch 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 the following:

- Donald M. Leebern, chair
- Juanita Powell Baranco, vice chair

- James E. Cofer, senior vice chancellor, Capital Resources
- Douglas H. Rewerts, vice chancellor, Facilities
- Roger C. Mosshart, assistant vice chancellor, Budgets
- Levy G. Youmans, assistant vice chancellor, Accounting
- Joan M. Elifson, interim senior vice chancellor, Academic Affairs
- James B. Mathews, vice chancellor, Information/Instruction Technology
- Randall Thursby, assistant vice chancellor, Information Technology
- Haskin R. Pounds, vice chancellor, Planning, Policy, Analysis
- Joseph Szutz, assistant vice chancellor, Planning
- Cathie M. Hudson, assistant vice chancellor, Planning
- Jan Kettlewell, interim assistant vice chancellor, K-12, DTAE
- Joseph Silver, assistant vice chancellor, Academic Affairs
- David M. Morgan, assistant vice chancellor, Academic Affairs
- Barry A. Fullerton, vice chancellor, Student Services
- Arthur N. Dunning, senior vice chancellor, Human and External Resources/Acting Deputy
- T. Don Davis, associate vice chancellor, Human Resources
- Elizabeth E. Neely, associate vice chancellor, Legal Affairs
- Lynn F. Warren, assistant vice chancellor, Contracts
- J. Burns Newsome, assistant vice chancellor, Prevention
- Thomas E. Daniel, vice chancellor, External Affairs
- Arlethia Perry-Johnson, assistant vice chancellor, Media and Publications

## The University System of Georgia

Since 1932, all state-operated institutions of higher education in Georgia, including the Georgia Institute of Technology, have sought to accomplish their goals of instruction, public service, and research through their affiliation with the University System of Georgia. Governed by the 16-member constitutional Board of Regents under the administration of the chancellor, the four universities, two regional universities, 13 senior colleges, and 15 two-year colleges that compose the System retain a high degree of autonomy while cooperating with member institutions within the structure of Board policy. In addition to the formulation and administration of policy, the Board of Regents is responsible for requesting appropriations from the Georgia legislature and for allocating these funds to member institutions.

To provide students in Georgia with quality instruction leading to a variety of degrees, the Board of Regents establishes minimum academic standards, granting to each member institution the prerogative of establishing higher standards. In addition, the Board has instituted a core curriculum for freshmen and sophomores whose educational goal is a degree beyond the associate level, in order to facilitate the transfer of credit within the University System. This curriculum requires 90 quarter hours in general studies—humanities, social sciences, mathematics, and natural sciences—and 30 in the student's chosen major area. Besides providing a foundation for sound instruction, the Board encourages public service and continuing education programs, including lectures, conferences, short courses, advisory services, extension courses, and teacher education consortiums. The Board also encourages research related to the educational objectives of the institutions and originating in societal need.

Appointed by the governor and confirmed by the Georgia Senate, the members of the Board of Regents—five from the state at large and one from each of the state's 11 Congressional districts—serve for seven-year terms; the chancellor, who is not a member of the Board, is chief executive and administrative officer for the Board and the University System. Each institution

has as its executive head a president whose election is recommended by the chancellor and approved by the Board.

## Member Institutions

### Key

*b* — On-campus Student Housing Facilities;  
Degrees Awarded: *A* — Associate;  
*B* — Bachelor's; *J* — Juris Doctor;  
*M* — Master's; *S* — Specialist in Education;  
*D* — Doctor's; *CD* — Doctor's, offered in cooperation with a University System university, with degree awarded by the University.

