1999

Clemson Graduate School Catalog, 1999-2000

Clemson University

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PURPOSE OF CATALOG

The purpose of this catalog is to provide students with a general description of Clemson University and give detailed information regarding the various colleges and departments within the University and curricula offered by the University. Inasmuch as the educational process necessitates change, the information and educational requirements in this catalog represent a flexible program which may be altered where such alterations are thought to be in the mutual interest of the University and its students.

The provisions of this catalog do not constitute any offer for a contract which may be accepted by students through registration and enrollment in the University. The University reserves the right to change without notice any fee, provision, offering or requirement in this catalog and to determine whether a student has satisfactorily met its requirements for admission or graduation. The University further reserves the right to require a student to withdraw from the University for cause at any time.

Each curriculum (Form GS2) shall be governed by the requirements in effect on the date of enrollment. If a student withdraws from the University and subsequently returns or does not remain continuously enrolled (summers excluded), the requirements in effect at the time of return will govern.

ORGANIZATION OF THIS PUBLICATION

The first 46 pages of the Graduate School Announcements describe the University, its academic and administrative officers, its fees and services and the Graduate School policies and procedures.

Beginning on page 47 are the graduate programs and courses offered under the colleges of Agriculture, Forestry and Life Sciences; Architecture, Arts and Humanities; Business and Public Affairs; Engineering and Science; Health Education and Human Development; and Graduate Interdisciplinary Programs.

STUDENT RESPONSIBILITY

All colleges and departments establish certain academic requirements that must be met before a degree is granted. Advisors, department heads and deans are available to help the student understand and arrange to meet these requirements, but the student is responsible for fulfilling them. If, at the end of a student's course of study, the requirements for graduation have not been satisfied, the degree will not be granted. For this reason, it is important for each student to acquaint himself or herself with all academic requirements throughout his or her graduate career and to be responsible for completing all such requirements within prescribed deadlines and time limits. Students registering at Clemson University accept and agree to abide by all published policies and regulations, including those which appear in this document, those published in any official University publication such as the Student Handbook and the Undergraduate Announcements, and those published on any official University Web site. Unless specifically noted otherwise, all policies and regulations apply equally to graduate students and undergraduate students.

EQUAL OPPORTUNITY IN PROGRAMS AND ACTIVITIES

Federal laws prohibit discrimination by programs and activities receiving federal financial assistance. The statutes listed below are applicable to Clemson University.

TITLE VI OF THE CIVIL RIGHTS ACT OF 1964

"No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."

TITLE IX OF THE EDUCATION AMENDMENTS OF 1972

"No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance."

SECTION 504 OF THE REHABILITATION ACT OF 1973

"No otherwise qualified handicapped individual in the United States shall, solely by reason of his handicap, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."

Clemson University conducts its programs and activities involving admission and treatment of students, employment, teaching, research and public service in a nondiscriminatory manner as prescribed by federal law and regulation.

Inquiries concerning the above may be addressed to:
President
Clemson University
Clemson, SC 29634-5002
or
Director
Office for Civil Rights
Department of Education
Washington, DC 20201
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<td>Late registration</td>
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<tr>
<td>August 17, Tu</td>
<td>Convocation</td>
</tr>
<tr>
<td>August 18, W</td>
<td>Classes begin; late enrollment fee applies</td>
</tr>
<tr>
<td>August 24, Tu</td>
<td>Last day to register or add a class</td>
</tr>
<tr>
<td>August 31, Tu</td>
<td>Last day to drop a class or withdraw from the University without a W grade</td>
</tr>
<tr>
<td>September 7, Tu</td>
<td>Last day to order diploma for December graduation</td>
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<td>October 8, F</td>
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<tr>
<td>October 18-19, M-Tu</td>
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</tr>
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<td>January 18, Tu</td>
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<tr>
<td>January 25, Tu</td>
<td>Last day to drop a class or withdraw from the University without a W grade</td>
</tr>
<tr>
<td>February 1, Tu</td>
<td>Last day to order diploma for May commencement</td>
</tr>
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<td>March 3, F</td>
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<tr>
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<td>Examinations</td>
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<tr>
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</tr>
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<td>May 12, F</td>
<td>Commencement</td>
</tr>
<tr>
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</tr>
<tr>
<td>May 12, F</td>
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<td>May 23, T</td>
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</tr>
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<td>Classes begin; late enrollment fee applies</td>
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<td>May 24, W</td>
<td>Last day to register or add a class</td>
</tr>
<tr>
<td>May 26, F</td>
<td>Last day to drop a class or withdraw from the University without a W grade</td>
</tr>
<tr>
<td>June 8, Th</td>
<td>Last day to drop a class or withdraw from the University without final grades</td>
</tr>
<tr>
<td>June 12, M</td>
<td>Last day to order diploma for August graduation</td>
</tr>
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<td>Last day to order diploma for August graduation</td>
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<tr>
<td>July 6, Th</td>
<td>Late registration</td>
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<tr>
<td>July 7, F</td>
<td>Classes begin; late enrollment fee applies</td>
</tr>
<tr>
<td>July 8, S</td>
<td>Last day to register or add a class</td>
</tr>
<tr>
<td>July 10, M</td>
<td>Last day to drop a class or withdraw from the University without a W grade</td>
</tr>
<tr>
<td>July 11, Tu</td>
<td>Last day to order diploma for December graduation</td>
</tr>
<tr>
<td>July 15, S</td>
<td>Last day to drop a class or withdraw from the University without final grades</td>
</tr>
<tr>
<td>July 21, F</td>
<td>Examinations</td>
</tr>
<tr>
<td>August 9, W</td>
<td>Candidates may access grades via telephone IVR, internet (CLEMWEB), or PC with modem</td>
</tr>
<tr>
<td>August 11, F</td>
<td>Graduation</td>
</tr>
<tr>
<td>August 12, S</td>
<td></td>
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### FALL SEMESTER 2000

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<td>Orientation</td>
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<tr>
<td>August 21-22, M-Tu</td>
<td>Late registration</td>
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<tr>
<td>August 22, Tu</td>
<td>Convocation</td>
</tr>
<tr>
<td>August 23, W</td>
<td>Classes begin; late enrollment fee applies</td>
</tr>
<tr>
<td>August 29, Tu</td>
<td>Last day to register or add a class</td>
</tr>
<tr>
<td>September 5, T</td>
<td>Last day to drop a class or withdraw from the University without a W grade</td>
</tr>
<tr>
<td>September 12, Tu</td>
<td>Last day to order diploma for December graduation</td>
</tr>
<tr>
<td>November 6-7, M-Tu</td>
<td>Fall break</td>
</tr>
<tr>
<td>November 8, W</td>
<td>Last day to drop a class or withdraw from the University without final grades</td>
</tr>
<tr>
<td>November 22-24, W-F</td>
<td>Thanksgiving holidays (Wednesday Nov. 22 is a tentative holiday)</td>
</tr>
<tr>
<td>December 7-8, Th-F</td>
<td>Classes meet; exams permitted in labs only</td>
</tr>
<tr>
<td>December 11-16, M-S</td>
<td>Examinations</td>
</tr>
<tr>
<td>December 20, W</td>
<td>Candidates may access grades via telephone IVR, internet (CLEMWEB), or PC with modem</td>
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<tr>
<td>December 21, Th</td>
<td>Graduation</td>
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<tr>
<th>Date</th>
<th>Event</th>
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<tr>
<td>January 7-8, Su-M</td>
<td>Orientation</td>
</tr>
<tr>
<td>January 8-9, M-Tu</td>
<td>Late registration</td>
</tr>
<tr>
<td>January 10, W</td>
<td>Classes begin; late enrollment fee applies</td>
</tr>
<tr>
<td>January 16, Tu</td>
<td>Last day to register or add a class</td>
</tr>
<tr>
<td>January 23, Tu</td>
<td>Last day to drop a class or withdraw from the University without a W grade</td>
</tr>
<tr>
<td>January 30, Tu</td>
<td>Last day to order diploma for May commencement</td>
</tr>
<tr>
<td>March 2, F</td>
<td>Last day to drop a class or withdraw from the University without final grades</td>
</tr>
<tr>
<td>March 19-23, M-F</td>
<td>Spring break</td>
</tr>
<tr>
<td>April 2, M</td>
<td>Registration for Fall Semester begins</td>
</tr>
<tr>
<td>April 7-14, S-S</td>
<td>Honors and Awards Week</td>
</tr>
<tr>
<td>April 26-27, Th-F</td>
<td>Classes meet; exams permitted in labs only</td>
</tr>
<tr>
<td>April 30-May 5, M-S</td>
<td>Examinations</td>
</tr>
<tr>
<td>May 10, Th</td>
<td>Candidates may access grades via telephone IVR, internet (CLEMWEB), or PC with modem</td>
</tr>
<tr>
<td>May 11, F</td>
<td>Commencement</td>
</tr>
<tr>
<td>May 11, F</td>
<td>9:30 a.m. (Colleges AF&amp;LS, AA&amp;H and E&amp;S)</td>
</tr>
<tr>
<td>May 11, F</td>
<td>2:30 p.m. (Colleges B&amp;PA and HE&amp;HD)</td>
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Note: Dates on this calendar were accurate at the time of printing; however, they may change as conditions warrant.
### DEADLINE DATES

<table>
<thead>
<tr>
<th>Last day for:</th>
<th>For those who expect to receive a graduate degree on:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submitting Form GS2, Graduate Degree Curriculum, to the Graduate School.</td>
<td>August 7, 1999</td>
</tr>
<tr>
<td>Submitting Form GS4, Application for Graduation and Diploma Order, to the Graduate School.</td>
<td>September 7, 1999</td>
</tr>
<tr>
<td>Ordering cap, gown and hood from the University Bookstore.</td>
<td>October 16, 1999</td>
</tr>
<tr>
<td>Submitting thesis/dissertation for format and content review by the thesis/dissertation committee. (Draft should contain all required sections even though content changes can still be requested by committee members.)</td>
<td>November 3, 1999</td>
</tr>
<tr>
<td>Taking of oral and/or written examination (GS7).</td>
<td>November 24, 1999</td>
</tr>
<tr>
<td>Final review and approval by the Graduate School of completed and signed theses and dissertations.</td>
<td>December 3, 1999</td>
</tr>
<tr>
<td>Submission of duplicated copies of theses and dissertations to the Graduate School and date at top of Approval Page.</td>
<td>December 10, 1999</td>
</tr>
</tbody>
</table>

* Although Form GS2 is accepted through the deadline dates listed, students are encouraged to submit this form within the time frame suggested under “Filing of a Graduate Degree Curriculum” in the Graduate School Announcements. The filing dates are deadlines for forms carrying all required signatures to be in the Graduate School Office.

† Form GS4 must be turned in for every semester student intends to graduate. A $25 late fee will be assessed to a student whose form is submitted the day after the deadline, and increases at the rate of $5 per day thereafter (excluding Saturday, Sunday or University holidays). Payment of fees must be made directly to the Bursar’s Office and the forms GS2 and GS4 submitted to the Graduate School Office.

Note: Dates on this calendar were accurate at the time of printing. Dates, however, may change as conditions warrant.

### CHECKLIST ON GRADUATE SCHOOL PROCEDURES

- The graduate student should carefully note this checklist as well as the above deadline dates.
- Select (in consultation with the appropriate department head) a major advisor and advisory committee (see page 26, 27).
- Submit Graduate Degree Curriculum (Form GS2) (see page 27).
- Submit completed thesis (if required) or dissertation to research advisor and arrange for final examination by the advisory committee (see pages 31-33).
- Complete final examination (Form GS7) (see page 33).
- Apply for admission to candidacy for a doctoral degree (Form GS5) (see page 27).
- Apply for admission to candidacy for a doctoral degree (Form GS5) (see page 27).
- Order cap, gown and hood from the University Bookstore.
- Pay binding fee to the bursar and submit approved copies of thesis or dissertation to the Graduate School. Doctoral candidates pay for abstract publication in Dissertation Abstracts International and microfilming of dissertation (see page 33).

The final responsibility for following Graduate School procedures rests with the graduate student. Special problems should be referred to the graduate deans.
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### COLLEGE OF HEALTH, EDUCATION AND HUMAN DEVELOPMENT

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(i) = interdisciplinary program
1 = GRE
2 = GMAT
3 = MAT
HISTORY OF CLEMSON UNIVERSITY

When one man of wisdom and foresight can look among the despair of troubled times and imagine what could be, great things can happen. That is what the University's founder, Thomas Green Clemson, was able to do in the post-Civil War days. He looked upon a South that lay in economic ruin, once remarking that "conditions are wretched in the extreme" and that "people are quitting the land." Still, among the ashes he saw hope. Mr. Clemson envisioned what could be possible if the South's youth were given an opportunity to receive instruction in scientific agriculture and the mechanical arts. He once wrote, "The only hope we have for the advancement of agriculture (in the U.S.) is through the sciences, and yet there is not one single institution on this continent where a proper scientific education can be obtained." When he was president of the Pendleton Farmers Society in 1866, Mr. Clemson served on a committee whose purpose was to promote the idea of founding an institution for "educating the people in the sciences."

When he died on April 6, 1888, a series of events began that marked the start of a new era in higher education in the state of South Carolina, especially in the study of science, agriculture and engineering. Mr. Clemson's passing set the stage for the founding of the university that bears his name - the beginning of a true "people's university," which opened the doors of higher education to all South Carolinians, rich and poor alike. In his will, Mr. Clemson bequeathed the Fort Hill plantation and a considerable sum from his personal assets for the establishment of an educational institution of the kind he envisioned. He left a cash endowment of approximately $80,000 as well as the 814-acre Fort Hill estate to South Carolina for such a college. The biggest obstacle in the creation of an agricultural college - the initial expense - was removed by Mr. Clemson's bequest.

In November 1889, Governor Richardson signed the bill accepting Thomas Clemson's gift. Soon after, a measure was introduced to establish the Clemson Agricultural College with its trustees becoming custodians of Morrill Act and Hatch Act funds made available for agricultural education and research by federal legislative acts. The founding of Clemson Agricultural College supplanted the South Carolina College of Agriculture and Mechanics, which had opened in Columbia in 1880.

Today, more than a century later, the University is much more than its founder ever could have imagined. With its diverse learning and research facilities, the University provides an educational opportunity not only for the people of the state, as Mr. Clemson dreamed, but for thousands of young men and women throughout the country and the world.

Thomas Green Clemson came to the foothills of South Carolina when he married Anna Maria Calhoun, daughter of South Carolina's famous statesman John C. Calhoun.

Born in Philadelphia, Mr. Clemson was educated at schools both in the United States and France, where he attended lectures at the Royal School of Mines, studied with prominent scientists in the private laboratories of the Sorbonne Royal College of France, and received his diploma as an assay from the Royal Mint in Paris. Mr. Clemson, then in his mid-20s, returned to America greatly influenced by his European studies. He became a great advocate of the natural sciences, achieving a considerable reputation as a mining engineer and a theorist in agricultural chemistry. He was also a gifted writer whose articles were published in the leading scientific journals of his day, an artist and a diplomat who represented the U.S. government as chargé d'affaires to Belgium for almost seven years.

Mr. Clemson had a lifelong interest in farming and agricultural affairs. He served as the nation's first superintendent of agricultural affairs (predecessor to the present secretary of agriculture position) and actively promoted the establishment and endowment of the Maryland Agricultural College in the 1850s. Though remembered today for these accomplishments, Thomas Clemson made his greatest historical contribution when, as a champion of formal scientific education, his life became intertwined with the destiny of educational and economic development in South Carolina. Although he never lived to see it, his dedicated efforts culminated in the founding of Clemson Agricultural College.

At the time of his death, Mr. Clemson was living at the Fort Hill homepage, which today is a national historic landmark and provides a historic centerpiece for the Clemson University campus. He had inherited the house and plantation lands of his famous father-in-law, Senator Calhoun, upon the death of Mrs. Clemson in 1875.

Clemson College formally opened in July 1893 with an enrollment of 446. From the beginning, the college was an all-male military school. It remained this way until 1935, when the change was made to "civilian" status for students, and Clemson became a coeducational institution. In 1964, the college was renamed Clemson University as the state Legislature formally recognized the school's expanded graduate offerings and research pursuits.

The enrollment of Clemson has grown from 446 students at the opening of the University to 16,685 for the first semester 1998-99. In addition to students from virtually every state, Clemson has approximately 740 enrolled students from 73 nations. Since the opening of the University, 77,750 students have been awarded bachelor's degrees. During this same period 23,400 graduate degrees have been awarded.

Clemson currently offers 115 graduate degree programs in 74 fields of study. Included in this total are 41 doctoral and 73 master's and one educational specialist programs.

THE CAMPUS

The 1,400-acre University campus is sited on the former homestead of statesman John C. Calhoun. Nestled in the foothills of the Blue Ridge Mountains and adjacent to Lake Hartwell, the campus commands an excellent view of the mountains to the north and west, some of which attain an altitude of over 5,000 feet above mean sea level.

The Norfolk and Southern Railway and U.S. Highways 76 and 123 provide easy access to the City of Clemson and to the University. G twee County Airport is four miles from the library. Both Atlanta, Ga., and Charlotte, N.C., are two hours' driving time away.

Campus architecture is a pleasing blend of traditional and modern facilities enhanced by a beautiful landscape of towering trees, grassy expanses and flowering plants. Academic, administrative and student service buildings on campus represent an insured value of $627 million. Clemson University's real estate holdings include over 32,000 acres of forestry and agricultural lands throughout the state, the majority of which are dedicated to Clemson's research and public-service missions.

Fort Hill, the former home of John C. Calhoun inherited by Thomas Clemson, and the Hanover House are listed on the
National Register of Historic Places and are open to the public. The campus also has two recognized Historic Districts.

The Strom Thurmond Institute houses the institute offices, Senator Thurmond’s papers and memorabilia, and the special collections of the Cooper Library. The institute is a part of an instructional and public-service district that includes the Brooks Center for the Performing Arts and the Madren Center for Continuing Education.

MISSION STATEMENT
The mission of Clemson University is to fulfill the covenant between its founder and the people of South Carolina to establish a “high seminary of learning” through its land-grant responsibilities of teaching, research and extended public service.

Clemson offers a broad array of high quality baccalaureate programs built around a distinctive core curriculum. Graduate and continuing education offerings respond to the professions, while doctoral and research programs reflect land-grant traditions and contribute to the economic future of the state and nation.

Public service extends educational programs and research findings to all citizens through personal consultation, information technology, educational and research centers, and Extension offices.

GUIDING PRINCIPLES
Clemson University is a public, selective land-grant university in a rural setting committed to high quality teaching, internationally significant research and extended public service in the context of general education, student development, public service, research and continuing education. Clemson’s desire is to attract a capable, dedicated and diverse student body of approximately 12,000 to 14,000 undergraduate and 4,000 to 5,000 graduate students from throughout the state and nation, with priority to students from South Carolina.

The University offers a wide variety of undergraduate and graduate degrees, with emphases in the areas of agriculture, engineering, natural resources, science and technology, architecture, business and education. The University also provides a strong fundamental education in the creative arts, health, human development, the humanities and social sciences to all students with the goal of developing their communication and critical-thinking skills, ethical judgment, global awareness, and scientific and technological knowledge.

Just as Clemson values its students, the University also values the men and women of its faculty and staff who have committed their talents and careers to its enduring mission as a land-grant university. Clemson pledges to support their work, to evaluate their professional performance, to compensate them at nationally competitive levels, and to encourage their professional development.

ACCREDITATION
Clemson University is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools to award the bachelor’s, master’s, specialist and doctor’s degrees. Curricula are accredited by Accreditation Board for Engineering and Technology, AACSB - The International Association for Management Education, Computing Sciences Accreditation Board, Council on Accreditations of the National Recreation and Park Association, Landscape Architecture Accreditation Board, National Architectural Accrediting Board, National Association of State Directors of Teacher Education and Certification, National Council for Accreditation of Teacher Education, National League for Nursing, Planning Accrediting Board and Society of American Foresters. Documentation of accreditation is available in the college deans’ offices.

UNIVERSITY GOVERNANCE AND ADMINISTRATION
The University is governed by a board of 13 members, six selected by the State Legislature and seven self-perpetuating life members, in accord with the will of Thomas G. Clemson. The Board of Trustees is primarily responsible for adopting the basic long-range objectives of the University and the basic policies for achieving them; providing policy instruction for long-range planning; adopting the statutes of the University; electing the president of the University; employing the secretary of the board; maintaining ownership of University assets; and overseeing the evaluation of the University.