### Universities

Athens 30602

University of Georgia — *b; A, B, J, M, S, D*

Atlanta 30332

Georgia Institute of Technology — *b; B, M, D*

Atlanta 30303

Georgia State University — *A, B, J, M, S, D*

Augusta 30912

Medical College of Georgia — *b; A, B, M, D*

### Regional Universities

Statesboro 30460

Georgia Southern University — *b; A, B, M, S*

Valdosta 31698

Valdosta State University — *b; A, B, M, S*

### Senior Colleges

Albany 31705

Albany State College — *b; A, B, M, S*

Americus 31709

Georgia Southwestern College — *b; A, B, M, S*

Augusta 30910

Augusta College — *A, B, M, S*

Carrollton 30118

West Georgia College — *b; A, B, M, S, CD*

Columbus 31993

Columbus College — *A, B, M, S*

Dahlonega 30597

North Georgia College — *b; A, B, M*

Fort Valley 31030

Fort Valley State College — *b; A, B, M*

Marietta 30061

Kennesaw College — *A, B, M*

Marietta 30060

Southern College of Technology — *b; A, B, M*

Milledgeville 31061

Georgia College — *b; A, B, M, S*

Morrow 30260

Clayton State College — *A, B*

Savannah 31406

Armstrong State College — *A, B, M, S*

Savannah 31404

Savannah State College — *b; A, B, M*

## **Two-year Colleges**

Albany 31707

Dartmouth College — *A*

Atlanta 30310

Atlanta Metropolitan College — *A*

Bainbridge 31717

Bainbridge College — *A*

Barnesville 30204

Gordon College — *b; A*

Brunswick 31523

Brunswick College — *A*

Cochran 31014

Middle Georgia College — *b; A*

Dalton 30720

Dalton College — *A*

Decatur 30089-0601

DeKalb College — *A*

Douglas 31533

South Georgia College — *b; A*

Gainesville 30503

Gainesville College — *A*

Macon 31297

Macon College — *A*

Rome 30163

Floyd College — *A*

Swainsboro 30401

East Georgia College — *A*

Tifton 31793

Abraham Baldwin Agricultural College — *b; A*

Waycross 31501

Waycross College — *A*

## **Board of Regents**

University System of Georgia

244 Washington Street, S.W.

Atlanta, Georgia 30334

(404) 656-6050

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Jerry T. Wilson, M.S., *associate director, Middle Georgia Technology Development Center*

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- Steven Danyluk, Ph.D., *director, Manufacturing Research Center*
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- John E. Endicott, Ph.D., *director, Center for International Strategy, Technology, and Policy*
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John White, Ph.D., *director, Center for Sustainable Technology*  
Carol Whitescarver, *director, Center for Rehabilitation Technology*  
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Norman Johnson, Ph.D., *marketing partner*  
S. Gordon Moore, *Investment Services partner*  
Jonnathyn Ogle, *Customer Supplier Relations partner*  
Zelice Roache, *Financial/Administrative partner*  
Gavin Samms, *managing partner*  
Cedric Stallworth, *Process Control partner*

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Ernie Murphrey, *associate vice president, Budget, Finance, and Administration*  
Linda Krantz, *executive assistant to the vice president*  
Henry Spinks, B.B.A., C.P.A., *controller*  
Billy B. Portwood, LL.B., *director, Budgets*  
Michael J. Brandon, B.S., *director, Financial Data Management*  
Delores Gaddis, *director, Purchasing*  
Rebecca Harrell, B.S., *manager, Accounts Payable*  
Kelly Kenion, B.S., *manager, Management Information Services*  
Margaret B. Kee, M.P.A., *manager, Financial Planning*

H. T. Marshall, LL.B., C.P.A., *director, Internal Auditing*  
Pat Brook, B.S., *manager, Payroll and Records Services*  
Bruce Spratt, *manager, General Accounting*  
John Stone, B.B.A., C.P.A., *manager, Capital Assets Accounting*  
David Welch, B.S., *director, Grants and Contracts*

## Registrar

Frank E. Roper, M.S.I.E., *registrar*  
William F. Leslie, M.S., *associate registrar*  
Annette Satterfield, A.B., *associate registrar*  
Marla Jo McIver, B.S., *director, Registration and Records*

## Research and Graduate Programs

Demetrius Paris, Ph.D., *vice president for Research and Graduate Programs*  
Helen E. Grenga, Ph.D., *associate vice president and dean*  
Maureen Kilroy, M.S., *director, Graduate Academic and Enrollment Services*  
Keith Oden, M.S., *director, Graduate Co-op and Fellowship Programs*

## Student Services

Roger E. Wehrle, B.S., *interim vice president of Student Services and director of Auxiliary Services*  
Vacant, *associate vice president*  
Carole E. Moore, Ph.D., *assistant vice president*  
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Terry L. Sichta, M.S., *director, Housing*  
Butch Stanphill, M.S., *director, Recreational Sports*  
Rich Steele, B.S., *director, Student Center/Auxiliary Services*  
William Miller Templeton, M.S., *director, International Student Services and Programs*  
Russell D. Terwilliger, Ph.D., *director, Student Counseling and Career Planning Center*

## Student Success Center

Barbara Hall, B.A., *acting executive director and associate vice president, Marketing and Enrollment Services*

John Hannabach, B.S., *director of Career*

*Services*

Paul D. Hurst, M.S., *director of Special Programs*

T. Jerry McTier, M.Ed., *director, Student*

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William M. Pouncey, M.B.A., *director, Policies*

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Deborah Smith, M.Ed., *director, Undergraduate*

*Admissions*





## Full-time Academic Faculty and Administrators

**As of February 24, 1995**

After each name, the highest earned degree and its source is listed. The academic rank is followed by the individual's major assignment.