The president is the chief executive officer of the University, providing leadership to all phases of University planning; coordinating the operations of all units of the University; carrying out major University public relations functions; evaluating the results of University plans; and appointing personnel who report to the president. The day-to-day operations of the University are administered by the president and executive officers for advancement, public service and agriculture, and student affairs.

The provost and vice president for academic affairs is the chief academic officer of the University. The provost is responsible directly to the president for all academic matters and has administrative jurisdiction over teaching and computing services. Vice provosts assist in administering and performing duties in coordinating graduate and undergraduate curricula; supervising computer information services, the libraries, scholarship and award programs; and other duties assigned by the provost.

Academic deans are the chief administrative officers of their individual colleges and report directly to the provost. They provide leadership in formulating and carrying out educational policy, review and make recommendations on personnel matters, and carry out and administer the academic and financial affairs of their colleges.

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Harold E. Cheatham, PhD, Dean, College of Health, Education and Human Development

ENROLLMENT OPPORTUNITIES

On-Campus Enrollment
Total enrollment for the fall semester of 1998 was 16,685. Of this number, 3,632 were graduate students. Approximately 1,758 were classified as full-time graduate students and 1,874 as part-time students. The number of male graduate students was 1,736, and 1,896 were female students. Most degree programs offered by the University are available on campus.

Off-Campus Enrollment
By virtue of its land-grant mission and at the direction of the state Legislature and/or the South Carolina Commission on Higher Education, Clemson University serves the entire state in certain academic disciplines such as agriculture, architecture, industrial education and others. Courses in these disciplines are offered at various off-campus locations across the state. In addition, the University serves South Carolina by offering some master's degree programs at evening off-campus centers.

- Master of Business Administration
  - Greenville and Greenwood
- Master of Education (various majors)
  - Greenville and Greenwood
- Master of Engineering (Civil Engineering)
  - Charleston
- Master of Health Administration
  - Greenville
- Master of Human Resource Development
  - Greenville
- Master of Professional Accountancy
  - Greenville
- Master of Public Administration
  - (with USC)
  - Greenville
- Master of Science in Nursing
  - Greenville
- Specialist in Education (Educational Administration)
  - Greenville

For further details, please refer to the individual college or department descriptions.

TELECAMPUSS
The University Telecampus program coordinates the development and delivery of graduate-credit courses through electronic media. This service is provided to increase the educational opportunities of adults who want professional development or continuing education courses but cannot attend classes on the main campus on a regular basis or during hours that conflict with work schedules. Through a digital satellite television network of South Carolina ETV, classes are broadcast live from the Clemson campus to viewing sites in Aiken, Beaufort, Charleston, Columbia, Florence, Greenville, Greenwood, Orangeburg and Rock Hill. A two-way audio linkage via telephone is provided so that students at remote sites may interact with the instructor and students in the Clemson classroom studio.

Information on courses and registration is available at the Telecampus Office, 346 Sarra Hult, Clemson, SC 29634-3121; or by calling 1-888-CLEMSON (1-888-252-6661) or email at telecampus_L@clemson.edu.

INTERNATIONAL ENROLLMENT
All Clemson University students are encouraged to participate in opportunities to enroll in courses designed to expand their knowledge and understanding of world affairs. The opportunity to study abroad, while essentially a composite of the undergraduate curriculum, is encouraged in many graduate programs. Graduate students in architecture, for example, spend a semester in Genoa, Italy, at the Clemson University Charles E. Daniel Center for Building Research and Urban Studies. Students in the Master of Business Administration program can study full time or part time in Asolo, Italy, or may take courses in Ljubljana, Slovenia. For more information on international enrollment opportunities, please contact your department chair or program coordinator.

ACADEMIC COMMON MARKET
The state of South Carolina, through its membership in the Southern Regional Education Board (SREB), authorizes its public universities to participate in the Academic Common Market (ACM). Under this program, students who are not residents of South Carolina can enroll in selected graduate programs at Clemson University and pay academic fees appropriate for South Carolina residents provided all of the following conditions are met:

The student’s state of legal residence is AK, AL, DE, FL, GA, KY, LA, MD, MS, OK, TN, TX, VA or WV. The desired program of study is: the Ph.D. program in industrial/organizational psychology, parks recreation and tourism management; the M.S. or Ph.D. program in engineering mechanics; the M.A. program in professional communication; the M.S. program in industrial psychology, applied sociology, architecture, textile science, bioengineering or textile chemistry; the master’s program in construction science and management (MCSM) or, the professional master’s program in parks, recreation and tourism management (PRTM). The Coordinating Board in the state of the student’s legal residence has selected one of the above programs for its residents.

Programs offered by Clemson University are subject to change without advanced notice. However, students who are enrolled in a program under the ACM provisions prior to its removal by Clemson University are entitled to continue and receive benefits provided they are continuously enrolled (summers excepted) and remain in good academic standing. The Graduate School should be consulted about any and all matters related to the ACM. The state coordinator for the Academic Common Market in South Carolina is the Commission on Higher Education.

UNIVERSITY VISITORS CENTER
The Clemson University Visitors Center, located at 111 Daniel Drive, adjacent to the Alumni Center, offers tours to all prospective students and their families. The center also provides information about academic programs and all areas of student life. Hours of operation are Monday - Friday from 8:00 a.m. to 4:30 p.m.; Saturday from 9:00 a.m. to 4:30 p.m.; and Sunday from 1:00 to 4:30 p.m. The Visitors Center
GRADUATE STUDY

Graduate study is much more than a continuation of undergraduate work. Its true spirit is one of inquiry and the desire to add to human knowledge. Graduate study therefore should be contemplated only by students who have already demonstrated in their undergraduate programs unusual intellectual attainments and the power of independent thought and investigation.

A great university is distinguished by the quality and dedication of its faculty, the excellence of its graduates and the pursuit of new knowledge through research and scholarship. Graduate education is a necessary and essential component of a research university. The unique nature of graduate education is its contribution to new knowledge through research and the integration of that knowledge through education and public service grounded in research. The presence of rigorous graduate programs enhances the quality of instruction available to all students.

THE GRADUATE SCHOOL

The purpose of the Graduate School is to promote superior research and scholarship and provide the highest levels of education and training for students who may pursue careers in academia, government, the non-profit sector, business and industry. The mandate of the Graduate School is to assist departments in recruiting and supporting outstanding students who will be capable of continual inquiry into fundamental questions in their fields and who can communicate clearly their findings through research, scholarship, teaching and service.

The Graduate School coordinates University-wide efforts in graduate education and is responsible for policies and standards governing graduate education. Clemson University's Graduate School administers all graduate programs of the University. Clemson University offers 41 doctoral, 73 master's and one educational specialist degree across 74 fields of study. The Graduate School oversees University fellowships and assistantships for graduate students.

Seven goals guide the day to day operations of the Graduate School. These are to:

• serve as a mediator for the graduate community;
• establish and promote a scholarly environment at all levels of inquiry;
• facilitate graduate program development and assist and coordinate interdisciplinary programs;
• develop and increase sources of financial support for graduate students; and
• advocate and promote the well being of graduate education.

Administrative Mission

It is the administrative mission of the Graduate School to serve the unique needs of the students, faculty, staff and the general public. Through efficient systems the Graduate School encourages success by providing accurate information in a friendly and supportive environment. The Graduate School upholds quality, academic and professional standards and provides guidance to facilitate the accomplishment of Clemson University's broader mission of teaching, research and public service.

The Graduate School unifies administrative procedures concerning all graduate work at Clemson University. This includes graduate admission policies, preparation and publication of theses and dissertations, graduate matriculation policies, fellowship and assistantship awards and the granting of degrees.

The Graduate School is the home of the Office of International Services and Diversity Programs (formerly the Office of International Programs and Services), and thus provides administrative support to facilitate international program development, international student enrollment (both graduate and undergraduate), study abroad and cultural diversity.

Seven Graduate School units support these functions: Administration, Graduate Admissions, Enrolled Student Services, Publications and Marketing, Graduate Fellowships and Assistantships, International Services and Study Abroad.

Academic Mission

The academic mission of the Graduate School is to foster excellence in scholarship and research and to ensure the highest quality and diversity of graduate education in keeping with the land-grant mission of teaching, research and public service.

University Graduate Council

University faculty provide direction for the Graduate School through the Graduate Council. The council provides oversight for policy and procedural implementation related to graduate education; receives, stimulates and originates proposals for the development of graduate education; reviews, considers and disseminates recommendations from its constituent committees; and approves and forwards recommendations to the Academic Council. The Graduate Council has five committees: Graduate Advisory; Graduate Curriculum; Admission and Continuing Enrollment; Fellowship and Awards; and Grievance.

The purpose, roles and compositions of the subcommittees are prescribed by the Faculty Manual. The Admissions and Continuing Enrollment Committee addresses concerns related to admission procedures and dismissions from graduate programs. Fellowships and Awards selects recipients for University-wide fellowships and graduate awards. The role of the Grievance Committee is outlined in detail in the section on Grievances in this document. The Graduate Curriculum Committee acts for the faculty in reviewing all proposals for curricular changes and recommends such changes to the provost. The committee is comprised of the graduate dean, as a nonvoting chairperson, and faculty elected from academic college graduate curriculum committees. The committee is guided by all applicable University rules and regulations and by the policies established by the Academic Council. The Graduate Curriculum Committee meetings are open to graduate students and faculty.

Graduate School Administration

Administration

Dr. Y.T. Shah, Chief Research Officer and Senior Vice Provost for Graduate Studies
Dr. Bonnie Holday, Dean of the Graduate School and Associate Vice Provost for Research
Dr. Frankie Felder, Associate Dean, International, Diversity and Enrolled Graduate Student Affairs
Dr. Mark McKnew, Associate Dean, Graduate Recruitment, Admissions and Residency

Michele Kelly, Administrative Assistant

Graduate Fellowships and Assistantships

Brenda J. Goodman
Sandra Witt

Graduate Admissions

Kaye Rackley
Jerry Courtney
Jan McCracken
Ann Willimon
Shirley Grimes
Betty James
edge to solve the problems of mankind, Clemson University is ranked among the top 25 universities in the United States in terms of revenue from patents and licenses. Ongoing research initiatives throughout the University are critical to maintaining America's competitiveness in a global marketplace and keeping our industries on the leading edge of progress. The Sponsored Programs Office coordinates these activities:

- sponsored research;
- educational services;
- public service proposals to outside agencies;
- patent disclosures, applications and negotiations of licensing agreements;
- facility security clearance.

Information and assistance are available on applications for research support from federal and state agencies, industrial organizations, foundations and institutes, as well as fellowships of interest to the faculty.

The chief research officer and senior vice provost for research and graduate studies oversees all aspects of campus research, providing advice on University research activities and administrative support for the internal funding of annual faculty research grants and awards.

**Oak Ridge Associated Universities**

Since 1952, students and faculty of Clemson University have benefited from its membership in Oak Ridge Associated Universities (ORAU). ORAU is a consortium of 87 colleges and universities and contractor for the U.S. Department of Energy (DOE) located in Oak Ridge, Tenn. ORAU works with its member institutions to help their students and faculty gain access to federal research facilities throughout the country; to keep its members informed about opportunities for fellowship, scholarship and research appointments; and to organize research alliances among its members.

Through the Oak Ridge Institute for Science and Education, the DOE facility that ORAU operates, undergraduates, graduates, postgraduates, as well as faculty enjoy access to a multitude of opportunities for study and research. Students can participate in programs covering a wide variety of disciplines, including business, earth sciences, epidemiology, engineering, physics, geological sciences, pharmacology, ocean sciences, biomedical sciences, nuclear chemistry and mathematics. Appointment and program length range from one month to four years. Many of these programs are especially designed to increase the numbers of underrepresented minority students pursuing degrees in science- and engineering-related disciplines.

A comprehensive listing of these programs and other opportunities, their disciplines, and details on locations and benefits can be found in the Resource Guide which is available at [http://www.orau.gov/oris/resgd.htm](http://www.orau.gov/oris/resgd.htm).

ORAU's Office of Partnership Development seeks opportunities for partnerships and alliances among ORAU's members, private industry and major federal facilities. Activities include faculty development programs, such as the Ralph E. Powe Jr. Faculty Enhancement Awards, the Visiting Industrial Scientist Program and various services to chief research officers. Additional information is available on ORAU's homepage([http://www.orau.gov](http://www.orau.gov)).

**South Carolina Agriculture and Forestry Research System**

Since 1886, researchers at the South Carolina Agriculture and Forestry Research System (SCAFRS) have been addressing the problems of agriculture, agribusiness, and the physical and social environment. In addition to the major activities of the SCAFRS on the Clemson University campus, research facilities are located in Blackville, Florence, Charleston, Columbia and Georgetown.

The mission of the SCAFRS is to develop knowledge through research that will provide information South Carolina citizens need to make intelligent decisions on matters concerning agriculture, forestry, natural resources and the environment. Scientists cooperate with researchers in other states and throughout the world to create a better standard of living for South Carolinians by enhancing the use of natural resources. Over the years, scientists have worked in food development and improvement, farming techniques and packaging of biological materials. They continue to work in the new scientific areas of genetic engineering and computer information.

The SCAFRS has an annual budget of more than $32 million, which supports the efforts of more than 145 research faculty and more than 230 support personnel. Graduate students use SCAFRS facilities in their research and educational programs.

**Research Centers and Institutes**

Clemson University operates several institutes and centers dedicated to teaching and research in specific disciplines. These centers typically encourage faculty from several academic departments to bring their research skills to bear on multi-disciplinary problems and issues. Three such programs are highlighted below.
THE ROBERT H. BROOKS RESEARCH INSTITUTE FOR SPORTS SCIENCE

Founded in 1994 through a $2.5 million pledge from alumnus Robert H. Brooks, the Brooks Research Institute exists to support interdisciplinary teaching, research and student learning opportunities in the thriving sports, recreation and leisure industries. What makes the Brooks Institute distinctive is its focus on the study of sports from a technological, managerial and cultural perspective as opposed to the physiological and psychological aspects of individual sports participation.

The institute was established in memory of four members of Brooks’ organization who were killed in an airplane crash en route to a NASCAR race in 1993 — including Brooks’ son, Mark, and team driver, Alan Kulwicki. The gift established endowments that, when fully funded, will support:

- The Brooks Research Institute operating fund;
- A motorsports program operating fund;
- The Mark Brooks Professorship of Sports Management;
- The Alan Kulwicki Professorship of Motorsports Engineering;
- The Dan Duncan Professorship of Sports Marketing;
- The Charlie Campbell Professorship of Sports Communication.

The goals of the institute are to:

- Support an interdisciplinary focus on sports science that incorporates the broad areas of engineering and science, business and marketing, arts and communication, health and rehabilitation, and humanities and social science.
- Facilitate faculty work in cross-disciplinary teams.
- Provide sports-related academic courses, hands-on research opportunities, cooperative education and internship opportunities for undergraduate and graduate students.
- Promote career opportunities for Clemson graduates in the sports industry.

In its brief history, the Brooks Research Institute has led to:

- Development of the nation’s first motorsports engineering academic program, which provides research and testing for race teams, suppliers, raceway sponsors and sports-related businesses, as well as educational opportunities for students.
- A two-year partnership with Ford that provided $600,000 for internships and student projects with NASCAR Winston Cup teams. The program has also initiated partnerships with BMW and DaimlerChrysler.
- An agreement with the National Hot Rod Association to develop a broad range of cooperative programs including internships and cooperative education opportunities for Clemson students, science youth outreach programs and scholarships.
- A project funded by the Clemson Athletic Department for sports marketing students to conduct attitudinal research with Clemson football fans to determine their perceptions of what the University is doing well and what it can do to better serve its audience.
- Internships for Clemson students with major area and national sports organizations.
- The establishment of the Clemson Motorsports Foundation as a subset of the Clemson University Foundation to facilitate and manage partnerships and funding agreements between Clemson and corporations interested in motorsports.

THE CLEMSON INSTITUTE OF ENVIRONMENTAL TOXICOLOGY

The Clemson Institute of Environmental Toxicology (CIET) is dedicated to excellence in research, education and public service programs in environmental toxicology and to seeking the best scientific data possible as a foundation for resolving ecological conflicts between aquatic and terrestrial wildlife resources and toxic substances released into the environment.

Research activities at CIET encompass the areas of analytical toxicology, aquatic ecotoxicology, biochemical and behavior toxicology, terrestrial ecotoxicology and ecological modeling. A strong basic research program at CIET examines how chemicals exert their toxicity and how variations lead to sensitivity or resistance in a wide array of wildlife species. Methods developed from basic research studies provide the means for assessing chemical exposure and impact in the field. Field studies, used to document the status of potentially affected wildlife, typically incorporate radiotelemetry, avian nest box monitoring, small mammal and avian censusing, water and vegetation sampling and collection of invertebrates and aquatic organisms.

The institute and department are housed in a 35,000-square-foot research facility located in Pendleton, S.C. The facility provides offices and state-of-the-art computer-controlled laboratories and specialized testing rooms. The aquatic ecotoxicology bioassay and research lab accommodates both static and flow-through bioassays with all trophic levels of aquatic plants and animals. An analytical chemistry lab facilitates metals analyses. The animal care facility has received accreditation by the American Association for the Accreditation of Laboratory Animal Care.

Equipment at the institute supports a wide variety of research. In addition to typical laboratory and system maintenance equipment, specialized equipment is also available to support gas-liquid, high performance liquid and gc/ms chromatography, atomic absorption spectrophotometry and radiation detection. Computer equipment provides support for geographic information systems (GIS) and ecological modeling and simulation.

CENTER FOR ADVANCED MANUFACTURING

Approved by the Commission on Higher Education in November of 1981 as the Engineering Center for Automated Manufacturing Technology, the Center was renamed CAM in July 1987. The objective of the Center is to advance the state of knowledge in manufacturing science and engineering.

The Center addresses this objective by conducting research in areas of factory automation, including robotic and intelligent machines; product design and manufacturing, including product realization, rapid prototyping (which includes the Laboratory to Advance Industrial Prototyping, computer-aided design and engineering, expert systems, materials and production processes); and manufacturing planning and control, including manufacturing systems.

The function of the Center is to perform basic and applied research in advanced manufacturing systems, processes and materials, which supports the needs of industrial and commercial business in South Carolina and the nation. Research and technology transfer activities through the Center have been supported by industry and government agencies. The Center is a partner with the South Carolina Manufacturing Extension Partnership (SCMEP) to support the needs of small- and medium-size industry in South Carolina and the region. Industrial participation is through Center affiliation or focused technology consortiums by grant or contract, and has included firms such as Rockwell Automation-Dodge, the Torrington Company, GE Power Generations and Michelin Tire. Government participation has been through contract from agencies such as NASA, NSF, DLA/DoD and NIST/SCMEP.

Faculty from the departments of Bioengineering, Chemical Engineering, Electrical and Computer Engineering, Industrial Engineering and Mechanical Engineering are the principal participants. Other engineering departments involved with the Center include Agricultural and Biological, Ceramics, the Materials Science and Engineering Program, and Engineering Graphics.
CLEMSON UNIVERSITY LIBRARIES

Clemson’s main library, the Robert M. Cooper Library, is located at the center of campus and provides students with a variety of services and up-to-date collections. More than 1.6 million items are available as books, periodicals, microforms, government publications and electronic materials.

Access to the Libraries’ collections is provided through the Online Libraries Catalog, a part of the Libraries’ CU Explorer system. To assist in finding journal and newspaper articles, the Libraries have provided access to a number of electronic indexes, several of them providing access to full-text journals online. CU Explorer is accessible from most computers on campus as well as through dial access. Among the regular services the Libraries offer are circulation, reference, interlibrary loan, class instruction, tours and photocopies. In addition, the Cooper Library houses two open computer laboratories. Assistance is available at the reference desk.

In addition to the Cooper Library, the University Libraries include the Emery A. Gunnin Architectural Library in Lee Hall and the Special Collections Unit located in the Strom Thurmond Institute Building. These branch libraries contain materials dealing with the special nature of their programs. A small reading room containing periodical literature related to chemistry is located in the Hunter Chemistry Laboratory. Detailed information regarding facilities, hours of operation, loan privileges, policies and fine regulations is available at the circulation and reference desks and on the Libraries’ Web site.

COMPUTING RESOURCES
Computing Facilities

The Division of Computing and Information Technology (DCIT) supports the computing activities of students, faculty and staff with an extensive network of computers. DCIT maintains and supports 13 computer labs located throughout the campus. The labs contain high-end PCs and laser printing equipment. All students have access to the Internet, electronic mail, word processing and spreadsheet applications. DCIT provides students and faculty members services through the Collaborative Learning Environment (CLE). The CLE facilitates the use of technology in teaching and research by offering a wide array of tools and resources. Access to CLE services for each course section is automatically maintained through the class enrollment system. For more information on the CLE, check the Web site at cle.clemson.edu.

An extensive array of computer hardware is housed at the Information Technology Center (ITC) in the Clemson Research Park. DCIT operates a statewide computing network incorporating processors from a variety of vendors. The major general purpose computers are an HDS Pilot 25 computer with one gigabyte of memory and 215 gigabytes of EMC storage running the OS/390 operating system and a SUN E3000 UNIX system. A host of Novell and SUN servers provide computing resources for client-server computing. Approximately 3500 PCs and workstations are connected to the campus FDDI/Ethernet network. A high performance computing environment is provided in the form of SUN E6000 with 4 gigabytes of memory, 16 336 MHz processors and 135 gigabytes of RAID disks.

Computer training is available to all faculty, students and employees as part of regular University courses, through short courses and in special training programs designed for various kinds of users. A complete list of DCIT services is available on the DCIT homepage (dcit.clemson.edu).

Collaborative Learning Environment (CLE)

The guiding mission of the Collaborative Learning Environment is to facilitate active learning and collaboration throughout the Clemson University campus. As a campus-wide initiative, the CLE’s goal is to provide technological support and service in the form of accessible networking space, computer training and state-of-the-art lab facilities.

The three core components that comprise the CLE mission are described below.

Class Workspace - The class workspace is network space that faculty and students can use to share resources, to communicate and to post/retrieve class assignments. Additionally, the CLE class workspace includes user tools to facilitate instructional and learning tasks.

Faculty and Graduate Student Training - The CLE includes a comprehensive training curriculum to introduce faculty and graduate students to alternative instructional strategies to improve the teaching/learning process. The CLE curriculum includes basic courses to familiarize faculty with the tools and services of the lab and CLE network. Multimedia and Web development courses are also available to help faculty develop discipline-specific multimedia applications.

Faculty Development and Training Labs - The CLE faculty development lab is in 131 Brackett Hall. This lab houses the necessary hardware, media and software to support faculty in their collaborative learning endeavors. A fully equipped smart classroom training lab is provided in 112 Brackett Hall, and schedules include one-to-two-hour sessions and some half-day sessions. Special seminars hosted by faculty peers are offered monthly, as well as additional seminars and workshops with guest speakers. Consulting and one-on-one help is provided through Open Sessions and Walk-in Clinics.

Policy on Misuse of Computing Resources for Students

Use of University computing resources, including network facilities, account numbers, data storage media, printers, plotters, microcomputer systems and software for computing activities other than those authorized by the University, is strictly prohibited. Unauthorized use of such resources is regarded as a criminal act in the nature of theft, and violators are subject to suspension, expulsion and civil and criminal prosecution.

The following are examples of misuse of computing resources:

- Unauthorized duplication, distribution or alteration of any licensed software. This includes software licensed by the University and licensed software accessed using the computing networks.
- Attempting to gain unauthorized access to any computing resource or data at Clemson or anywhere on the Internet, or attempting to disrupt normal operation of any computing resource or network.
- Attempting to use another student’s or employee’s computer account or data, without their permission, for any reason.
- Using the University electronic mail system to: attack other computer systems; falsify the identity of the source of electronic mail messages; send harassing, obscene or other threatening electronic mail; attempt to read, delete, copy or modify the electronic mail of others without their authorization; or send, without official University authorization, "for-profit" messages, chain letters or other unsolicited "junk" mail.
- Knowingly infecting any computing resource with a software virus.
- Tampering with the University computer network or building wiring or installing any type of electronic equipment or software which can be used to capture or change information intended for someone else.
- Using University computing or network resources for personal gain or illegal activities such as theft, fraud, copyright infringement, sound or video recording
piracy, or distribution of child pornography or obscenities.

In any investigation of misuse of computing resources, the University reserves the right to inspect, without notice, the contents of computer files, regardless of medium, the contents of electronic mailboxes and computer conferencing systems, systems output, such as printout, and to monitor network communication.

GRADUATE ADMISSIONS

ADMISSION PROCEDURES

Applicants may apply by submitting the normal paper application or by submitting an application electronically on the World Wide Web. The Internet address for Clemson University's Graduate School Netscape server is http://www.grad.clemson.edu/. Applicants may check the status of their application at this same Internet address or by email at gradapp@clemson.edu.

Application Deadlines

Application for admission of United States citizens and residents should be received no later than five weeks prior to registration. This means that every required item in support of the application (completed application form, application fee, transcripts, letters of recommendation and test scores) must be on file with the Graduate School by this date. Applicants to programs requiring standardized test scores should complete these examinations at least 12 weeks before registration.

Unless all admission credentials reach the Graduate School at least five weeks prior to registration, an acceptance cannot be guaranteed. Students applying to a graduate major significantly different from their undergraduate major may anticipate a longer period of time for a decision. A number of programs have earlier deadlines or restrict admission to fall semester only. Students are advised to contact the department for the deadlines of the program of proposed study.

Applications for admission of prospective international students should be completed by April 15 and September 15 for registration in the fall and spring semesters, respectively. This means that every required item in support of the application (completed application form, application fee, transcripts, letters of recommendation, test scores and financial certificate) must be on file with the Graduate School by these dates. The actual application should have been on file at least four weeks in advance of these dates. Thus, international applicants should have been on file at least four weeks in advance of these dates. Thus, international applicants living outside the United States should complete the required standardized tests at least three months prior to April 15 or September 15, as appropriate. Issuance of Form I-20 or Form IAP-66 for a student visa will normally be completed no later than June 1 and October 15 for registration in the fall and spring semesters, respectively. These dates apply to international applicants from abroad. Initial enrollment of international students in the summer sessions is strongly discouraged and is permitted only on rare occasions.

Application Fee and Time Limit

For applicants wishing to enroll in the Graduate School, a nonrefundable fee of $40* payable to Clemson University via a money order or a check drawn on a United States bank must accompany the application material. Without this fee, applications will not be processed. Generally, acceptance under an application is valid for one year beyond the initial date desired for enrollment inclusive. However, departments reserve the right to deny deferred admission because of limited space and/or resources. Thus, students wishing to defer enrollment must request and receive written approval for such action from the respective department. Graduate School alumni who apply after one year from the date of their graduation will be required to pay an application fee.

Duplication of Higher Degrees

The duplication of higher degrees is discouraged on the same basis as the duplication of the bachelor's degree. Thus, a student holding a master's degree may not as a rule become a candidate for another master's degree in the same field of study. Nor may the holder of a master's degree in the same field of study, received at another institution, become a candidate for another master's degree in the same field at Clemson.

Medical Requirements

Graduate students entering Clemson University for the first time receive a medical history form. Prior to registration, the medical form (including immunization documentation) must be completed and returned to the Medical Records Department at Redfern Health Center. Students will not be allowed to complete registration without meeting immunization requirements.

The University requires that all new students have documentation of two red measles (rubeola) vaccinations on or after their first birthday. Those students who were born prior to January 1, 1957, are exempt from the measles requirements. A tuberculin skin test (PPD or Mantoux) is required within the past year. If there is a history of a positive skin test, a chest X-ray also is required within the past year. Students not in compliance with immunization requirements will not be allowed to complete registration.

Disposition of Application Materials

Clemson University reserves the right to destroy all application materials submitted for admission two years after the date of the last correspondence. Application materials will not be returned.

Appel of Denied Admission

A student may appeal if he/she believes that admission was unfairly denied. Notice of intention to appeal must be filed in writing with the Graduate School within 30 days of the date of the letter indicating rejection, and no later than three days prior to the first day of classes of the semester of intended first enrollment.

ACADEMIC REQUIREMENTS

New Applicants

As a minimum and general requirement for admission to any of the University's graduate programs, a prospective student must hold at least a four-year bachelor's degree from an institution whose scholastic rating is satisfactory to the University and must have the approval of the appropriate department chair or program coordinator. Although the quality of an applicant's previous academic record always plays an integral role in any admission decision, a general division in requirements, based on the degree objective, exists as follows:

1. Master of Arts, Master of Science and Doctor of Philosophy Degrees. Criteria for admission to these University-wide degrees include satisfactory scores on the

* Subject to change.
The Graduate School reserves the right to require additional indicators prior to reaching an admission decision. Neither an academic record exceeding minimum requirements, satisfactory scores on standardized tests nor professional expertise alone will assure a student's admission in this competitive environment. Rather, the total record must indicate the strong likelihood of successfully completing graduate study.

Assessment of Previous Academic Work

The grade point ratio representing an assessment of an applicant's undergraduate work will be based on the last half of the course work listed on the transcript or transcripts. In conventional cases, this will equate to the full junior and senior years. As a minimum, 60 semester hours (or 90 quarter hours) will be examined, and in no cases will a partial term, session or enrollment period be utilized. Excluded in the computation are courses graded P/F and certain electives having no relationship to a curriculum. Departments are at liberty to discount further courses in assessing an applicant's academic record. Certain professional programs may use the total undergraduate grade point average to satisfy accreditation standards. In evaluating the grade point ratio of an applicant's graduate work, all graduate course work will be used except research and/or courses graded P/F.

Applicants Presently Enrolled in Graduate School

Students enrolled in a master's degree program at Clemson University who wish to continue their studies in another graduate program after completing their initial degree objective may apply by submitting the normal application, color-coded green. This application must be supported by the student's advisory committee for the master's degree or other faculty designated by the graduate dean who are associated with the applicant's present or proposed program.

Students holding both the bachelor's and master's degrees from Clemson University are encouraged to pursue doctoral programs at other institutions.

Change of Degree Program

Students who have enrolled in a given degree program within the past two calendar years may request a change of major and/or degree without submitting a new application. Instead, the student must submit to the Graduate School Form GS14 endorsed by the department chair(s) or program chairperson(s) of the affected degree program(s). All program and Graduate School requirements must be met before final approval will be granted.

Re-admission

A former graduate student who has not maintained continuous enrollment (summers excluded), but who is academically eligible to continue in the graduate degree program where he/she was most recently enrolled, may be permitted to return. The procedures are dictated by the period of absence from enrollment as follows:

1. Less than Two Years. The student simply notifies the Graduate School and the program coordinator of his or her plans to return.

2. Two to Six Years. A new application must be submitted and endorsed by the program coordinator and the Graduate School. The application must show any intervening graduate work, and appropriate official transcripts of the work may be required by the Graduate School.

3. Six or More Years. A new application and all supporting materials will be required; that is, such persons are considered to be new applicants.

Former graduate students described above who wish to return to Clemson University to pursue an undergraduate degree and/or course work with no immediate plans for graduate work should contact the Registrar's Office for procedures.

Academic Renewal

The student who was dismissed from the Graduate School for a grade point deficiency and who has not enrolled for a period of four or more academic years may apply to the Graduate School for readmission under special conditions known as academic renewal. Under these conditions, the previous graduate credits attempted and quality point deficit will not constitute a liability in a new grade point computation. However, no credits passed or their attending quality points will be available to the student for a degree at Clemson, and any courses previously passed may not be validated by special examination. The previous record will appear on the permanent record as well as the notation of readmission under the policy of academic renewal.

** GRE or GMAT scores more than five years old relative to date of initial enrollment will not be accepted.
*** TOEFL scores more than two years old relative to date of initial enrollment will not be accepted.
ADMISSION CLASSIFICATIONS

Admission to a Degree Program

Candidates for admission to a degree program will be admitted in one of the following categories:

1. Full Status. The applicant's credentials equal or exceed every minimum admission criterion prescribed for the particular degree.

2. Provisional Status. At least one admission criterion prescribed for the particular degree is marginal. Such applicants will be required to remove the provisional status with a satisfactory academic performance during the first semester.

3. Conditional Acceptance. At least one item required for admission is not available. Notice of conditional acceptance may be given to highly qualified applicants prior to receipt of the degree they are presently pursuing; however, all requirements for this degree must be completed prior to enrolling in the proposed graduate program at Clemson University. Likewise, conditional acceptance may be given prior to receipt of satisfactory GRE or GMAT scores, if required, but such scores must be received prior to or during the first semester of enrollment.

Seniors lacking less than a full semester of work to complete the requirements for their bachelor's degrees may apply to a graduate program and, if granted conditional acceptance, be allowed to enroll in courses for graduate credit (see "Seniors" on page 16).

In addition to meeting the minimum and general requirements for admission listed under "Academic Requirements" (see page 14), the student must be recommended for admission by the program coordinator or department chair and must meet any special departmental requirements.

Admission as a Nondegree Student

Admission in this category is restricted primarily to those persons who may benefit professionally from additional study at the graduate level, for example, public school teachers who are required to complete graduate courses for recertification. In general, the only supportive material required for such admission is a valid transcript showing an appropriate background and confirming the awarding of a bachelor's degree or higher.

Students in the nondegree category may not be candidates for advanced degrees and may not receive a graduate appointment for financial assistance. Should the student subsequently be admitted to a degree program, a maximum of 12 semester hours of graduate credit taken at any campus (nondegree and/or transfer) may be applied toward the degree. In all cases the nondegree student must receive permission from the program coordinator or the department chair before enrolling in graduate courses. This classification is not open to international students.

Students enrolled in a nondegree status are subject to the same academic regulations regarding continuous enrollment as apply to those in a degree program (see page 29).

Admission as a Postbaccalaureate Student

An applicant may be accepted by the Graduate School as a postbaccalaureate student if he/she applies to a specific graduate degree program and does not have the appropriate academic background. The applicant must be recommended by the department chair or program chairperson and must meet all the other requirements for admission to that degree program regarding grade point ratio and standardized test scores. A change in academic discipline between the undergraduate and graduate levels may require a longer review time by the department. A student in this category who is denied admission because of failure to meet the minimum requirements has access to the same appeal procedure as any other student applying to the Graduate School.

Applicants will be classified as postbaccalaureate students if they are not qualified to take at least one graduate course per semester that can be included in the minimum hours required for the graduate degree. Additionally, any student required to complete 18 or more semester hours of undergraduate credits will be classified as postbaccalaureate. Until the required number of undergraduate credit hours is less than or equal to 18, and the student is qualified to take an appropriate graduate course each semester, the student will remain classified as postbaccalaureate. A department or a student may request postbaccalaureate status even though the above criteria are satisfied.

When a postbaccalaureate student becomes eligible for classification as a graduate student, reapplication for admission to the Graduate School and the decision as to eventual admission status (full status or provisional) will be made according to criteria used by the department and the Graduate School for all other applicants to the particular degree program. The postbaccalaureate student is expected to maintain a B average and receive no grade lower than a C to qualify for admission to a graduate program.

Postbaccalaureate students may enroll in the same number of credits per semester as any undergraduate student but cannot enroll in graduate courses (600 level or above) or receive a graduate assistantship. No degree or certificate shall be awarded to students in the postbaccalaureate status, and students who subsequently desire to obtain an additional baccalaureate degree must apply through the Office of Transfer Admissions. The applicability of credits earned toward the undergraduate degree will be determined by the policy pertaining to transfer students. Academic and other fees for postbaccalaureate students shall be those applicable to undergraduates with the exception of the application fee and admissions deposit.

A student possessing an undergraduate or graduate degree who wishes to enroll in specific undergraduate courses for reasons other than future admission to the Graduate School shall not be classified as postbaccalaureate and shall be governed by policies established by the Office of Admissions and Registration.

ENROLLMENT IN GRADUATE COURSES

Transient Graduate Students

A student who has been admitted to a degree program at another institution and who wishes to take courses for transfer to that institution may be permitted to enroll as a nondegree student in graduate courses on receipt of Form GS8, Transient Graduate Status, which may be obtained from the Graduate School at Clemson University. This form, an abbreviated application to the Graduate School, must be presented two weeks prior to registration. A student may earn no more than a total of 12 semester hours while in transient status.

Seniors

Enrollment in any graduate course is subject to approval by the department offering the course and the Graduate School. This approval is required prior to registration and may be obtained by completing and returning to the Graduate School office the appropriate form (Form GS6, available at the Graduate School office). The total course work load for the semester must not exceed 18 hours, and the cumulative graduate credits earned by seniors shall not exceed 12 semester hours.

Seniors with a cumulative grade point ratio of 3.0 or higher may enroll in 700- and/or 800-level courses and may choose to use these courses to meet requirements for the bachelor's degree. However, courses used for this purpose cannot be counted...
later toward an advanced degree. Alternatively, such students may take 600-, 700- or 800-level courses in excess of the requirements for their undergraduate degrees and may request that these courses be included as a part of their graduate program if they are subsequently admitted to the Graduate School at Clemson. Courses cannot be taken at the 600 level if their 300- and 400-level counterparts are required for the undergraduate degree in the same academic major as the proposed graduate degree.

A senior with a cumulative grade point ratio less than 3.0 may apply to the Graduate School for conditional acceptance (see page 16). If accepted, the student may enroll in graduate courses for inclusion in a future graduate program, subject to approval of Form GS6. The form must be turned in and accepted by the Graduate School before a student can preregister or register for graduate courses.

In all cases, the credits and quality points associated with senior enrollment in graduate courses will be part of the undergraduate record.

Teacher Certification or Recertification

Initial certification (endorsement) at the graduate level is available only in educational administration, reading and personnel services (elementary and secondary counseling). Students seeking admission to these programs should hold an appropriate teacher's certificate.

Those who possess a bachelor's degree or higher and who desire initial certification in a teaching area must complete the undergraduate courses needed for certification in a postgraduate status administered by the Office of Transfer Admissions and may not enroll in graduate courses until their eligibility for certification has been established by their major department.

Prospective students should understand that the material in this catalog applies only to requirements for graduate degrees and has no direct relation to certification or recertification for public school teachers. The Graduate School gives no assurance that a program for a graduate degree and a program for a certificate or recertification thereof, will coincide. Students interested in professional certificates should, prior to beginning any work, confer with the dean of the College of Health, Education and Human Development or the appropriate department chair in that college.

University Employees

With the approval of the appropriate dean or director, a qualified employee of Clemson University may pursue graduate work for credit. However, no member of the faculty or staff who has a rank higher than instructor or its equivalent may be considered as a candidate for an advanced degree in the academic department where employed.

Limitations on the number of hours taken per semester are explained under "Enrollment Limits" (see page 29).

Restrictions

Enrollment in any graduate course is subject to approval by the department offering the course and requires permission of the instructor, whether or not such is specifically stated in the course description. To enroll in or receive credit for any courses of the 600 series or above, the student (with the exception of certain seniors) must have been officially admitted by the Graduate School either to a degree program (see page 16) or as a nondegree student (see page 16), or must have been granted conditional acceptance (see page 16).

Students may not enroll in 600-level courses for which undergraduate credit has been awarded, nor can graduate credit be awarded retroactively for undergraduate courses already completed.

### FINANCIAL INFORMATION

#### ACADEMIC EXPENSES

**Academic Fees**

1. **Graduate Assistants.** Graduate assistants pay a flat fee of $612* per semester and $171* for each summer session. Graduate assistants may elect to sign a payroll deduction agreement at the time of registration; however, it should be noted that payroll deductions are not available during summer sessions. The deduction will be for academic fees and/or the health fee, up to the maximum amount due. Details on the deferred payment schedule may be found under the heading "Fiscal Policy" (see page 21).

   In order for graduate assistants to qualify for this academic fee structure and deferred payment schedule, the assistantship appointment must be made known to the Graduate School by the employing department and the duties must commence within the three-day period following the first day of normal registration in regular semesters. Should the assistantship begin after the three-day period, through no fault of the student, the student will receive a refund on a prorata basis for the difference between normal academic fees and those charged as a result of the assistantship. Likewise, if an assistantship is terminated prior to the end of the regular semester or session, the student may be liable only for a prorated amount of the fee reduction already enjoyed.

   International graduate students are required to be in proper immigration status before any assistantship offer is extended or attending benefits ensue.

2. **Graduate Fellows and Trainees.** Graduate fellows and trainees pay fees applicable to South Carolina residents, as shown in the next paragraph. Fellowship and traineeship recipients are eligible for appointment as departmental graduate assistants. For students holding both fellowships or traineeships and assistantships, the fee structure for assistantships prevails.

3. **Graduate Students.** Semester charges for graduate students are determined by the credit load with no distinction between graduate and undergraduate credits.