Professional registration is indicated with the state(s) of registration as follows:

P.E. = Professional Engineer

L.S. = Land Surveyor

R.A. = Registered Architect

L.A. = Landscape Architect

P.G. = Professional Geologist

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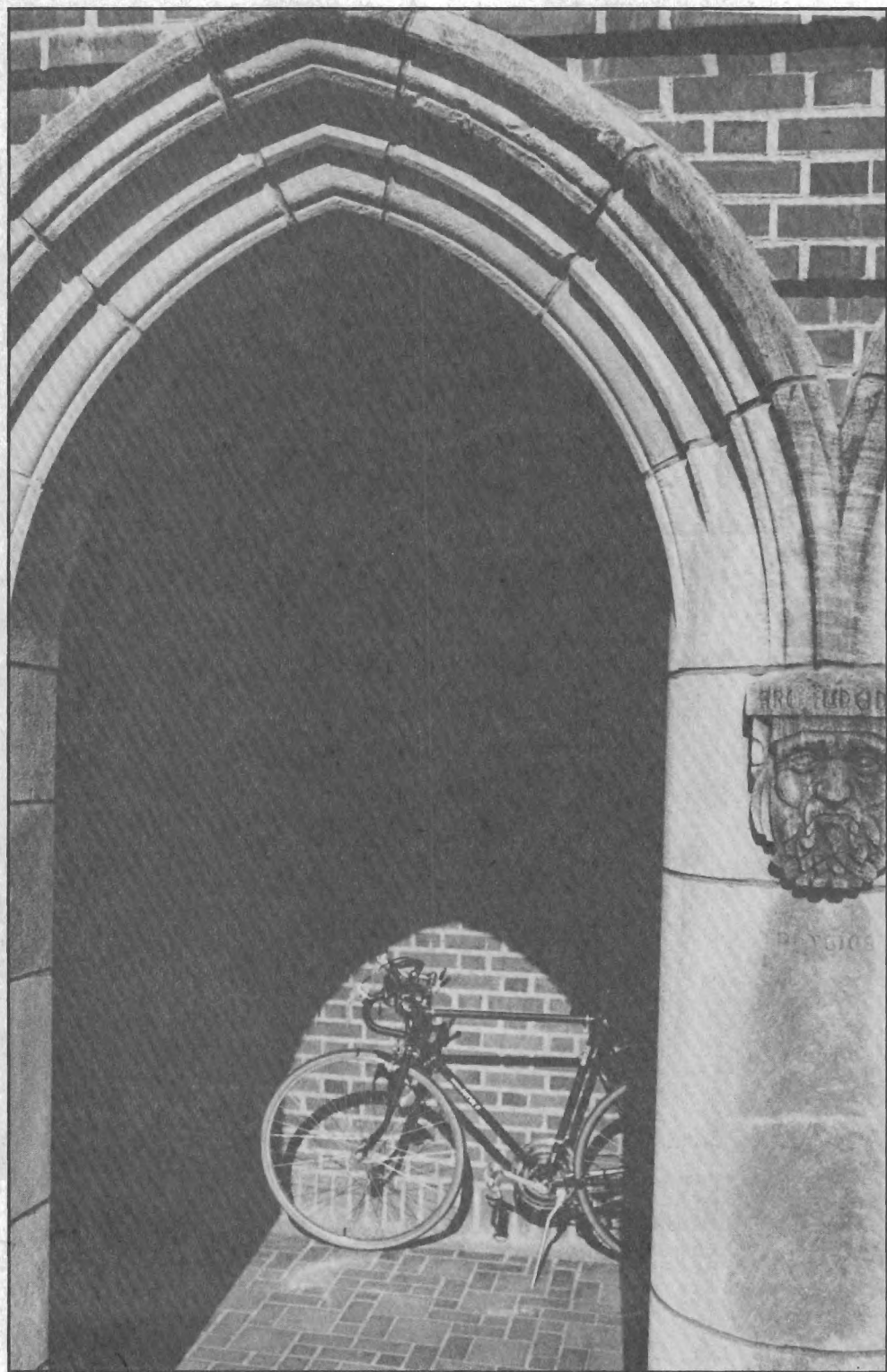
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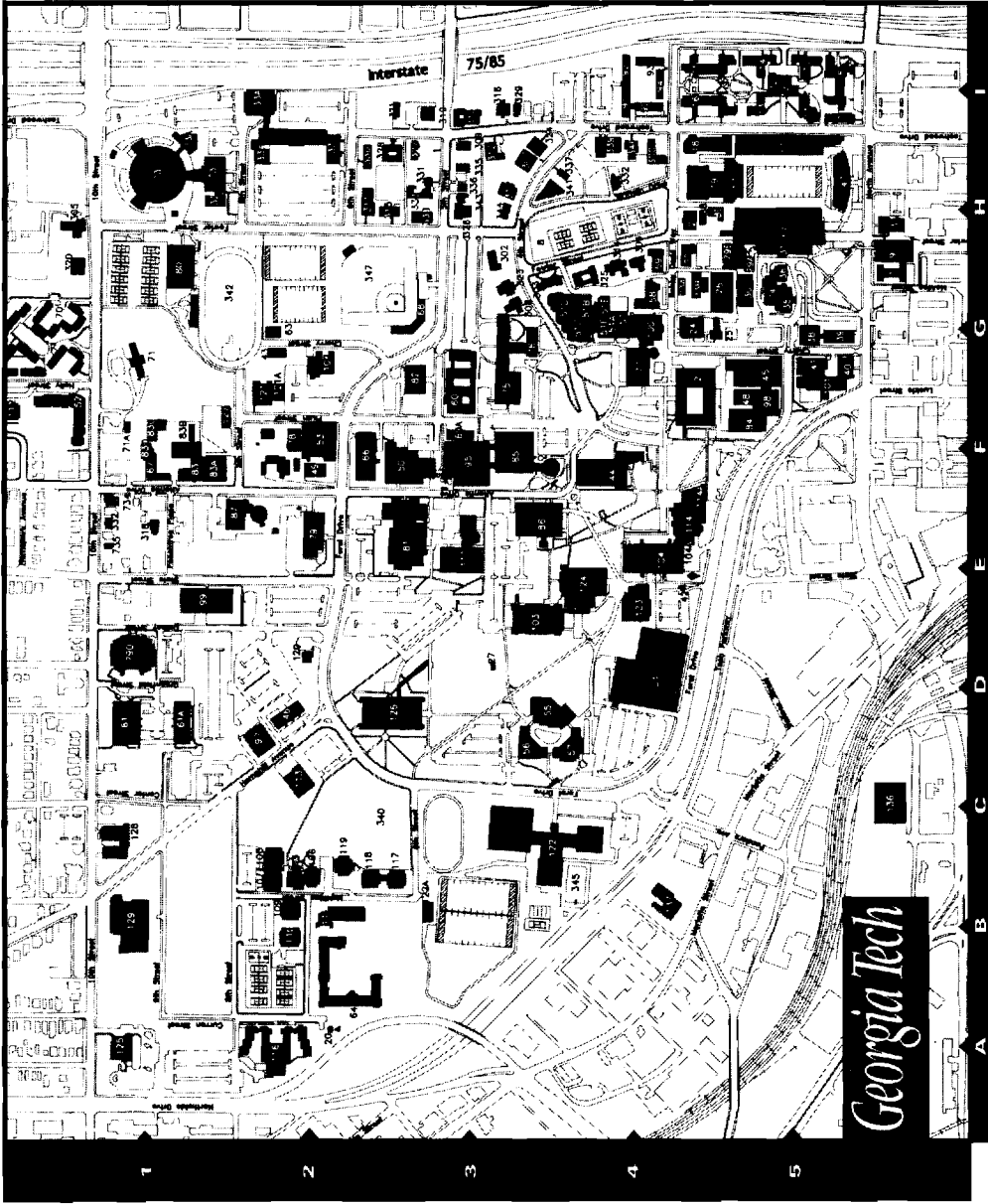
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1. McDaniel Residence Hall
2. Robert Alumni Faculty House
3. Burge Apartments
4. Wardlaw Center
5. Brown Residence Hall
6. Smith Residence Hall
7. Harris Residence Hall
8. Howell Residence Hall
9. Cloudman Residence Hall
10. Brittain Dining Hall
11. Harrison Residence Hall
12. Glenn Residence Hall
13. Towers Residence Hall
14. Edge Intercollegiate Athletic Center
15. Heisman Gymnasium and Swimming Pool
16. Bobby Dodd Stadium at Grant Field
17. 190 Third Street
18. Daniel Laboratory
19. Lyman Hall
- 19a. Emerson Building
- 19b. Civil Engineering High Bay Lab
20. Student Success Center (under construction)
21. Carnegie Building
22. Administration Building
23. A. French Building
24. Holland Heating and Air Conditioning Plant
25. Army ROTC
26. L.W. Chapin Building
27. Savant Building
28. Swann Building
29. Guggenheim Aeronautics Building
30. Knight Aerospace Engineering Building
31. Engineering Science and Mechanics Building
32. Weber Space Science and Technology Building
33. Mechanical Engineering Research Building
34. Coon Mechanical Engineering Building
35. Skiles Classroom Building
36. D.M. Smith Building
37. Gilbert Memorial Library and Information Center
38. Old Civil Engineering Building
39. Navy ROTC
40. Alpha Epsilon Pi
41. Field Residence Hall
42. Hopkins Residence Hall
43. Hanson Residence Hall