4. **Postbaccalaureate Students.** Postbaccalaureate students pay the same academic fees as graduate students and are subject to out-of-state fees, if applicable.

5. **Permanent University Faculty and Staff.** Permanent Clemson University employees may take up to four credit hours free per semester or summer session. Beyond these hours, they pay the following:

   Academic Fee (per semester hour) $174.*

   A permanent employee (as defined by the Clemson University Office of Business and Finance) is a person employed full time (37.5-40 hours per week, 9 or 12 months per year) in a regular position, subject to the full control and responsibility of the University and receiving full remuneration for his or her services in the regular University budget.

   Faculty should be aware of the policy restricting pursuit of advanced degrees as found under "University Employees" (see page 17).

* Subject to change.
Graduate Assistantship Prorata Tuition Policy

<table>
<thead>
<tr>
<th>Adding an assistantship</th>
<th>Dropping an assistantship</th>
</tr>
</thead>
<tbody>
<tr>
<td>The first two weeks of class</td>
<td>Graduate Assistantship Fee</td>
</tr>
<tr>
<td>Between drop/add and the last day to drop or withdraw without a W</td>
<td>50% of total tuition and 100% of fees; or graduate assistant fee if new money to the University</td>
</tr>
<tr>
<td>After the last day to drop or withdraw without a final grade</td>
<td>No benefit</td>
</tr>
</tbody>
</table>

Auditing Fees

Full-time students or graduate assistants may audit courses as part of their schedule. Part-time students are charged according to the following schedule:

<table>
<thead>
<tr>
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<th>Level Courses</th>
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<td>Other Graduate Courses</td>
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Surcharge for students paying full-time fees taking off-campus:

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</tr>
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<td>Undergraduate Courses</td>
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Academic fees for classes taught out-of-state or out-of-country are determined on the basis of location.

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Academic Fees

<table>
<thead>
<tr>
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<th>South Carolina Resident</th>
<th>Nonresident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time Graduate Student (12 or more hours)</td>
<td>$1,840*</td>
<td>$4,728*</td>
</tr>
<tr>
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<td></td>
<td></td>
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<td>Part-time Graduate Student (less than 12 hours)</td>
<td>$174* (per hour)</td>
<td>$388* (per hour)</td>
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<td>Off-Campus Rates including Telecampus:</td>
<td></td>
<td></td>
</tr>
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<td>800+ Level Courses (includes sections 130/150)</td>
<td>$245* (per hour)</td>
<td>$490* (per hour)</td>
</tr>
<tr>
<td>Other Graduate Courses</td>
<td>$195* (per hour)</td>
<td>$425* (per hour)</td>
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<tr>
<td>ALL STUDENTS (excluding Graduate Assistants):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory Fee:</td>
<td>$25* (per lab seat)</td>
<td>$25* (per lab seat)</td>
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</tbody>
</table>

Health Fee

All graduate students enrolling in seven or more credits in the fall or spring semester are required to subscribe to the health fee of $95* per semester. During the summer sessions, all graduate students enrolling in four or more credits will be required to subscribe to the health fee of $34* per regular session. Exemptions to this requirement include students not taking classes on the main campus, international visitors/scholars and employees of Clemson University. Graduate assistants who have authorized a payroll deduction of academic fees may include the cost of the health fee. Any student not mandated to pay the health fee may do so voluntarily and benefit from the services.

The health fee provides for the services of the University physicians, psychologists, nurse practitioners and health educators. Included in the medical fee is an excess accident and sickness benefit available for after-hours urgent care. For more detailed information, see "Health Services" (see page 42), or contact Redfern Health Center at (864) 656-2233.

The University offers a plan of accident and sickness insurance designed to help cover major medical expenses. Information on this insurance plan is sent to all students prior to the beginning of the fall semester. The health center strongly encourages students who do not have adequate insurance coverage to purchase the additional coverage.

Athletic Contests and University Concerts

Departmental graduate assistants and graduate resident assistants are eligible to purchase two season tickets per sport at the faculty-employee rates. Applications must be completed at the Jerey Athletic Center ticket office.

For full-time graduate students enrolled in 12 or more semester hours and paying full tuition and fees, tickets to home football and basketball games are available at no charge upon presentation of a valid ID at times and places published by the Athletic Department. Students are admitted to all other on-campus intercollegiate athletic events, except NCAA-sponsored championship play-off tournaments, upon presentation of ID. The Athletic Department will make every effort to accommodate all students who want to attend an athletic event. However, when ticket demands are greater than available seats, the Athletic Department reserves the right to refuse to admit students if this would endanger the safety of participants and spectators.

* Subject to change.
Graduate students, full-time and part-time, may attend University concerts. Announcements on campus determine whether admission is by ticket, by presenting student ID or free.

The ticket privileges just described do not apply to students enrolled solely in the M.B.A. program on the campuses of Furman University or Lander University.

Vehicle Registration

Vehicles must be registered immediately upon being brought to campus. The cost of vehicle registration is $45 for one year, August 15 to August 15, and motorcycle registration is $18. Parking permits and further information may be obtained from Parking Services, (864) 656-2270.

FINANCIAL ASSISTANCE

Fellowships and Traineeships

Approximately 140 outstanding graduate students hold fellowships or traineeships at Clemson University. In order for a monetary award to be designated a fellowship or a traineeship, it must provide the recipient a minimum of $1,000 for the academic year. These awards, received from a variety of alumni, foundation, governmental, individual or industrial sources, require no services. Payment in excess of actual educational costs is subject to federal and state taxes.

Graduate Alumni Fellowships, University Research Fellowships and George R. MacDonald Fellowships are University-wide awards administered by the Graduate School. These awards of $5,000 each for the academic year are made on a competitive basis to nominees selected by the departments. Scholarly potential and academic excellence are the sole criteria for the awards.

Additional fellowships and traineeships are administered by the individual colleges and departments. Some awards, such as the Industrial Graduate Residency Fellowships, may limit the student’s research to areas of interest to the donor and require a period of residency at the industrial site. Detailed information is available in the colleges or departments.

South Carolina Graduate Incentive Fellowships of $5,000 for master’s students or $10,000 for doctoral students are available to minority graduate students. These awards are renewable. Master’s students must be citizens of South Carolina. Preference is given to new applicants and those who express a commitment to remain and be employed in the state for two years. These fellowships are administered by the Graduate School.

Unless otherwise stipulated by the grantor and/or donor, holders of fellowships or traineeships are required to enroll in the same minimum credit load as is applicable to departmental graduate assistants. Continued receipt of any fellowship or traineeship is contingent on the student’s maintaining a satisfactory academic status. Normally a student cannot hold concurrently two or more fellowships or traineeships (or the equivalent thereof) administered by the University, regardless of the funding sources. Fellowship recipients are eligible for appointment as departmental graduate assistants.

Fellowships and traineeships usually are offered in early March. Inquiries may be made to the department of the student’s major interest or to the Graduate School.

Loans

The Office of Student Financial Aid administers federal financial aid for graduate students. Many types of federal aid, such as the Federal Pell Grant, are not available to graduate students. However, the Federal Stafford Loan has extended loan limits for graduate students and is available to most students regardless of income.

U.S. citizens and eligible non-citizens can apply for the Federal Stafford Loan by completing the Free Application for Federal Student Aid (FAFSA). The suggested deadline to apply is April 1 for the following fall semester.

Graduate students accepted into a degree program may borrow funds to cover their established cost of attendance, less any fellowship stipends or fee waivers, up to $18,500 per year.* Further information and application forms are available from the Office of Student Financial Aid, G01 Sikes Hall, Box 345123, Clemson, SC 29634-5123.

Eligibility for Loans

In order to qualify for a loan, graduate students must be enrolled in at least five credits in a regular semester (fall or spring) and three credits for the summer in any combination of enrollments. The Financial Aid Office reserves the right to deny loans in the summer when abnormal enrollments may be contrary to federal loan regulations.

Special Employment Restrictions

Graduate students who are employed in programs administered directly or indirectly by Clemson University are not loaned in default on payments of student loans will be subject to wage withholding (garnishment) according to Legislative Authority P.L. 102-1064; To U.S.C. S1095A et seq.

STUDENT EMPLOYMENT

Graduate Assistantships

Approximately 1,850 graduate students hold Clemson University appointments. These are of two kinds: (1) graduate assistantships requiring, for the most part, half-time employment and (2) fellowships or traineeships which require no service to the University.

Clemson University, as a member of the Council of Graduate Schools in the United States, subscribes to the following policy inherent in the resolution adopted by the Council regarding graduate appointments. In every case in which an appointment for the next academic year is offered to students currently enrolled in or accepted to graduate programs, the student, if acceptance is indicated before April 15, will have complete freedom through April 15 to submit a resignation, a resignation of the appointment in order to accept one elsewhere. However, an acceptance given or left in force after April 15 commits the student not to accept another appointment (at Clemson or elsewhere) without first obtaining a written release from the first party to whom a commitment has been made. Similarly, an offer made after April 15 is conditional on presentation by the student of the written release from any previously accepted offer.

To be eligible for any graduate appointment, a graduate student must satisfy the appropriate minimum enrollment requirement described in each section below and the enrollment limit requirements (see page 29). The University reserves the right to withdraw the appointment at any time because of failure to meet these requirements. Graduate students also should understand that an appointment may be withdrawn at any time for failure to maintain a satisfactory academic status including grades (see “Academic Standards/Grading” on page 27), special examinations and research efforts.

Departmental Graduate Assistantships

Assistantships are available in academic departments involving primarily instruction, research or extension and in nonacademic departments involving primarily administration. Application forms may be obtained from the Graduate School or from department chairs and should be completed and filed as early as possible in the academic year before the student enrolls. Selection of assistantship recipients as well as notification of the appointment, its duration and the stipend are the responsibilities of the employing departments. All graduate assistants are granted partial remission of academic and other fees and

*Subject to change.
enjoy certain other benefits provided for University staff personnel.

1. Eligibility. To qualify for a departmental assistantship, the graduate student must possess at least a bachelor's degree and be enrolled in a graduate degree program. In addition, the graduate student must devote 10 to 30 hours of service per week to the University and be engaged in employment that bears a recognizable relationship to his or her major field of study. Multiple employment of graduate students by the University (graduate appointment and/or hourly employment) is permitted. It is the responsibility of the secondary employer to receive permission of the primary employer and the Graduate School prior to assignment of any additional work and to ensure that the maximum work load of 30 hours per week is not exceeded. Upper limits on academic loads as related to hours of service per week are found in the section entitled "Enrollment Limits" (see page 29).

International graduate students who are interested in receiving an assistantship should submit Test of English as a Foreign Language (TOEFL) and Test of Written English (TWE) scores. International students seeking graduate teaching assistantships, whose native language is not English and whose secondary education (and beyond) was not taught fully in English, are required to pass the standardized exam, Test of Spoken English (TSE). Specialists in English as a Second Language administer this test at Clemson University after the students have arrived. Prospective international TAs also undergo an interview during which they are evaluated by faculty members in their respective departments. Videotaped oral presentations are utilized in some departments. Successful scores on the test, the interview, and the presentation (if required) are completed before the student can be approved as a teaching assistant.

2. Minimum Stipend. The minimum graduate assistantship stipend must be commensurate with a rate 1.2 times the prevailing federal minimum wage.

3. Minimum Enrollment. A minimum enrollment is required for appointment as a graduate assistant. During the academic year, the minimum enrollment is nine semester hours for all graduate assistants. Minimum enrollment in the summer sessions is three semester hours per session. Undergraduate credits may be included in the minimum provided they are relevant to the student's degree program and required by the advisory committee. Credits in GS 799 may be included in the minimum in unusual cases cleared in advance with the Graduate School.

4. Employment Schedule and Leave without Pay. Graduate students with 9-month or 12-month graduate teaching assistantship appointments work on the same calendar as faculty with 9-month or 12-month appointments, respectively. Duties over holiday periods for graduate research assistantships should be agreed upon in writing by the student and the immediate faculty advisor in charge of the research program.

A graduate assistant may request up to four weeks of leave without pay per semester and one week of leave without pay per summer session from his or her immediate supervisor for illness of a close family member, death in the immediate family and personal illness or hardship. If leave is not approved by the administrator of the graduate assistantship, the graduate assistant may petition the Graduate School for approval.

A graduate assistant is eligible for up to six weeks of maternity leave without pay. The request for maternity leave must be made to the department at least one month in advance.

Graduate Resident Assistantships

Part-time employment on the program staff of the residence halls is available to qualified graduate students. Preference is given to those who have had a successful undergraduate experience as a residence hall assistant. In general, 20 hours of service per week are required, and compensation for such employment amounts to a room or apartment, partial remission of academic and other fees, and approximately $1,000 per semester. Graduate resident assistants are subject to an enrollment limitation (see page 29), and the required minimum enrollment is coincident with that of departmental graduate assistants. Interested applicants should apply directly to the Housing Office. A personal interview is required prior to final selection.

Assistantship Appointment Process

Each graduate assistant shall be provided a document to sign and return to the employing department at the time the offer is accepted. The document shall provide a brief description of the expectations of the employer, the anticipated beginning and ending dates, stipend amount, average hours of service per week, work schedule (where appropriate) and the conditions for reappointment, if any. In addition, the assistant must be apprised of the financial penalties that may be incurred regarding academic fees should the assistantship start after the beginning or be terminated before the end of the semester or sessions. (See "Academic Fees" on page 17.)

Termination of Assistantships

1. Termination of Assistantship by Student. Normally an assistantship is offered on an annual or on an academic year basis. A student may terminate an assistantship at the conclusion of a semester or summer session without penalty. However, if the student terminates his or her assistantship during a semester, the student may be liable, calculated on a prorata basis, for the difference between the normal academic fees and the reduced fees assessed as a result of the assistantship. If, in the opinion of the immediate supervisor of the assistantship, the termination was justifiable, the administrator may recommend to the dean of the Graduate School that no additional charge be made to the student.

2. Termination of Assistantship for Cause. If, in the opinion of the immediate supervisor of the assistantship, a student is not carrying out the duties of the assistantship in a satisfactory manner, the assistantship may be terminated and the student held liable, calculated on a prorata basis, for the reduction in academic fees assessed as a result of the assistantship.

The procedure to be followed before terminating an assistantship for cause follows:

The immediate supervisor should first discuss the problem with the student and try to resolve the problem. A record of this conversation is placed in the student's departmental file. If the performance of the student remains unsatisfactory, a signed written warning from the department chair is sent to the student by certified or registered U.S. mail detailing the nature of the problem. The graduate dean shall be notified. If the performance of the student remains unsatisfactory, the department chair gives the student a written notice of termination. At least two weeks should elapse between the written warning and the notice of termination. The graduate dean shall be notified. The student has the right to file a grievance with the Graduate Student Grievance Committee (see page 34).

3. Termination for Academic Requirements. The assistantship may also be terminated for dropping below the minimum credit hours required as described on this page or for failure to meet other academic requirements.
students for benefits affor ded those on graduate assistantship appointments.

**FISCAL POLICY**

**Settlement of University Fees**

The entire amount of the expense for each semester or summer session is due and payable at the beginning of each semester or summer session, and no student is enrolled officially until all expenses are satisfied. In special cases, the University will accept, at the beginning of a semester, a non-interest-bearing promissory note for a portion of the semester residence hall and board fee. In such cases, the note for the first semester charges will be due October 1, and the note for the second semester charges will be due March 1. Upon certification by the dean of the Graduate School and upon authorization by the student of a payroll deduction for payment, deferred payment of academic and health fees may be granted to a student employed as a graduate assistant. The total amount deferred shall not exceed the total of the graduate assistant fees for the semester. Payment of the amount deferred is to be made in six equal installments through payroll deductions beginning with the second pay period of the semester. Should an assistantship be terminated, any unpaid balance of funds deferred is payable immediately as well as any additional fees due. No deferred payments are permitted for summer sessions for any graduate student.

All other transactions relating to payment should be conducted with the Office of Business Affairs. All checks and money orders should be made payable to Clemson University. A personal check given in payment of University expenses which is returned by the bank unpaid immediately creates an indebtedness to the University. Returned Checks/Charge Cards

A check or charge card given in payment of University expenses or a check cashed by the University that is returned unpaid by the bank immediately creates an indebtedness to the University. The Office of Business Affairs, G12 Sikes Hall, administers matters related to the collection of all returned checks for students and nonstudents.

The Bursar’s Office will redeposit returned checks in payment of academic fees for the fall and spring semesters. A $20* returned check charge will be assessed for each returned item in accordance with state laws. Students with returned items for payment of academic fees are also subject to a late payment fee of $5* per calendar day, not to exceed $350*, beginning on the day after the last day of late registration. If the note is returned to the University in a timely manner with no response by the student or drawer, a written request to disenroll the student will be made to the registrar. If the request is approved, the percentage of refund will be applied to the debt. If the check is returned after the mid-point of the semester with no response, by the student or drawer, a decision will be made by the director of business affairs and the registrar as to the effects of disenrollment. At this point, the student will owe 100 percent of tuition and fees, even if he/she has been disenrolled. The University may restrict subsequent payment for academic and other fees by accepting only cash, certified checks, cashier’s checks or money orders. Any individual who cashes a two-party check or uses a two-party check for payment of University expenses will be held responsible for that check if it is returned unpaid by the bank. Checks used as payment for various University services, such as meal plans, housing, etc., that are later returned unpaid by the bank give the University the right to cancel such services and cause forfeiture of any refund.

Any returned item not collected by the above procedures may be turned over to a collection agency and the indebtedness reported to a credit bureau. Costs of collection will be added to the debt. Transcripts and diplomas will be withheld pending payment and the debt may be deducted from state income tax refunds. Abuse of check cashing and check payment privileges may result in the restriction of such privileges for an indefinite period of time based on the frequency and/or dollar amount, as determined by the Office of Business Affairs.

**Past Due Accounts**

Any indebtedness to the University which becomes past due immediately jeopardizes the student’s enrollment, and no such student will be permitted to re-enroll for an ensuing semester or summer school term. Billing fees and/or collection costs may be added to the indebtedness. Further, any student who fails to pay all indebtedness, including collection costs, to the University may not be issued a transcript or diploma. Unresolved debts may be turned over to a collection agency, be reported to a credit bureau and deducted from state income tax refunds. Debts include but are not limited to the following: parking violations, library fines, rent, academic fees, and others.

**Refund of Academic Fees**

*Regular Semester.* No refunds will be made on a semester’s academic and medical fees after four weeks from the last day

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*Subject to change.*
to register. In the case of a withdrawal from school, the refund will be based on the effective date of withdrawal as shown on the official University withdrawal form. Refunds for full-time students who drop to part time and part-time students who drop credit hours will be based on the date the course is dropped. To be eligible for a refund, the request must be received by the Office of Business Affairs prior to the beginning of the next term. If a student withdraws prior to the last day to register, refunds for periods of four weeks or less shall be made on the schedule indicated below.

### Schedule

![Schedule](image)

#### FINANCIAL INFORMATION

**Schedule**

- **Student**: who
- **__**

#### SOUTH CAROLINA RESIDENCE REQUIREMENTS

**APPLICATION FOR RESIDENT STATUS**

Any prospective or enrolled graduate student who is uncertain of his/her status concerning entitlement to payment of in-state tuition and fees has the responsibility of securing a ruling from the university by providing all relevant information on special application forms. These forms can be obtained from the Graduate School (E-106 Martin Hall; Clemson University; Clemson, SC 29634) and are to be completed and returned to that office at least two weeks prior to the first day of class for any semester or summer term for which the student is attempting to qualify for payment of the in-state tuition and fee rate.

#### ENTITLEMENT

Eligibility for payment of in-state tuition and fees shall be determined under the provisions of sections 59-112-10 through 59-112-100, South Carolina code of laws, 1976, as amended. This law is set forth in its entirety as follows (subject to further amendment by the General Assembly).

#### STATUTES

**Definitions**—section 59-112-10. As used in this chapter:

A. The words "state institution" shall mean those post-secondary educational institutions under the jurisdiction of the following: (1) Board of Trustees, Clemson University; (2) Board of Trustees, Medical University of South Carolina; (3) Board of Trustees, South Carolina State College; (4) State College Board of Trustees; (5) Board of Visitors, the Citadel; (6) Board of Trustees, University of South Carolina; (7) Board of Trustees, Winthrop College; and (8) State Board of Technical and Comprehensive Education.

B. The word "student" shall mean any person enrolled for studies in any state institution.

C. The word "residence" or "reside" shall mean continuous and permanent physical presence within this state, provided, that temporary absences for short periods of time shall not affect the establishment of a residence.

D. The word "domicile" shall mean a person's true, fixed, principal residence and place of habitation; it shall indicate the place where such person intends to remain, and to which such person expects to return upon leaving without establishing a new domicile in another state. For purposes of this section one may have only one legal domicile; one is presumed to abandon automatically an old domicile upon establishing a new one. Housing provided on an academic session basis for students at state institutions shall be presumed not to be a place of principal residence, as residency in such housing is by nature temporary.

E. The words "in-state rates" shall mean charges for tuition and fees established by state institutions for persons who are domiciled in South Carolina in accordance with this act; the words "out-of-state rates" shall mean charges for tuition and fees established by state institutions for persons who are not domiciled in South Carolina in accordance with this act.

F. The words "independent person" shall mean a person in his majority, or an emancipated minor, whose predominant source of income is his own earnings or income.
from employment, investments, or payments from trusts, grants, scholarships, loans, or payments of alimony or separate maintenance made pursuant to court order.

G. The words "dependent" or "dependent person" mean: (1) one whose financial support is provided not through his own earnings or entitlements, but whose predominant source of income or support is payments from a parent, spouse, or guardian, and who qualifies as a dependent or an exemption on the federal tax return of the parent, spouse, or guardian; or (2) one for whom payments are made, under court order, for child support and the costs of his college education by an independent person meeting the provisions of section 59-112-20 a or b. However, the words "dependent" or "dependent person" do not include a spouse or former spouse who is the recipient of alimony or separate maintenance payments made pursuant to court order.

H. The word "minor" shall mean a person who has not attained the age of eighteen years; and the words "emancipated minor" shall mean a minor whose parents have entirely surrendered the right to the care, custody and earnings of such minor and are no longer under any legal obligation to support or maintain such minor.

I. The word "parent" shall mean a person's natural or adoptive father or mother; or if one parent has custody of the child, the parent having custody; or if there is a guardian or other legal custodian of such person, then such guardian or legal custodian; provided, however, that where circumstances indicate that such guardianship or custodianship was created primarily for the purpose of conferring South Carolina domicile for tuition and fee purposes on such child or dependent person, it shall not be given such effect.

J. The word "spouse" shall mean the husband or wife of a married person.

South Carolina domicile defined for purposes of rates of tuition and fees—section 59-112-20. South Carolina domicile for tuition and fee purposes shall be established as follows in determinations of rates of tuition and fees to be paid by students entering or attending state institutions:

A. Independent persons who reside in and have been domiciled in South Carolina for a period of no less than twelve months with an intention of making a permanent home herein, and their dependents, may be considered eligible for in-state rates.

B. Independent persons who reside in and have been domiciled in South Carolina for fewer than twelve months but who have full-time employment in the state, and their dependents, may be considered eligible for in-state rates for as long as such independent person is employed on a full-time basis in the state.

C. Where an independent person meeting the provisions of section 59-112-20 b above, is living apart from his spouse, or where such person and his spouse are separated or divorced, the spouse and dependents of such independent person shall have domiciliary status for tuition and fee purposes only under the following circumstances: (1) if the spouse requesting domiciliary status for tuition and fee purposes remains domiciled in South Carolina although living apart or separated from his or her employed spouse, (2) if the dependent requesting domiciliary status for tuition and fee purposes is under the legal custody or guardianship of the parent not having legal custody but paying child-support, so long as either parent remains domiciled in South Carolina.

D. The residence and domicile of a dependent minor shall be presumed to be that of the parent of such dependent minor.

Effect of change of residency—section 59-112-30. When the domicile of a student or of the person upon whom a student is financially dependent changes after enrollment at a state institution, tuition and fees shall be adjusted as follows:

A. Except as provided in section 59-112-20 a or b above, when domicile is taken in South Carolina, a student shall not become eligible for in-state rates until the beginning of the next academic session after expiration of twelve months from date of domicile in this state.

B. When South Carolina domicile is lost, eligibility for in-state rates shall end on the last day of the academic session in which the loss occurs; however, application of this subsection shall be at the discretion of the institution involved.

C. Notwithstanding the other provisions of this section, any dependent person who has been domiciled with his family in South Carolina for a period of not less than three years immediately prior to his enrollment may enroll in a state-supported institution of higher learning at the in-state rate and may continue to be enrolled at such rate even if the parent, spouse, or guardian upon whom he is dependent moves his domicile from this state.

Effect of marriage—section 59-112-40. Except as provided in section 59-112-20 above, marriage shall affect determina-

Military personnel and their dependents—section 59-112-50. Notwithstanding other provisions of this act, during the period of their assignment to duty in South Carolina members of the armed services of the United States stationed in South Carolina and their dependents may be considered eligible for in-state rates. When such armed service personnel are ordered away from the state, their dependents may continue for an additional twelve months to have this eligibility at the state institutions where they are enrolled at the time such assignment ends. Such persons and their dependents may be considered eligible for in-state rates for a period of twelve months after their discharge from the armed services even though they were not enrolled at a state institution at the time of their discharge, if they have evinced an intent to establish domicile in South Carolina and if they have resided in South Carolina for a period of at least twelve months immediately preceding their discharge.

Faculty, administrative employees and dependents thereof—section 59-112-60. Full-time faculty and administrative employees of state institutions, and the spouses and children of such persons, shall be excluded from the provisions of this act.

Abatement of rates for nonresidents on scholarship—section 59-112-70. Notwithstanding other provisions of this act, the governing boards listed in section 59-112-10 a above, are authorized to adopt policies for the abatement of any part or all of the out-of-state rates for students who are recipients of scholarship aid.

Administration of chapter; burden of proving eligibility of students—section 59-112-80. Each state institution shall designate an official to administer the provisions of this act. Students making application to pay tuition and fees at in-state rates shall have the burden of proving to the satisfaction of the aforesaid officials of state institutions that they have fulfilled the requirements of this act before they shall be permitted to pay tuition and fees at such rate.

Penalties for willful misrepresentation—section 59-112-90. Where it appears to the satisfaction of officials charged with administration of these provisions that a person has gained domiciliary status improperly by making or presenting willful misrepresentations of fact, such persons should be charged tuition and fees past due.
and unpaid at the out-of-state rate, plus interest at a rate of eight percent per annum, plus a penalty amounting to twenty-five percent of the out-of-state rate for one semester; and until these charges have been paid no such student shall be allowed to receive transcripts or graduate from any state institution.

Regulations—section 59-112-100. The Commission on Higher Education may prescribe uniform regulations for application of the provisions of this act and may provide for annual review of such regulations.

REGULATORY GUIDELINES

Rates of tuition and fees—section 62-600.
A. Resident classification is an essential part of fee determination, admission regulations, and other relevant policies of state institutions. It is important that such institutions have fair and equitable regulations which can be administered consistently and are sensitive to the interests of both students and the state. The Commission on Higher Education hereby establishes regulations for the statute governing residency and tuition for fee purposes to be applied consistently by all South Carolina institutions of higher education. These regulations do not address residency matters relating to either in-county or international categories used within the state’s technical colleges.

B. Institutions of higher education are required by the statute to determine the residence classification of applicants. The initial determination of one’s resident status is made at the time of admission. The determination made at that time, and any determination made thereafter, prevails for each subsequent semester until the determination is successfully challenged. The burden of proof resides with the student to show evidence as deemed necessary to establish their residency status.

A. The rules regarding the establishment of legal residence for tuition and fee purposes for institutions of higher education are governed by the South Carolina Code of Laws.

B. As prescribed by the code, residence for tuition and fee purposes can be established by (1) independent persons, (2) dependent persons, and (3) independent immigrants, or dependent immigrants.

Definitions—section 62-602.
A. A “resident student” for tuition and fee purposes is defined as an independent person who has been domiciled in South Carolina continuously for at least twelve months immediately preceding the first day of classes of the term for which resident classification is sought and for whom there is an absence of such evidence in other states or countries, notwithstanding other provisions of the statute. In the instances of dependent students and their families who are citizens or permanent residents, the domicile of the spouse, parent, and/or guardian for at least the twelve months immediately preceding the first day of classes of the term for which resident classification is sought is considered in determining residency status.

B. “Reside” is defined as continuous and permanent physical presence within the state, provided that temporary absences for short periods of time shall not affect the establishment of residence. Temporary absences shall be absences which are thirty days or less. Excluded are absences associated with requirements to complete a degree, absences for military training service, and like absences, provided South Carolina domicile is maintained. Absences of more than thirty days may affect the establishment or maintenance of residence for tuition and fee purposes. In the instance of dependents, except for nonresident aliens, where the spouse, parent and/or guardian “reside” will be considered in determining residency status.

C. “domicile” is defined as true, fixed, principal residence and place of habitation, indicating where a person intends to remain, or to where one expects to return when away. Generally, an applicant must be domiciled in the state for twelve months for residency consideration.

D. “Independent person” is defined as one in his/her majority (eighteen years of age or older), whose predominant source of income is his/her own earnings or income from employment, investments, or payments from trusts, grants, scholarships, loans, or payments made in accordance with court order. An independent person must provide more than half of his/her support during the twelve months immediately prior to the date the classes begin for the semester for which resident status is requested and cannot be claimed as a dependent or exemption on the federal tax return of his/her parent, spouse, or guardian for the year in which resident status is requested.

E. “Dependent person” is defined as one whose predominant source of income or support is from payments from a parent, spouse, or guardian and who qualifies for and is claimed as a dependent or exemption on the federal income tax return of the parent, spouse, or guardian. A dependent person is also one for whom payments are made, under court order, for child support and the cost of the dependent person’s college education.

F. “Terminal leave” is defined as a transition period following active employment and immediately preceding retirement (with a pension or annuity), during which the individual may use accumulated leave.

G. “Immediately prior” is defined as a period of time not exceeding ninety days and immediately preceding the first day of classes for the term in question.

H. “Continue to be enrolled” is defined as continuous enrollment without an interruption that would require the student to pursue a formal process of readmission to that institution. Formal petitions of applications for change of degree level shall be considered readmissions.

I. “Nonresident alien” is defined as a person who is not a citizen or permanent resident of the United States. By virtue of their nonresident status “nonresident aliens” generally do not have the capacity to establish domiciles in South Carolina.

J. “Academic session” is defined as a term or semester of enrollment.

Citizens and permanent residents—section 62-603.
A. Independent persons who have physically resided and been domiciled in South Carolina for twelve continuous months immediately preceding the date the classes begin for the semester for which resident status is claimed may qualify to pay in-state fees. The twelve-month residency period does not start until the independent person begins to take steps which indicate that the independent person intends to establish a permanent home in the state. Absences from the state for more than thirty days during the twelve-month period may affect the establishment of permanent residence for fee and tuition purposes. Seats an independent person should take to establish a permanent home in South Carolina are listed in the section entitled “establishing the requisite intent to become a South Carolina domiciliary.”

B. The resident status of a dependent person is based on the resident status of the person who provides more than half of the dependent person’s support and claims the dependent person as a dependent for federal income tax purposes. The residence and domicile of a dependent minor and other dependent person shall be presumed
to be that of their parent(s), spouse, or guardian(s).

C. In the case of divorced or separated parents, the resident status of the dependent person may be based on the resident status of the parent who supports and/or claims the dependent person as a dependent for tax purposes, or it may be based on the resident status of the parent who has legal custody of the dependent person.

Nonresident aliens, noncitizens, and nonpermanent residents—section 62-604.

A. Except as otherwise specified in this section, all noncitizens and nonpermanent residents of the United States will be assessed tuition and fees at the nonresident, out-of-state rate. Independent aliens, including refugees, untainted, and paroles and their dependents, may be entitled to resident, in-state classification once they have been awarded permanent resident status by the U.S. Department of Justice and meet all the statutory residency requirements provided that all other domiciliary requirements are met. Time spent living in South Carolina immediately prior to the awarding of permanent resident status may not be counted toward the twelve month residency period. Certain nonresident aliens present in the United States in specific visa classification may be granted in-state residency for tuition and fee purposes as prescribed by the Commission on Higher Education.

B. The adviser's manual of federal regulations affecting foreign students and scholars will serve as the primary resource reference for defining visa categories.

Establishing the requisite intent to become a South Carolina domiciliary—section 62-605.

A. Residence status may not be acquired by an applicant or student while residing in South Carolina for the sole purpose of enrollment in an institution or for access to state-supported programs designed to serve South Carolina residents. If a person asserts that his/her domicile has been established in this state, the individual has the burden of proof. Such persons should provide to the designated residency official any and all evidence which the person believes satisfies the burden of proof. The residency official will consider any and all evidence provided concerning such claim of domicile but will not necessarily regard any single item of evidence as conclusive evidence that domicile has been established.

C. For independent persons, examples of intent to become a South Carolina resident may include, although any single indicator may not necessarily be conclusive, indicia as listed below. The absence of indicia in other states is required before the student is eligible to pay in-state rates. Indicia may include the following:

1) statement of full-time employment;
2) possession of a valid South Carolina voter registration card and voting in South Carolina elections;
3) designating South Carolina as state of legal residence on military record;
4) possession of a valid South Carolina driver's license, or if a nondriver, a South Carolina identification card;
5) possession of a valid South Carolina vehicle registration card;
6) continuous presence in South Carolina during periods when not enrolled as a student;
7) paying South Carolina income taxes as a resident during the past tax year, including income earned outside of South Carolina from the date South Carolina domicile was claimed;
8) ownership of principal residence in South Carolina; and
9) licensing for professional practice (if applicable) in South Carolina.

D. These indicia will likewise be considered for spouses, parents, and guardians of dependent persons who wish to establish South Carolina domicile. As noted under "citizens and permanent residents" above, the resident status of a dependent person matches that of the person who provides more than half of the dependent person's support and claims the dependent person as a dependent for federal income tax purposes.

Maintaining residence—section 62-606.

A. A person's temporary absence from the state does not necessarily constitute loss of South Carolina residence unless the person has acted inconsistently with the claim of continued South Carolina residence during the person's absence from the state. The burden is on the person to show retention of South Carolina residence during the person's absence from the state. Steps a person should take to retain South Carolina resident status for fee and tuition purposes include continuing to use a South Carolina permanent address on all records; retaining South Carolina voter's status; voting by absentee ballot; maintaining South Carolina driver's license; maintaining South Carolina vehicle registration; satisfying South Carolina resident income tax obligation. Individuals claiming permanent residence in South Carolina are liable for payment of income taxes on their total income from the date they established South Carolina residence. This includes income earned in another state or country.

B. South Carolina residents (and their dependents) who serve in the military may continue to be eligible to pay in-state fees as long as they continuously claim South Carolina as their state of legal residence during their military service. South Carolina residents who change their state of legal residence while in the military lose their South Carolina resident status for fee and tuition purposes. To re-establish their South Carolina resident status, such persons must take steps which indicate that they plan to re-establish permanent residence in the state. These persons must then physically reside in the state for twelve continuous months.

Effect of marriage—section 62-608.

A. In ascertaining domicile of a married person, irrespective of gender, such a review shall be determined just as for an unmarried person by reference to all relevant evidence of domiciliary intent.

B. If a nonresident marries a South Carolina resident, the nonresident does not automatically acquire South Carolina resident status. The nonresident may acquire South Carolina resident status if the South Carolina resident is an independent person and the nonresident is a dependent of the South Carolina resident.

C. Marriage to a person domiciled outside South Carolina shall not be solely the reason for precluding a person from establishing or maintaining domicile in South Carolina and subsequently becoming eligible or continuing to be eligible for residency.

D. No person shall be deemed solely by reason of marriage to a person domiciled in South Carolina to have established or maintained domicile in South Carolina and consequently to be eligible for or to retain eligibility for South Carolina residency.
Exclusions—section 62-609.

A. Persons in the following categories may qualify to pay in-state fees without having to establish a permanent home in the state for twelve months. Persons who qualify under any of these categories must meet the conditions of the specific category on or before the first day of classes of the term for which payment of in-state fees is requested.

1) "military personnel and their dependents": members of the United States armed forces (and their dependents) who are stationed in South Carolina on active duty may be considered eligible to pay in-state fees. "armed forces" shall mean the United States Air Force, Army, Marine Corps, and Navy. When such personnel are ordered away from the state, their dependents may continue to pay in-state fees for an additional twelve months. Such persons (and their dependents) may also be eligible to pay in-state fees for a period of twelve months after their discharge from the military, provided they have demonstrated an intent to establish a permanent home in South Carolina and they have resided in South Carolina for a period of at least twelve months immediately preceding their discharge. Military personnel who are not stationed in South Carolina and/or former military personnel who intend to establish South Carolina residency must fulfill the twelve month "physical presence" requirement for them or their dependents to qualify to pay in-state fees.

2) "faculty and administrative employees, and their dependents": full-time faculty and administrative employees of South Carolina state-supported colleges and universities are eligible to pay in-state fees. Dependants of such persons are also eligible.

3) "residents with full-time employment and their dependents": persons who reside, are domiciled, and are full time employed in the state and will continue to work full time until they meet the twelve-month requirement are eligible to pay in-state fees, provided that they have taken the steps to establish a permanent home in the state (see "establishing the requisite intent to become a South Carolina domicile"). The dependents of such persons are also eligible.

4) "retired persons": retired persons who are receiving a pension or annuity who reside in South Carolina and have been domiciled in South Carolina as prescribed in the statute for less than a year may be eligible for in-state rates and state-supported aid if they maintain residence and domicile in this state.

Persons on terminal leave who have established residency in South Carolina may be eligible for in-state rates even if domiciled in the state for less than one year, if they present documentary evidence for their employer showing they are on terminal leave. The evidence should show beginning and ending dates for the terminal leave period and that the person will receive a pension or annuity when he/she retires.

B. Full-time employment shall mean employment which consists of at least thirty-seven and a half hours a week on a single job in a full-time status. However, a person who works less than thirty-seven and a half hours a week but receives or is entitled to receive full-time employee benefits shall be considered to be employed full time.

C. Persons participating in southern regional education board-sponsored programs, including the contract for services and the academic common market programs, must have continuously resided in the state for other than educational purposes for the two years immediately preceding application for consideration and must meet all residency requirements during this two-year period.

Application for change of resident status—section 62-610.

A. Persons applying for a change of resident classification must complete a residency application/petition and provide supporting documentation prior to a reclassification deadline as prescribed by the institution.

B. The burden of proof resides with those persons applying for a change of resident classification who must show required evidence to document the change in resident status.

Incorrect classification—section 62-611.

A. Persons incorrectly classified as residents are subject to reclassification and to payment of all nonresident fees not paid. If incorrect classification results from false or concealed facts, such persons may be charged tuition and fees past due and unpaid at the out-of-state rate. The violator may also be subject to administrative, civil, and financial penalties. Until these charges are paid, such persons will not be allowed to receive transcripts or graduate from a South Carolina institution.

B. Residents whose resident status changes are responsible for notifying the residency official of such changes.

Inquiries and appeals—section 62-612.

A. Inquiries regarding residency requirements and determinations should be directed to the institutional residency official.

B. Each institution will develop an appeals process to accommodate persons wishing to appeal residency determinations made by the institution's residency official. Neither the primary residency official nor appellate official(s) may waive the provisions of the statute governing residency for tuition and fee purposes.

**GENERAL GRADUATE SCHOOL REGULATIONS**

Graduate students are subject to the usual procedures and regulations of the University, except as these procedures and regulations apply to undergraduate students only. Immediately upon enrollment, a student should become acquainted with the degree requirements and the regulations of the Graduate School published in this catalog. Each advisor and student should have a current copy of the graduate catalog.

**PROCEDURES TO FOLLOW IN PURSUING A DEGREE**

The information presented below is not intended as a step-by-step outline of all procedures to be followed while pursuing a graduate degree. Rather, it is an explanation of primary factors encountered during the process.

The Major Advisor

A student, with the aid and approval of the department chair or program coordinator, must select a major advisor. This advisor must be a member of the program faculty offering the degree and meet the requirements for advisory committee membership described below. In departments or programs with large faculties, new graduate students may be assigned a temporary advisor. This advisor recommends and approves courses to be taken during the student's first semester. The course work selected should be of a fundamental or core nature so the advisory committee will have maximum flexibility to formulate the remainder of the student's program of study.
The Advisory Committee

The advisory committee approves the student’s graduate degree curriculum, supervises the graduate program, administers the final oral examination, and initiates the recommendation for the awarding of the degree. Additionally, the advisory committee may administer qualifying or preliminary and/or final comprehensive examinations. One member of the committee is designated as chairperson or major advisor and normally directs the student’s dissertation or thesis, if required. This committee is selected by the student and approved by the department chair or program coordinator.