44. Perry Residence Hall
45. Matheson Residence Hall
46. Presbyterian Center
47. Baptist Student Union
48. Alpha Delta Pi
49. Alpha Kappa Alpha
50. Zeta Tau Alpha
51. Catholic Center
52. Peters Parking Deck
53. Beta Theta Pi
54. Sigma Nu
55. Phi Delta Theta
56. Chi Phi
57. Hinman Research Building
58. Rich Building (Computing Services)
59. Hightower Textile Engineering Building
60. Houston Bookstore
61. Wenn Student Center
62. Student Services Building
63. Student Theater
64. Bogg Chemistry and Biochemistry Building
65. Bunger-Henry Chemical Engineering and Ceramic Engineering Building
66. Van Leer Electrical Engineering Building
67. College of Architecture
68. Delta Tau Delta
69. Sigma Alpha Epsilon
70. Alpha Tau Omega
71. Wesley Foundation (Methodist)
72. Phi Kappa Tau
73. Delta Sigma Phi
74. Sigma Chi
75. Theta Xi
76. Phi Kappa Sigma
77. Kappa Alpha
78. Lambda Chi Alpha
79. Delta Upsilon
80. Alpha Xi Delta
81. Delta Sigma Theta
82. Lutheran Center
83. Sigma Phi Epsilon
84. Navy Reserves Center
85. Joseph M. Pettit Building (MiRC)
86. College of Computing
87. Emerson (Cherry) Building
88. Whitehead Memorial Infirmary
89. Rose Bowl Field
90. Alpha Chi Omega
91. Tau Kappa Epsilon
92. Phi Sigma Kappa
93. Pi Kappa Phi
94. Theta Chi
95. Phi Gamma Delta
96. Kappa Sigma
97. Zeta Beta Tau
98. O'Keefe Building
99. Coliseum Annex
100. James K. Luck, Jr., Building
101. Personnel Building
102. Alexander Memorial Coliseum
103. Bill Moore Tennis Complex
104. Tennis Center
105. Griffin Track
106. Aerospace Fluid Mechanics Laboratory
107. Landscaping Services Building
108. Civil Engineering Laboratory
109. GTRI Research Area 2
110. King Plant Operations Building
111. President's Home
112. Chi Psi
113. Pi Kappa Alpha
114. Callaway Apartments