A minimum of three faculty members shall be selected for a student seeking a master’s or specialist’s degree, and a minimum of four faculty members shall be selected for a student seeking a doctoral degree. The majority of the advisory committee, including the major advisor, must be comprised of Clemson University faculty from the program offering the particular degree and who hold full-time tenure-track positions. If a minor is declared, this area must be represented on the committee. Committee members of interdepartmental programs shall be appointed according to bylaws, formulated by the program faculty and endorsed by the Graduate School, that assure appropriate representation of the participating departments.

Part-time visiting and other non-tenure-track faculty employed by Clemson University may serve on the committee. Persons not employed by the University may serve if they have been appointed to an adjunct faculty status. Part-time, visiting adjunct and other non-tenure track faculty will have full voting status on the outcomes of all examinations given by the committee.

The student, department and committee members are notified of the appointments by means of the approved GS2 form.

Filing of a Graduate Degree Curriculum

A graduate degree curriculum (Form GS2) must be filed with the Graduate School by those students who are in degree programs. Since fixed curricula normally do not exist for graduate degrees, this planned program represents the formulation of an individual student’s curriculum as recommended by the advisory committee. It must adhere to departmental as well as Graduate School policies. This program constitutes the core of the student’s Graduate Degree Curriculum (Form GS2) and appears on the form at the location entitled REQUIRED COURSES (GRADUATE LEVEL ONLY). Undergraduate deficiencies are listed at the designated location. Supplemental courses, carrying undergraduate or graduate credit and chosen to broaden the student’s academic experience, are not required on Form GS2. However, if a listing is desirable, such courses will be listed as departmental requirements at the designated location. Graduate credit is received only for courses numbered 600 or above; no student shall receive both undergraduate and graduate credit for the same course. The Graduate School discourages inclusion of 600-level courses in the minimum hours required for graduate degrees if these courses are clearly equivalents of undergraduate courses required for an undergraduate degree in the same major at Clemson University. Transfer credit appearing in the curriculum must adhere to the stipulation described under “Acceptance of Transfer Credit” (see page 29).

Before a curriculum is approved, it must be reviewed and signed by the advisory committee. It is then submitted to the department chair(s) and college dean(s) for approval and is forwarded to the Graduate School for approval and appropriate distribution of copies.

If it becomes necessary to change the graduate degree curriculum, a revised Form GS2 must be filed. This new form requires all necessary signatures.

Candidates for master’s or specialist’s degrees should submit the curriculum by the middle of their second semester,* and doctoral candidates no later than the beginning of their second year of study. A $25** late fee is assessed a student whose credit is submitted after the deadline dates, and increases at the rate of $5** per day thereafter (excluding Saturday, Sunday or University holidays). * See page 3 for due dates for submitting Form GS2 forms.

Admission to Candidacy for a PhD Degree

Admission to the Graduate School does not qualify a student as a candidate for an advanced degree. Candidacy is granted when the examining committee submits Form GS5 indicating the successful completion of the comprehensive examination (see page 32).

All students desiring admission to candidacy must have received full status admission to the Graduate School, have a satisfactory academic standing, and have on file an approved graduate degree curriculum (Form GS2).

Application for a Diploma

A formal application for a diploma is placed by the student when the Form GS4 is filed. This order is submitted to the Graduate School and must be resubmitted should the student not graduate on the anticipated date. A $25** late fee is assessed a student whose Form GS4 is submitted after the deadline dates, and increases at the rate of $5** per day thereafter (excluding Saturday, Sunday or University holidays).

Awarding of Graduate Degrees Posthumously

A graduate student with a grade point ratio of 3.0 or above and plan of study (Form GS2) on file, who qualifies for graduation at the end of the semester or summer session and dies during that period or the subsequent semester or summer session, may be awarded the graduate degree posthumously provided the faculty of the college so recommends.

ACADEMIC REGULATIONS

Permanent Academic Records

The student’s permanent academic record is a historical record of the student’s academic progress. It is maintained in the Registrar’s Office and contains personal identifying information, grades and credits. Where appropriate, statements of a corrective nature, withdrawals, suspension for failure to meet academic standards, suspension for disciplinary reasons and graduation data are added.

Academic Standards (Grading)

Most graduate courses are graded on an A-B-C-F scale. Thesis and dissertation research and several other graduate courses are graded on a pass/fail basis. Courses graded pass/fail are not included in the academic average; however, the grade is placed on the student’s permanent record. Only credit hours for which a grade of pass is achieved apply toward the number of credit hours required for the degree. The accumulation of grades of pass in thesis or dissertation research does not imply completion of the research, but indicates satisfactory progress on that research.

A minimum grade of C must be made on all course work to obtain graduate credit. The student must maintain a cumulative B average in all graduate-level courses (600 level or above). In addition, graduate students must maintain an overall cumulative B average in all courses (undergraduate/graduate) since admission to the Graduate School excluding those taken on a pass/fail basis. (See “Enrollment on a Pass/Fail Basis” on page 29.)

Students who fail to meet these requirements become ineligible for graduation and are placed on academic probation. The probationary status will remain in effect until nine additional semester hours of graduate credit have been attempted.

*An academic year is defined as the total of two academic semesters.
**Subject to change.
Students who fail to remove the probationary status as prescribed are subject to academic dismissal and will not be permitted to continue in the Graduate School without the recommendation of the program coordinator and written approval of the Graduate School. Withdrawal from a course while on probation will not be allowed unless prior approval is obtained from the Graduate School. Any unauthorized withdrawal will be considered as an unsatisfactory academic performance.

The cumulative B average requirements described above apply independently to graduate degrees sought at Clemson University; that is, the grade point ratio computation begins anew after the student has completed the first degree. However, when a doctoral degree is pursued after completion of a master's degree in the same major, the grade point ratio computation continues for both degrees.

A grade lower than the specified minimum can be raised to count toward an advanced degree only by repetition of the course. Reexamination is not permitted.

Appeal of Dismissal
A graduate student can be dropped from the Graduate School at any time for failure to maintain an adequate academic status. A student may appeal if he/she believes that the dismissal was unfair or improper. Notice of intention to appeal must be filed in writing with the Graduate School no later than three days prior to the first day of classes of the next regularly scheduled term, including summer sessions.

Final Examinations in Graduate Courses
Graduate course work specifications vary widely among disciplines. Evaluation of graduate work is based upon a number of observations, presentations, tests, papers and/or other measures. The final evaluation includes an examination at the conclusion of the course, which in most cases will be written, but may take on other forms.

Incomplete Graduate Course Work
Except for courses graded on a pass/fail basis, the grade of incomplete (I) may be given for incomplete work for any graduate course in which work remains unfinished and the student is unable to fulfill all requirements because of circumstances beyond his or her control. This grade is not given in lieu of unsatisfactory or failing grades received for completed courses for the purpose of improving the grade later.

It is the student’s responsibility to contact the instructor regarding the work required to complete the course. Upon request by the student, the instructor shall provide a written statement of the work to be completed.

The grade of I will be valid in normal lecture or laboratory courses for only 30 days after the beginning of the next scheduled session, excluding summers and irrespective of the student’s enrollment status. Within this period, the student must complete his or her work or obtain an extension, approved by the instructor and chair of the department responsible for the course, stating the reason for the request and the length of time needed. Normally, only one request for an extension for each grade of I will be granted.

Students receiving a grade of I in courses such as special problems or other unstructured, independent study courses as designated by the Graduate School must complete all work and receive a final grade within one calendar year. At the discretion of the instructor, the deadline for removal of these incomplete grades may be less than one year.

A graduate student will not be permitted to repeat any portion or reregister for any course for which the grade of I has been given. Should any work remain incomplete at the expiration of the appropriate deadlines described in the previous paragraphs, a grade of F will be recorded on the student’s permanent record. Although the Graduate School will attempt to bring the deadlines to the attention of the student and instructor, it is the sole responsibility of the graduate student to comply with these regulations.

Students who receive a grade of I while enrolled in the Graduate School at Clemson University remain ineligible for graduation until the incomplete work has been made up and a letter grade submitted to the Office of Admissions and Registration.

Grades of I will have a 10-working-day period after the deadline for the instructor to grade the work and submit the make-up grade card to the Registrar’s Office. Work submitted by the student after the printed deadline should not be accepted by the instructor unless an extension has been approved. Requests for extensions, like the make-up work, should be submitted by the deadline printed on the make-up card. Grades of I that remain after the 10-working-day period will be converted automatically to an F.

Withdrawal from Courses
The academic calendar provides official dates for withdrawing from a class without record or without final grades. Withdrawal from graduate course work beyond the first few weeks of class is strongly discouraged, particularly from those courses listed on a student’s Form GS2. Withdrawals after the first two weeks of class should only be made for unusual academic reasons or for pressing medical or personal reasons. Students who officially withdraw within the first four weeks of classes will have no grades recorded, while those who officially withdraw after the first four weeks and prior to the last five weeks will have a grade of W (withdraw) entered on the official records. Students may not withdraw within the last five weeks of classes.

A graduate student may withdraw from a class using the computer/phone registration on-line system. The graduate student is encouraged to discuss withdrawals from courses with his/her major advisor. International graduate students should discuss course withdrawals with a counselor in the International Services and Diversity Programs office of the Graduate School. It is important that an international student not fall below the required credit hours. If the advisor does not agree with the course withdrawal, the student may appeal to the department chair. A refusal by the department chair may be appealed to the dean of

<table>
<thead>
<tr>
<th>Student Category</th>
<th>Semester</th>
<th>Maximum 6-Week Session</th>
<th>Credit Hours 3-Week Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time Students</td>
<td>18</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Graduate Assistants (1/4 time)</td>
<td>15</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Graduate Assistants (1/2 time)</td>
<td>12</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Graduate Assistants (3/4 time)</td>
<td>12</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Persons Employed Full Time</td>
<td>6</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
the Graduate School. The date on which the graduate student withdraws on-line is the official date of withdrawal recorded by the registrar.

The withdrawal dates described above apply to the regular semesters only. Reference should be made to the academic calendar (see page 2) for the appropriate dates for the summer sessions.

Failure to attend classes or verbal notification to instructors does not constitute withdrawal. Students who drop out of a course without officially withdrawing as previously described will be credited with a failure. The student may use the electronic registration system to withdraw from courses.

Continuous Enrollment
Although continuous enrollment is not a formal requirement for an advanced degree, graduate students are expected to pursue their degrees with a minimum of interruption. Students who do not remain continuously enrolled (summers excluded) are subject to the requirements in effect at the time of return.

Only students who are enrolled are eligible to use University facilities and human resources and/or receive any form of financial aid. Students who have completed all required work and who find it necessary to be enrolled during a given semester so as to use facilities or human resources may enroll in GS 799 for a minimum of one credit.

Enrollment Limits
Upper limits on graduate student enrollment per semester refer to graduate and undergraduate credits combined and should be attempted only by the most qualified students.

Should the six-week and three-week sessions run concurrently, the total credits are not permitted to exceed the upper limit for the six-week session.

Quarter-time, half-time and three-quarter-time graduate assistants are defined as those who contribute an average of 10, 20 and 30 clock hours per week, respectively, of service to the University for the entire semester. A person employed full time is defined as anyone employed five full working days per week regardless of the employer(s). A graduate student who becomes employed full time while the assistantship is in force must notify the Graduate School and the department providing the assistantship. Graduate students paid solely on an hourly basis are not classified as graduate assistants but are subject to the same limitation in credit loads previously described.

Enrollment on a Pass/Fail Basis
The only graduate courses that may be taken on a pass/fail basis are thesis and dissertation research and a small number of unstructured courses in which the pass/fail grading system appears directly in the course description.

Graduate students shall not enroll on a pass/fail basis or audit any course required by the department or program. All other courses may be taken on a pass/fail basis or audit.

This decision must be made by the last day to add a class and is implemented by the student's major advisor or department chair forwarding a request to the Graduate School.

Auditing by Graduate Students
Permission for a student to audit a particular graduate course is at the discretion of the chair of the department, the coordinator of the program offering the course or the instructor. The principal factors involved in granting permission are that the auditor must possess the necessary academic background and space must be available.

Audited courses do not carry credit, and the fact that a course has been audited is not noted on the graduate student's official record. Graduate auditors are not required to stand tests or examinations. However, the instructor, at his or her own discretion, may demand or deny the auditor's participation in class to whatever extent deemed desirable.

A graduate student may not satisfy by audit a stated prerequisite for a graduate course. Additionally, a graduate student may not establish credit through examination in any course for which he/she was previously registered as an auditor.

Acceptance of Transfer Credit
The number of credit hours that may be transferred from an accredited institution shall be no greater than one-third (1/3) of the graded course work required for a master's degree. No more than 12 semester credit hours earned in a non-degree status at Clemson University can be applied to a degree program. For the doctoral degree, as many as 48 semester credit hours of work may be transferred.

In all cases, the use of transfer credits must be recommended by the student's advisory committee and approved by the department. Under no circumstances will transfer credit be awarded for research, internship or courses graded P/F, or for courses in which a grade lower than B, or its equivalent, has been received. Grades earned for courses taken at institutions other than Clemson University will not be included in the student's academic average.

Credits may be transferred for work completed at off-campus centers of accredited institutions provided such courses are acceptable, without reservation, in degree programs at those institutions. No credit will be given for continuing education units, correspondence, extension or service courses, or for concentrated courses and workshops that award credits at a rate exceeding one credit per week. All transfer credits must be verified by an official transcript from the institution at which the work was completed. Course work completed outside the six-year time limit may not be transferred to Clemson University or validated for graduate credit. (See "Time Limit" on page 30 for clarification.) Valid transfer credits will appear on the student's transcript as credits earned.

It is the student's responsibility to request a transcript of transfer credits to be sent directly to the Graduate School. The degree will not be conferred at the close of the term during which the student has been registered elsewhere for the purpose of transferring credits.

Independence of Graduate Degrees
If a student simultaneously pursues two master's degrees, one-sixth (1/6) of the total graded course work may be used toward both degrees. The Graduate Degree Curriculum (Form GS2), must clearly denote that the student is working toward two degrees and identify the courses that are being applied to both programs. Committee members, department chair and dean of both graduate programs must approve the two GS2 forms.

A graduate student who has completed the requirements for a graduate degree cannot use credits toward a second degree. Thus, the degrees are independent, implying that the formal curriculum for the degree at Clemson University can contain no credits used for an earlier degree.
DEGREE REQUIREMENTS

Courses are offered leading to the research degrees of Master of Arts, Master of Science and Doctor of Philosophy. In addition, courses are offered leading to the professional degrees of Doctor of Education, Specialist Education, Master of Agriculture, Master of Architecture, Master of Business Administration, Master of City and Regional Planning, Master of Construction Science and Management, Master of Education, Master of Engineering, Master of Fine Arts, Master of Forest Resources, Master of Health Administration, Master of Human Resource Development, Master of Industrial Education, Master of Parks, Recreation and Tourism Management, Master of Professional Accountancy and Master of Public Administration.

MASTER'S DEGREE

Course Work

The total number of graduate credits required for the degree is determined by the student's advisory committee, consistent with the specific program guidelines and Graduate School policy. These credits constitute the core of the student's Graduate Degree Curriculum (Form GS2) and appear on the form at the location entitled REQUIRED COURSES (GRADUATE LEVEL ONLY). Undergraduate deficiencies are listed at the designated location. Supplemental courses, carrying undergraduate or graduate credit and chosen to broaden the student's academic experience, are not required on Form GS2. However, if a listing is desirable, such courses will be listed as departmental requirements at the designated location.

The Graduate School requires each degree program to consist of a minimum of 30 semester hours of graduate credit with at least 12 semester hours, exclusive of master's thesis research (891), in the major discipline as defined by the advisory committee, subject to degree program regulations. A minor outside that degree program, if chosen, shall consist of at least six semester hours in that area. The following conditions, appropriate for the types of degrees, must also be observed:

1. Master of Arts or Master of Science (Thesis Option). Each program includes a minimum of 24 semester hours of graduate credit exclusive of six semester hours of master's thesis research (891). At least one-half of the total graduate credit hours required by the advisory committee, exclusive of thesis research, must be selected from courses numbered 800 or above.

2. Master of Arts or Master of Science (Nonthesis Option). Each program includes a minimum of 30 semester hours of graduate credit, none of which may be master's thesis research. At least one-half of the total graduate credit hours required by the advisory committee must be selected from courses numbered 800 or above.

3. Professional Master's Degrees. Each program includes a minimum of 30 semester hours of graduate credit. Except for professional programs in the College of Architecture, Arts and Humanities that require a thesis, research credits (891) may not be included in the program requirements. Any additional requirements for these degrees are described under the colleges which offer the degrees.

Residence

There is no University-wide residence requirement for a master's degree. However, individual degree programs may establish a requirement, which will be described and publicized for all prospective master's degree candidates in the particular program.

Time Limit

A master's student has six years to complete a degree. Therefore, all course work to be credited toward any master's degree must have been enrolled in and completed within six calendar years prior to the date on which the degree is to be awarded. For example, a person graduating in the spring semester must have started and completed all course work within the 72-month period beginning with the summer term six years earlier. When recommended by the student's advisory committee and approved by the graduate dean, as many as six semester hours of course work at Clemson University completed outside the six-year limit may be validated by a written comprehensive examination based on the latest syllabus and course content. Such examinations will be under the direction of the department regularly offering the course or courses for which the student seeks validation. Independent study courses are not subject to validation. Course work completed outside the six-year time limit at an institution other than Clemson University may not be transferred to Clemson or validated for graduate credit.

Foreign Language

A reading knowledge of one approved foreign language is a departmental requirement for certain Master of Arts and Master of Science degrees. Languages commonly accepted are French, German, Spanish, and in some cases, Russian or a classical language. Upon the recommendation of the chair of the Department of Languages, knowledge of another language may be approved provided that adequate justification can be presented, that the language is not native to the student, and that a proper testing procedure can be established. Any expense incurred in obtaining assistance for such testing must be paid by the student.

The language level expected is a basic reading knowledge equivalent to that provided by two years of study at the college level. The requirement may be satisfied in one of the following ways: 1) by completing 202 course or a course at the 300/400 level in the approved language with a grade of B or better; 2) by passing a translation test administered by the Department of Languages; 3) by passing French, German or Spanish 151. The requirement must have been completed within six years prior to the student's finishing the graduate degree.

The Department of Languages will administer the foreign language translation test three times annually: on the second Thursday of October, on the second Thursday of March and once during the summer, in conjunction with the final examination of the specific graduate language courses, if offered, or otherwise on the second Thursday in July. The student will be assessed a $20 fee for the test administration for foreign language translations tests, unless the graduate student fulfills the language requirement within a designated language course. Applications, available in the Department of Languages, must be filed with the Department of Languages at least three weeks before the test date.

On the recommendation of the chair of the Department of Languages, a student may satisfy the requirement by having completed at least 12 semester credit hours in an approved foreign language with an average grade of B or better. These credit hours must be earned from an accredited baccalaureate institution and must have been completed in total within six years prior to the student's finishing the graduate degree.

Off-campus Research

Although thesis research is normally performed at Clemson University, it is recognized that Clemson University may not have on its campus certain specialized equipment or facilities that would be desirable for advanced training at the master's
level. Thus, for those cases in which thesis or other advanced study is required and the facilities to pursue such study are not available on the Clemson campus, permission may be granted for off-campus research. The requirements to be satisfied in such cases are identical to those listed for the doctoral degree under "Off-campus Research" (see page 32), with the exception that the off-campus research supervisor need not hold the Ph.D. degree, provided he/she is qualified and certified for the supervisory position by the department and college involved and by the graduate dean.

Final Examination

Each candidate for the master's degree, after completion of the thesis, if required, and at least three weeks before the degree is to be awarded, must pass a final examination. The examination may be oral and/or written, and is administered by the advisory committee or a standing committee appointed in accordance with published program policies. The purpose of the examination is to ascertain the general knowledge of the candidate with particular reference to the major and minor subjects and the thesis or departmental report.

The Graduate School will be notified of the time and place of the examination at least 10 days prior to the time scheduled. Members of the faculty, as well as members of the Graduate Curriculum Committee and the dean of the Graduate School, are invited to attend the examination. Within five days after the examination, the examining committee, through Form GS7, will notify the Graduate School of the results of the examination. A student who fails a final examination may be allowed a second opportunity only with the recommendation of the advisory committee. Failure of the second examination will result in dismissal from the Graduate School. A majority decision is required, dissenting members of the examining committee should feel free to forward a minority report to the Graduate School.

SPECIALIST IN EDUCATION DEGREE

The requirements pertaining to residence, time limits and final examinations for master's degrees also apply to the Specialist in Education Degree. Course work required includes 30 semester hours beyond the master's degree to be selected from five areas prescribed by the Department of Elementary and Secondary Education.

DOCTOR OF PHILOSOPHY DEGREE

Course Work

Work leading to the Doctor of Philosophy degree is planned to give the student a comprehensive knowledge of his or her field of specialization and a mastery of the methods of research. The degree is not awarded solely on the basis of course work completed, residence or other routine requirements. The final basis of granting the degree is the student's grasp of the subject matter of a broad field of study, competency to plan and conduct research, and ability to express himself or herself adequately and professionally in oral and written language.

The advisory committee aids the student in developing a graduate degree curriculum, which includes the selection of specific courses and their sequence. Although no minimum course work requirements exist for the doctoral degree, committees are encouraged to require courses other than those that directly support the dissertation research. Work in the minor field or fields, if required, normally comprises from 12 to 24 hours in courses carrying graduate credit. A minimum of 18 hours of doctoral research is required. Should the direction of study or research interest change, the student may request the appointment of a new advisor.

Residence

Residence is a necessary concept in graduate education, particularly in the preparation of the dissertation. The purpose of residence is to require the student to spend a specified minimum amount of time as follows:

1. in direct personal association with members of the faculty of the University;
2. under direct tutelage and advisement of a research advisor and advisory committee in the department or program of the major; and
3. participating in other normal activities pertinent to graduate education such as seminars and close association with other student researchers.

To receive the Doctor of Philosophy degree, the student must complete at least 15 semester hours of graduate credit including research credit hours (991) on the Clemson University campus in a continuous 12-month period.

For students employed substantially more than half time, a statement specifying the manner in which the residence requirement is to be satisfied shall be formulated by the advisory committee and be included in the graduate degree curriculum. Also, upon completion of the final examination, the student's committee will forward to the Graduate School a statement approved by the department chair and college dean certifying that residence requirements have been met.

Time Limit

Because no minimum course work requirements exist for the Doctor of Philosophy degree, the time limitation for completion is determined by the dates by which essential ingredients of the degree are completed. The following must be passed in the five-year period prior to graduation:

1. comprehensive examination (see page 33);
2. foreign language examination, if required by program (see below),
3. defense of dissertation (see page 33), and
4. approval of dissertation by the Graduate School (see page 33).

Foreign Language

Certain doctoral programs include a foreign language requirement. Languages commonly accepted are French, German, Spanish, and in some cases, Russian or a classical language. Upon the recommendation of the chair of the Department of Languages, knowledge of another language may be approved provided that adequate justification can be presented, that the language is not native to the student and that a proper testing procedure can be established. Any expense incurred in obtaining assistance for such testing must be paid by the student.

The language level expected is a basic reading knowledge equivalent to that provided by two years of study at the college level. The requirement may be satisfied in one of the following ways: 1) by completing 202 course or a course at the 300/400 level in the approved language with a grade of B or better; 2) by passing a translation test administered by the Department of Languages; 3) by passing French, German or Spanish 151. The requirement must have been completed within six years prior to the student's finishing the doctorate degree.

The Department of Languages will administer the foreign language translation test three times annually: on the second Thursday of October, on the second Thursday of March, and once during the summer, in conjunction with the final examination of the specific graduate language courses, if offered, or otherwise on the second Thursday in July. The student will be assessed a $20 fee for the test administration for foreign language translation tests, unless the graduate student fulfills the language requirement within a designated language course. Applications, avail-
able in the Department of Languages, must be filed with the Department of Languages at least three weeks before the test date.

The foreign language requirement must be satisfied in a five-year period prior to the awarding of the doctoral degree. On the recommendation of the chair of the department of languages, a student may satisfy the requirement by having completed at least 12 semester credit hours in an approved foreign language with an average grade of B or better. These credit hours must be earned from an accredited baccalaureate institution and must have been completed in total within six years prior to the student’s finishing the graduate degree.

Off-campus Research

Under special circumstances, it may appear desirable that doctoral research be conducted away from the Clemson University campus. If such research is to be performed under the immediate direction of a Clemson University faculty member acting as dissertation advisor and supervisor, then in order to accommodate the student as well as to exercise proper and necessary control over this most important phase of doctoral study, the following additional requirements will be made:

1. Written Consent and Research Plan. The student must have the written consent of his or her dissertation advisor, full advisory committee, department chair, college dean and the graduate dean. Prior to departure from campus, the student must submit a written plan for his or her research effort to the advisory committee for approval. The plan should include a discussion of the problem and intended scope of the investigation, and should be structured in terms of a specific time frame.

2. Statement from Organization Where Research Will Be Conducted. The advisory committee may require a statement from an appropriate officer of the organization at which the student will be located agreeing to (a) the student’s plan to complete dissertation research using the organization’s equipment and facilities; (b) the apportioning of at least 25 percent or other appropriate amount of the student’s employment hours to dissertation research; and (c) the organization’s release of patent rights or copyrights arising from discoveries or concepts that evolve during the course of the student’s doctoral research.

3. Travel. The student may be required to travel to Clemson University, not at the expense of Clemson University, to meet with the dissertation advisor and advisory committee as often as is deemed necessary by the committee. Further, the student may, at the discretion of the dissertation advisor and advisory committee, be required to return to the Clemson campus subsequent to the performance of the mechanics of the research for the purpose of comprehensive review and analysis of the research.

4. Continuous Enrollment. The student must maintain continuous enrollment at Clemson University each semester while the research is in progress. It will be the student’s responsibility to make suitable arrangements with the department to maintain this continuous registration. Normally the student will not be required to register for summer sessions; however, he/she must be registered for the term that involves the review of the completed dissertation and/or the final examination.

5. Supervision and Reports. When doctoral research is conducted away from the Clemson campus and under the immediate direction of a dissertation supervisor who is employed by an organization other than Clemson University, in order to accommodate the student, as well as to exercise proper and necessary control over this important phase of doctoral study, the following requirements must be met:

(a) An employee, having earned a Ph.D. and being engaged in the general subject area of the student’s research, must be designated by an officer of the organization to supervise the student’s research work.

(b) The employee must be recommended to the provost by the appropriate college dean for appointment as an adjunct professor of Clemson University.

(c) A resume of the research supervisor must be submitted to the student’s full advisory committee for its review and recommendation to the graduate dean.

(d) The research supervisor must submit a final statement regarding the dissertation research, as well as interim reports if the committee deems such necessary.

(e) The off-campus research supervisor cannot serve as the student’s major advisor.

Qualifying Examinations

Some doctoral programs require preliminary or qualifying examinations prior to the comprehensive examination. The structure, duration, review and re-examination policies for these examinations are defined in writing by the program faculty and are available from the program coordinator. A copy of these policies is also to be filed with the Graduate School.

Comprehensive Examinations before Admission to Candidacy

Prior to taking the comprehensive examination before admission to candidacy, the doctoral student must have selected an advisory committee and filed an approved graduate degree curriculum (Form GS2) with the Graduate School.

Satisfactory completion of the comprehensive examination must occur no less than six months and no more than five years prior to the date of graduation. For examinations consisting of several parts (for example, a written plus an oral, or a written in cumulative format), the date of completion will coincide with the date of the last examination activity. However, the time span from the beginning to the end of the examination must not exceed 12 months, and failure of any portion that negates further examining will be reported as a failure of the examination. The student has five calendar years after the date of the completion of the comprehensive examination to complete all other degree requirements. A student who completes all the degree requirements will be invited to participate in the next scheduled graduation ceremonies.

A comprehensive examination is attempted only at the recommendation of the student’s advisory committee after completion of most of the required coursework. The function of the examination, which may be written or a combination of written and oral, is to obtain objective evidence of an adequate intellectual mastery of the areas of the major and minor specializations. This examination must be administered by the Clemson University program faculty offering the degree. The examining committee may be the student’s advisory committee or a standing committee appointed in accordance with published program policies. A majority decision is required; dissenting members of the examining committee should feel free to forward a minority report to the Graduate School. The chairperson of the advisory committee will inform the Graduate School of the result, via Form GS5, within three weeks following the examination. The student’s performance on this examination will determine whether he/she will be recommended for admission to candidacy for the degree.

Should the student fail to pass the comprehensive examination, he/she may be given a second opportunity if so recommended by the examining committee. A second failure shall result in the student being declared ineligible to receive the Doctor of Philosophy degree at Clemson University.
Final Doctoral Examination

The candidate for the Doctor of Philosophy degree must pass a final oral examination (dissertation defense) at least three weeks prior to the time of the commencement at which he/she plans to obtain the degree. The examination will be conducted by the student's advisory committee, and all faculty members are invited to participate. The Graduate School will be notified of the time and place of the examination at least 10 days prior to the time scheduled. Members of the faculty, as well as members of the Graduate Curriculum Committee and the dean of the Graduate School, are invited to attend the examination. Exceptional cases may arise; however, and the guidelines below shall apply to any sponsored projects requiring that results be kept confidential.

This final examination demands a broad and penetrating interpretation by the student of the research project and conclusions. It may include examination of the student in the major and minor fields of specialization. A student who fails a final oral examination may be allowed a second opportunity only with the recommendation of the advisory committee. Failure of the second examination will result in dismissal from the Graduate School.

DOCTOR OF EDUCATION DEGREE

Degree requirements pertaining to residence, time limit, and comprehensive and final examinations are the same as those for the Doctor of Philosophy degree. In addition, the candidate for the Doctor of Education degree must arrange with his or her advisory committee to engage in an internship appropriate to his or her field of professional service.

THESIS AND DISSERTATION

Candidates for advanced degrees receive academic credit for conducting research and preparing a thesis (master’s candidates) or a dissertation (doctoral candidates) under the direction of the research advisor. In those Master of Arts or Master of Science degree curricula requiring a thesis, six credits of research (891) are required. The thesis option curricula in the Master of Architecture, Master of City and Regional Planning, and Master of Fine Arts degree programs require 15, 6-9 and 15 credits of research, respectively. A dissertation, mandatory for all candidates for the Ph.D. or Ed.D. degrees, requires 18 credits of doctoral research (991) exclusive of any research credits earned at the master’s level.

The accumulation of grades of pass in thesis or dissertation research does not imply completion of the research, but only indicates satisfactory progress.

1. Student Responsibility. The student, in consultation with his or her major advisor, shall provide each remaining advisory committee member with a copy of the manuscript for initial review. This action should take place well in advance of, and not less than three weeks prior to, the final examination and defense of the thesis or dissertation. Students must prepare the manuscript in a publication style acceptable to the advisory committee. When the manuscript is approved by the advisory committee, the thesis or dissertation is presented to the Graduate School for final review and signature prior to duplication.

Three copies of the thesis or dissertation, required for hard binding, must be submitted to the Graduate School by the deadline date appropriate for the anticipated graduation date. A binding fee of $30* must be paid to the bursar and the completed forms returned to the Graduate School at the time the duplicated theses or dissertations are submitted. If the student desires, two personal copies may be bound at a cost of $10* per copy; additional copies may be bound at a cost of $15* per copy.

For doctoral candidates, a fourth copy of the dissertation is required for microfilming and is placed by the Graduate School with University Microfilms, Inc., of Ann Arbor, Mich. An additional copy of the approval page, title page and abstract must also be submitted, with the abstract not exceeding 350 words. Occasionally, this will necessitate revision of the longer original abstract, which is retained in all copies. The abstract should be written and edited in a form suitable for publication and database retrieval. It is the responsibility of the candidate to make these revisions; further information may be obtained from the Graduate School. The total microfilming fee is $55* and must be paid to the bursar simultaneously with the binding fees. A fee of $35* is necessary if copyright is desired.

2. Faculty Responsibility. The research advisor determines when the manuscript is suitable for initial review by the remaining committee members. Guidelines for the review process and a thesis/dissertation review form are available in the departments and the Graduate School. These guidelines are designed to produce a timely review by each committee member and to provide a measure of protection for all affected parties against problems resulting from lack of communication and/or attention. If the student requests, the research advisor is obligated to initiate the thesis/dissertation review form and forward it to the remaining committee members along with the manuscript. The research advisor must be cognizant also of departmental practices regarding the quality of the manuscript at the various review stages and of the wishes of the department chair, as an ex-officio committee member, to exercise the option of approving the thesis or dissertation in its final form.

Committee members should normally complete the initial review in three weeks or less. Provisions of the guidelines, however, allow for additional time if necessary. Failure of a committee member to complete the initial review within six weeks may result in his or her replacement, provided the student has requested use of the thesis/dissertation review form. A second review after revisions should be completed in one week, with provisions being available for additional time.

It should be understood that a vote to pass a student on his or her performance at the thesis/dissertation defense (Form GS7) does not imply final approval of the thesis or dissertation. Approval of the thesis or dissertation is given by faculty signing the approval page.

Restrictions on Use of Theses and Dissertations

Unpublished theses and dissertations submitted to the Graduate School in partial fulfillment of the requirements for graduate degrees and deposited in the University library are, as a rule, open to the public for reference purposes. However, extended quotations or summaries may be published only with the permission of the author and the graduate dean.

Publication Policy

A university’s primary function is the accumulation and dissemination of knowledge. It is therefore expected that the results of research performed using University facilities be published in the open literature (i.e., theses, dissertations, journals, magazines or books) and that any information obtained may be freely disclosed by the faculty in the teaching programs of the University.

Exceptional cases may arise, however, and the guidelines below shall apply to any sponsored projects requiring that results be kept confidential.

1. The University shall not accept awards that require research results to be kept confidential. A definite term of confidentiality shall be stated in a written nondisclosure agreement and shall

*Subject to change.
not exceed one year beyond the date of notification to the sponsor that a manuscript suitable for publication has been prepared. Exceptions may be granted by the University administration only under unusual circumstances; e.g., national security, national emergency, classified activities or certain confidential agreements.

2. Students associated with confidential projects must have prior approval for the use of results in preparing reports, theses or dissertations in fulfillment of degree requirements. The Graduate School will normally not accept a thesis or dissertation that must be held in confidence for more than one year. Documents submitted in partial fulfillment of degree requirements will be retained by the Graduate School (or the department in the case of project reports for nonthesis programs) in accordance with the nondisclosure agreement. The student's thesis or dissertation defense shall not be open to those not bound by the nondisclosure agreement.

Patents and Copyrights
All students enrolling in the Graduate School at Clemson University do so with full understanding that:

1. The University has full ownership rights in any inventions, discoveries, developments and/or improvements, whether or not patentable (inventions), which are conceived, developed or reduced to practice, or caused to be conceived, developed or reduced to practice, by graduate students during the course of their research activities conducted as part of any Graduate School curriculum. Any such invention will be handled by the University in the same manner as set forth in The Faculty Manual of Clemson University, the pertinent provision for which appears as Part VIII B entitled "Patent Policy."

2. Copyright ownership of any research work will be determined by University policy and by policies of organizations responsible for publishing or distributing copyrighted materials.

INTRODUCTION
The Graduate Student Academic Grievance Committee hears all grievances involving the following: (a) grievances of a personal or professional nature involving an individual student and a faculty member; (b) the claim by a student that the final grade in a course was inequitably awarded; (c) cases where the grievance involves graduate student employment; and (d) graduate student academic dishonesty. In all unresolved cases the committee makes its recommendations to the president through the provost. All proceedings of the committee are confidential.

Membership of this committee consists of the following: five faculty members involved in graduate education (one from each college) elected by the collegiate faculty for three-year terms, two graduate students nominated annually by the Graduate Student Government (GSG) and appointed by the provost, and one representative of the Graduate School serving in a non-voting, advisory role. Each year the chair is elected from among the continuing faculty members. The terms of appointment begin with each fall registration.

Scientific Research
Graduate students conducting scientific research in a student role at Clemson University do so with the full understanding of the following:

1. At the discretion of their thesis advisor or employment supervisor, as appropriate, students may be required, at the initiation of the research efforts, to maintain and preserve all primary data and materials associated with the research, and deliver these materials to their supervisor in complete, cataloged and identified form before the students will have been deemed to have completed the requirements for their program of study.

2. At the discretion of their thesis advisor or employment supervisor, as appropriate, students may be required to keep a clear, concise and complete research notebook(s) as an accurate record of their research activities and deliver these notebooks to their supervisor before they will have been deemed to have completed the requirements for their program of study.
parties, the committee will provide an opportunity for a hearing on the grievance. Two weeks' notice will be provided to all parties in the grievance. Either party to the grievance may petition for a hearing on the grievance.

7. The hearing on the grievance will be informal and closed to the public. The chairperson of the committee shall take whatever action is necessary to ensure an equitable, orderly and expeditious hearing. Minutes of the meeting will be taken, and all parties to the grievance will be given an opportunity to be heard. Each party is responsible for having present at the hearing all witnesses who will speak on his or her behalf. In addition, the chairperson may request the presence at the hearing of any other person who has pertinent information on the grievance.

Witnesses shall not be present during the hearing proceedings except when called upon to speak before the committee. The parties will be permitted to question all individuals present at the hearing and heard by the committee. If any witness is unable to be present at the hearing, the chairperson may, at his or her discretion, accept a written statement from that witness to be presented at the hearing. The parties shall be accorded the right to assistance of counsel of their own choice; however, the role of counsel shall be solely to assist the party, and counsel shall not be permitted to participate actively in the proceedings.

8. Upon conclusion of the hearing, the committee, meeting in executive session, shall reach, by a majority vote of those committee members present, a solution to the grievance. If the chairperson can persuade all parties to the grievance to accept the committee's solution within fourteen calendar days, the matter of the grievance will be considered closed when the solution is effected.

9. If, after the conclusion of the hearing, the chairperson cannot obtain approval of the committee's recommended solution from all involved parties, the grievance will be referred to the president of the University via the provost, with the committee's solution as the recommended solution to the grievance. When grievances are referred in this manner, the president shall make the final decision on behalf of the University.

10. The Graduate School shall keep in confidence all records pertinent to each grievance and pass these records to the Office of the Provost for filing. Records shall be available to succeeding chairpersons of the Graduate Student Grievance Committee.

11. A majority of committee members shall constitute a quorum for transaction of committee business; at least one appointed faculty member and one appointed graduate student must be present.

12. The Graduate Student Grievance Committee shall meet as often as necessary to dispense expeditiously with grievances brought before the committee.

13. These rules and procedures can be amended by the Graduate Student Academic Grievance Committee. Such rule changes will not affect any case under consideration at the time of the change. Notification of any amendments to these rules and procedures should be given to the president of the University via the Academic Council.

POLICY ON ACADEMIC MISCONDUCT

A university is a community of scholars dedicated to the free inquiry of knowledge and truth. It follows as a basic tenet that scholars will conduct themselves with integrity in academic pursuits. In instances where the academic standards may have been compromised, Clemson University has a responsibility to protect this process and to respond appropriately and expeditiously to charges of academic misconduct. Academic misconduct includes, but is not limited to, submission of fraudulent admission credentials, academic dishonesty, falsification of data in research and plagiarism in theses, dissertations or other final projects.

I. General

A. Academic dishonesty includes giving, receiving or using unauthorized aid on any academic work.

B. Plagiarism, a form of academic dishonesty, includes the copying of language, structure or ideas of another and attributing the work to one's own efforts.

C. All academic work submitted for grading contains an implicit pledge and may contain, at the request of the instructor, an explicit pledge by the student that no unauthorized aid has been received.

D. Academic dishonesty includes attempts to copy, edit or delete computer files that belong to another person or use Computer Center account numbers that belong to another person without the permission of the file owner, account number owner or file number.

II. Penalties

A. A student guilty of the first offense of academic dishonesty typically will receive a grade of F for the course. In flagrant cases, the student may also be suspended for one or more semesters or may be permanently dismissed.

B. A student guilty of the second offense of academic dishonesty will receive a grade of F for the course, will be suspended for one or more semesters and may be permanently dismissed. Suspension and dismissal require approval of the president of the University.

III. Procedures

Academic honesty is the individual responsibility of each student. Students should report violations of this policy either to the instructor of the affected course or to any member of the administration. When, in the opinion of an instructor, a student has committed an act of academic dishonesty, the following procedure must be followed:

1. The instructor will inform the student in private of the nature of the alleged charge of academic dishonesty and will simultaneously request in writing that the department chair verify from the registrar if the incident is a first offense.