115. Healey Apartments
116. Psi Upsilon
117. Phi Kappa Theta
118. Neely Nuclear Research Center
119. Electronics Research Building (GTRI)
120. Howey Physics Building
121. Mason Civil Engineering Building
122. Baker Building (GTRI)
123. Centennial Research Building (GTRI, GTRC)
124. Advanced Technology Development Center
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127. DramaTech Theater
128. Environmental Safety Building
129. Main Electric Substation
130. Purchasing/Central Receiving Building
131. WREK Signal Tower
132. Groseclose Industrial and Systems Engineering Building
133. Instructional Center
134. Ivan Allen College of Management, Policy, and International Affairs
135. Callaway Student Athletic Complex
136. SAC Recreation Fields
137. Burger Bowl Field
138. Freeman Residence Hall
139. Montag Residence Hall
140. Fitten Residence Hall
141. Fulmer Residence Hall
142. Commander Commons Building
143. Armstrong Residence Hall
144. Hefner Residence Hall
145. Couch Building
146. Caldwell Residence Hall
147. Folk Residence Hall
148. George and Irene Woodruff Residence Hall/ Dining Hall
149. Alpha Gamma Delta
150. Outdoor Recreation at Georgia Tech (ORGT) Building
151. Southern Regional Education Board
152. Alpha Phi Alpha
153. Institute of Paper Science Technology (IPST)
154. Center for Rehabilitation Technology
155. Manufacturing Research Center (MRC)
156. Outdoor Pool
157. Athletic Association (AA), Field House
158. Clydeck
159. O'Keefe South Wing
160. O'Keefe Gym
161. POD Custodial Services
162. Graduate Living Center (under construction)
163. Plant Operations Storage
164. Undergraduate Residence Hall (under construction)
165. Phi Mu
166. Fiber Optic Network Building
167. Georgia Tech Water Sports

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