2. When this information has been received, the instructor will notify the student in writing of the charge of academic dishonesty and the penalty recommended by the instructor and approved by the chair of the department in which the course is taught. The notification will further state that if the student regards the charge as unfair, the student has seven days from the date of receipt of notice to file a grievance with the Graduate Student Grievance Committee.

3. If no grievance is filed by the student, the instructor will forward copies of the written notification to the dean of the college and to the registrar.

4. Should the act of dishonesty not be in the college of the student's major, the registrar will notify the major department chair.

5. A charge of academic dishonesty in a course must be made within 45 calendar days of the date printed on the grade report for the semester or session in which the course is completed. For grades that replace an original grade of I (incomplete), the 45 days begin the day the I is converted to the final grade.

POLICY ON ACADEMIC MISCONDUCT FOR FORMER STUDENTS

It is possible that an act of academic misconduct will remain undiscovered until after a degree is awarded. In such a case, Clemson University reserves the right to revoke any degree based on new revelations about scholarly issues including, but not restricted to, admission credentials, course work, research, theses, dissertations or other final projects.
I. Submission of Fraudulent Admissions Credentials

The submission of fraudulent admissions credentials in the student's application or any other documents submitted for admission to Clemson University may result in initiation of action under the Policy and Procedure on Revocation of Academic Degrees.

II. Academic Dishonesty in Course Work

In the event that the act is alleged to have occurred within the context of a course and is consistent with the general definition of academic dishonesty presented in Sections I of the Policy on Academic Misconduct for enrolled students, the same procedures in that policy will apply except for academic misconduct listed in III below.

Graduate Students:

If the resulting penalty is either the assignment of a grade of D or F in a required graduate course, or the issuance of any grade that causes the student not to possess a cumulative B average in both graduate courses and in all courses, action under the Policy and Procedures on Revocation of Academic Degrees may be initiated.

Undergraduate Students:

If the resulting penalty causes the student to no longer have the necessary credit hours and/or course work for receiving a degree, action under the Policy and Procedures on Revocation of Academic Degrees may be initiated.

III. Falsification of Data and Plagiarism in Theses, Dissertations or Other Final Projects

Data falsification, plagiarism (as defined in the Academic Misconduct Policy) and other acts of academic dishonesty in a thesis, dissertation or other final project are serious acts of misconduct. Allegations of this type of misconduct may result in initiation of action under the Policy and Procedure on Revocation of Academic Degrees (see page 38).

Grade Protests

A student wishing to protest a course grade must first attempt to resolve any disagreement with the instructor. In failing to reach a satisfactory resolution, the student may follow the procedure under "Grievances" (see page 34). All grade changes and grievances must be filed within 90 calendar days from the date on the grade report.

ACADEMIC RESEARCH

Policy on Research Ethics

I. PREAMBLE

Research institutions have a critical responsibility to provide an environment that promotes integrity, while at the same time encouraging openness and creativity among scholars. Care must be taken to ensure that honest error and ambiguities of interpretation of scholarly activities are distinguishable from outright misconduct. To address all allegations of fraud or misconduct, definitions, policies and procedures must be in place to facilitate and guide such processes.

This policy is applicable to all researchers associated with Clemson University, including faculty, students and staff. If charges are brought against non-faculty members of Clemson University, appropriate substitutions should be made for the role of the Faculty Senate officers and dean. If charges are brought against a former student that could result in the student's degree being revoked, those charges should be processed through the University's Policy and Procedure on Revocation of Academic Degrees rather than through this policy.

II. DEFINITIONS

A. Research

Research is used in a general sense (as opposed to scientific research) to yield a policy applicable to all academic disciplines in the University.

B. Misconduct

Dishonest deviation from accepted practices in conducting research activities.

C. Fraudulent failure to comply with university, regulatory and funding agencies requirements affecting specific aspects of the conduct of research.

This definition includes:

- Falsification of data - ranging from falsification or intentional misrepresentation of methods, materials or results to selective reporting of findings, such as the purposeful omission of conflicting data with the intent to manipulate the results;
- Plagiarism - representation of borrowed work as one's own;
- Misappropriation of others' ideas - the unauthorized and intentionally dishonest use of privileged information (such as that which might be gained during peer, paper or grant reviews), however obtained;
- Malicious and public misrepresentation of a colleague's ethical research behavior;
- Conflicts of interest that could influence the researcher's decisions or conclusions, or which could provide unfair gain to the researcher;
- Other misuse of position as researcher for personal gain;
- Exploitation (such as failure to credit work, misrepresentation of research relationship, etc.) of students, or other persons, for research purposes.

This definition does not include:

- Non-fraudulent failure or inadequacy of performance, incompetence or honest error;
- Non-fraudulent breaches of contracts;
- Employment discrimination, sexual harassment, violation of human subjects policy or animal welfare policy, or other forms of misconduct that are the concerns of different, distinctive administrative policies.

C. Inquiry

Expeditious gathering and review of information to determine if an investigation is warranted.

This is not a formal hearing, but a process designed to separate frivolous, unjustified or mistaken allegation from facts regarding the incident.

D. Investigation

A formal examination and evaluation of all relevant facts to determine if an instance of misconduct has occurred.

E. Disposition

The Committee of Investigation shall only determine whether a breach of ethics has occurred and will not make recommendations relative to the nature or severity of the action to be taken.

If the investigation committee finds that the complaint was intentionally dishonest and malicious, the committee can recommend action against the accuser.

In the event that allegations are not confirmed, the institution shall make full efforts to restore the reputation of the accused; the accused's recommendations to accomplish this should be accommodated insofar as is possible.

III. PROCEDURES

A. Overall Structure

An allegation or complaint involving the possibility of misconduct can be raised by anyone. The allegation should be made in writing to the Faculty Senate president in a confidential manner. Accusations must be signed.

Charges must be filed within seven years of the date on which the event in question occurred. If the date of limitation is in question, the Faculty Senate president, the chair of the Faculty Senate Research Committee and the vice president for research shall determine whether the given event occurred within the specified time limit.

The Faculty Senate president and the chair of the Faculty Senate Research Committee should accept the accusation only after they are satisfied that its substance complies with this policy's definition of
"misconduct." At this time, and at their discretion, they may consult with the vice president for research relative to the alleged research ethics violation.

A meeting should be scheduled to occur within 20 calendar days following acceptance of the accusation for the accused to appear before the president of the Faculty Senate and the chair of the Faculty Senate Research Committee for the purpose of hearing the charge(s) and being informed of who authored the charges. The accused will be asked to plead "guilty" or "not guilty" to each charge. If the accused pleads "guilty", the president of the Faculty Senate will report the facts to the vice president for research, who will, within 90 calendar days, prepare a report for the provost.

If the accused pleads "not guilty", or if the accused refuses to respond, an inquiry, the first step of the review process, should result. The vice president for research should be notified of the inquiry. In the inquiry state, factual information is gathered and expeditiously reviewed to determine if an investigation of the charge is warranted. An inquiry is not a formal hearing; it is designed to separate allegations deserving of further investigation from frivolous, unjustified or clearly mistaken allegation.

The vice president for research will inform the accuser of the disposition at the conclusion of the investigation stage.

During the initial meeting with the accused for the purpose of presenting charges, only the Faculty Senate president, the chair of the Faculty Senate Research Committee and the accused with his/her lawyer, if desired, may be present. During hearings by the Committee of Inquiry or the Committee of Investigation, only duly appointed members of the given committee and the committee's invited witnesses with his/her lawyer, if desired, may be present.

B. Inquiry

The vice president for research and the Faculty Senate president will appoint, within 10 calendar days of a response of "not guilty" to charges by the accused, a Committee of Inquiry of three faculty members with one individual appointed as chair.

For any specific allegation or set of allegations, the Committee of Inquiry will determine if an investigation is warranted. The Committee of Inquiry will submit a written report to the vice president for research and the Faculty Senate president within 30 calendar days of the formation of the Committee of Inquiry.

C. Investigation

If the Committee of Inquiry so recommends, the vice president for research and the Faculty Senate president will appoint within 20 calendar days a Committee of Investigation consisting of five faculty members, other than those serving on the Committee of Inquiry, to conduct a full investigation.

The Committee of Investigation, meeting in closed sessions, will review all materials, question relevant parties, and allow for all parties to present their views separately (without the presence of the other parties) to the committee.

The Committee of Investigation will prepare, within 90 calendar days, a report indicating whether ethics violations have occurred; the report may include estimation of one or more of the following:

- the scope of the intentional dishonesty perpetrated by the accused;
- the degree of gain that might accrue to the accused because of the unethical behavior;
- the seriousness of harm intentionally perpetrated against other individuals.

The estimation shall be used in determining disciplinary action against the accused. In less serious cases, action may include a verbal reprimand, or, if conditions warrant, a letter in the offender's personal file. In more serious cases, action might include such sanctions as additional supervision of research activity, loss of merit pay or recommendation against promotion. In only the most serious cases should dismissal be considered.

The report will be submitted to the vice president for research and the Faculty Senate president, who will forward the report to the provost.

The provost will review the report and render a decision within 15 calendar days. Any recommendation that may constitute disciplinary action against a faculty member will be referred by the provost to the appropriate dean or other administrator as determined by the provost. The dean or administrator will decide the appropriate action within 15 calendar days.

If disciplinary action taken against a faculty member constitutes a grievable action under either Faculty Grievance Procedure I or Faculty Grievance Procedure II, the faculty member may file a grievance in accordance with the appropriate procedure. Disciplinary action against other individuals associated with the University are subject to applicable grievance procedures.

D. Guiding Principles

Maximize confidentiality and protect the reputations for both the accused and accuser during the full process.

Assure the respondent a fair hearing and access to reports.

Minimize the number of individuals involved in the inquiry and investigation phases.

Individuals chosen to assist in the inquiry process should have no real or apparent conflicts of interest bearing on the case in question. They should be unbiased and have appropriate background for judging the issues being raised.

Consultation of University legal counsel is probably necessary.

Appropriate funding agencies should be fully informed in writing at both the outset and conclusion of an investigation.

All detailed documentation of the committees of Inquiry and Investigation shall be maintained by the Office of the Vice President for Research for at least three (3) years and must, upon request, be provided to authorized personnel.

Appropriate interim administrative actions will be taken by the vice president for research at the outset of the inquiry stage to protect supporting funds and to ensure that the purposes of the project are being met.

Executive Interpretation

II. B. The Research Ethics Policy clearly restricts action to matters of research ethics; it does not address such things as simple ineptitude, non-fraudulent breach of contract or malpractice covered by existing policy (see exclusions under section II). Note the following:

- The definition includes malicious and public (suggesting that neither maliciousness nor publicness, alone, is sufficient) misuse of the research ethics policy itself (reference section II. E.).

- Exploitation of others includes misuse of colleagues, such as intentional and malicious failure to credit the work of another, deliberately misleading other individuals to obtain research goals, etc. It does not include benign activity that seems to, or may actually, exploit.

- This policy should not be construed to include any activity that is benign in intent (not malicious, deliberately misleading, etc.).

II. E. It is the responsibility of University faculty to protect its research integrity by condemning unethical research activity, by investigating credible charges of unethical research brought against the faculty's peers, by taking steps to restore the reputations of peers that are charged unjustly or in error, by assessing the damage done by an unethical peer if appropriate (see section III. C.), and by seeking sanction through University administrative authorities against those who violate ethical research practices. Appropriate administrative personnel alone have the
authority to deprive one of property or liberty interests (within legal constraints). Consequently we feel that the assessment and pursuit of sanctions against an individual should not be a matter addressed by this policy.

III. A. Charges which do not fall within the purview of this policy (see section II. B.) should not be forwarded to a Committee of Inquiry. The processes of Inquiry and Investigation threaten an academician's most cherished professional possession - his or her reputation. That reputation should not be threatened without clear cause, thus charges that do not involve “Research Ethics” as defined by this document should be pursued through other channels. For these reasons, the president of the Faculty Senate and the chair of the Faculty Senate Research Committee, upon receipt of the charges, should confirm that the charges comply in substance with this policy's definitions before any action is initiated. This is not to say that the president of the Faculty Senate and the chair of the Faculty Senate Research Committee should judge the legitimacy of the charges or the facts of the case.

Because the vice president for research has an overall view of University policy and activities that may be valuable at this stage of the process, the president of the Faculty Senate and the chair of the Faculty Senate Research Committee, at their discretion, may consult with the vice president for research prior to rendering a decision about whether the charges should go forward under this policy.

It is in the interest of the accused and the University to provide an opportunity to the accused to abbreviate the procedures outlined in this policy. Specifically, the accused need not be subjected to the trauma of a peer investigation if indeed he/she would prefer to admit guilt and be excused from further investigation. Hence, the vice president of the Faculty Senate may not be grounded (not that the charge is false), but the procedure should be such that the accused need not be subjected to the potential damage to reputation increases as the scope of an inquiry grows. The pertinent question is, how far should a Committee of Inquiry go to protect an unjustly charged individual against a more extensive investigation given the need to limit the scope of knowledge about the charges?

The answer is that the Committee of Inquiry should limit its efforts to the minimum needed to establish that the facts in the case are contentious, or that there is a probability that the accused’s position is or is not credible. Certainly the accused should have the opportunity to respond to the charges before the Committee of Inquiry.

The Committee of Inquiry may need to seek clarification from the accuser and may even need to resolve doubts by seeking evidence from another source. At all times, however, the Committee of Inquiry should seek to confine the extent of knowledge about the charges leveled, and consequently should cease its inquiry as soon as it can conclude that the charges may or may not be grounded (not that the charges are or are not true). Strategies may include strictly limiting the number of individuals approached about the matter, limiting witnesses to individuals who have prior knowledge of the charges, or soliciting documentation from involved parties.

In addition to determining probability of ethics violation, the Committee of Inquiry should clarify the charges brought against the accused. This involves throwing out charges that are frivolous or ungrounded, and identifying those charges that may be grounded.

A subsequent Committee of Investigation, because its investigation is more thorough, need not, of necessity, be bound to the scope defined by the Committee of Inquiry, but should give credence to its recommendations.

III. C. The Committee of Investigation is responsible for determining whether an ethics violation has occurred relative to the situation addressed by the charges. Such violation need not be limited to the specific charges, but should be related to the incidents addressed by those charges. The person who brings charges may be aware of only some of the ethical violations associated with a given incident, thus an investigation needs the freedom to note problems relative to that incident which may uncovery during the course of investigating the charges.

The Committee of Investigation, like its predecessor, is concerned with protecting the integrity of the parties involved. Consequently, it too should balance the need for information upon which to make a decision against the need for confidentiality. In this case, however, the balance should favor the gathering of information. It is important that this committee be correct in its decision than it is to limit the scope of knowledge about the investigation. The committee should, of course, cease operation when it has enough information to make a just decision, but should not jeopardize justice in the name of confidentiality.

POLICY AND PROCEDURE ON REVOCATION OF ACADEMIC DEGREES

Preamble

Academic institutions have a critical responsibility to provide an environment that promotes integrity, while at the same time encouraging openness and creativity among scholars. Care must be taken to ensure that honest error and ambiguities of interpretation of scholarly activities are distinguishable from outright misconduct. This policy is applicable to fraudulent or other misconduct in obtaining an academic degree which is so egregious that a mechanism for revoking an academic degree, either graduate or undergraduate, must be undertaken. The Clemson University Board of Trustees has the sole authority to revoke any degree previously awarded.

DEFINITIONS

As used herein, the following terms shall apply:

When the degree holder was an undergraduate student:

"Dean" shall mean the dean of the academic college where student was enrolled.

"Committee of Investigation and Recommendation" shall be composed of the members of the standing University Undergraduate Continuing Enrollment Appeals Committee. An undergraduate student will be appointed to the Committee of Investigation and Recommendation by the president of the student body within ten calendar days of notification by the president of the Faculty Senate. Any member of the Continuing Enrollment Appeals Committee who is a faculty member in the department that awarded the degree involved shall not be a member of the Committee of Investigation and Recommendation for that particular investigation. If there are fewer than three non-disqualified faculty members, the president of the Faculty Senate shall appoint
additional faculty members to bring the number of faculty committee members up to three. If the president of the Faculty Senate is from the same department that awarded the degree involved, the president-elect of the Faculty Senate shall appoint the additional member.

When the degree holder was a graduate student:

"Dean" shall mean the dean of the Graduate School.

"Committee of Investigation and Recommendation" shall be composed of the members of the standing University Graduate Admissions and Continuing Enrollment Appeals Committee, except for the associate dean of the Graduate School who shall not be a member of the Committee of Investigation and Recommendation. A graduate student will be appointed to the Committee of Investigation and Recommendation by the president of Graduate Student Government within ten calendar days of notification by the president of the Faculty Senate. Any member of the Graduate Admissions and Continuing Enrollment Appeals Committee who is a faculty member in the department that awarded the degree involved shall not be a member of the Committee of Investigation and Recommendation for that particular investigation. If there are fewer than three non-disqualified faculty members, the president of the Faculty Senate shall appoint additional faculty members to bring the number of faculty committee members up to three. If the president of the Faculty Senate is from the same department that awarded the degree involved, the president-elect of the Faculty Senate shall appoint the additional member.

COMPLAINT
An allegation or complaint involving the possibility of misconduct can be raised by anyone. The allegation should be made in writing to the dean.

Initial Review
The dean will conduct the initial review to determine whether or not the allegation has merit. The dean may discuss the matter with the former student's advisory committee (if any) and other faculty as appropriate. The dean may also contact persons outside the University who may be able to provide factual information on the alleged misconduct or who may otherwise have expertise concerning issues involved in the alleged misconduct. If the dean determines that the allegation has merit, he/she will terminate the investigation. If the dean determines that serious academic misconduct is suspected, the dean will notify the president of the Faculty Senate in writing in a confidential manner. The dean shall also notify the vice president for academic affairs and provost of the charge but will not discuss any details of the charge.

Committee of Inquiry
The president of the Faculty Senate shall, within ten (10) calendar days of receipt of the notification from the dean, appoint three (3) faculty members to the Committee of Inquiry and notify the president of Graduate Student Government or the president of the student body, as appropriate, who shall appoint a graduate or undergraduate student, as appropriate, to the Committee of Inquiry within ten (10) calendar days of notification. The president of the Faculty Senate shall also notify the degree holder of the formation of a Committee of Inquiry.

If the Faculty Senate president is from the same department that awarded the degree involved, the president-elect of the Faculty Senate shall appoint the Committee of Inquiry. The faculty members will be appointed from departments which did not award the degree involved. The committee will elect its chairman from the faculty members on the committee.

For each allegation, the Committee of Inquiry will review the complaint and any other information provided by the dean and determine whether there is sufficient evidence to warrant a formal charge of academic misconduct and further investigation under this policy. While the Committee of Inquiry shall not make a recommendation as to whether a degree should be revoked, the purpose is to provide a review to separate frivolous, unjustified or mistaken allegations from those requiring a more detailed and formal investigation. The Committee of Inquiry will review the evidence and must determine that the alleged misconduct more probably than not occurred in order for the committee to recommend a formal charge and further investigation.

Within thirty (30) calendar days of the formation of the Committee of Inquiry, the Committee of Inquiry will submit a written report to the president of the Faculty Senate. If the Committee of Inquiry's report finds that the investigation should not proceed, the president of the Faculty Senate shall terminate the investigation and notify the appropriate persons. If the Committee of Inquiry's report finds that a formal charge and further investigation are warranted, the president of the Faculty Senate shall, within ten (10) calendar days of receipt of the report of the Committee of Inquiry, send a copy of that report to the dean and to the Committee of Investigation and Recommendation. The president of the Faculty Senate shall also immediately notify the president of Graduate Student Government or president of the student body (whichever is appropriate) that a student representative needs to be appointed to the Committee of Investigation and Recommendation. The president of the Faculty Senate shall also notify the vice president for academic affairs and provost of the Committee of Inquiry's recommendation. No details of the charge will be discussed. Note: A majority vote of the Committee of Inquiry is necessary to recommend that a formal charge and further investigation are warranted. A tie vote means that an investigation is terminated as stated herein.

Notification to Degree Holder
The dean shall issue in writing, within ten (10) calendar days of receipt of the report of the Committee of Inquiry, a formal charge of academic misconduct to the degree holder. This written notice shall detail the factual allegations for the charge and the evidence supporting the charge. This written notice shall also inform the degree holder of his/her right to appear at a hearing as stated in this policy. The dean shall also send with this notice a copy of this Policy and Procedure on Revocation of Academic Degrees to the degree holder. This notice shall be delivered to the accused person or sent by certified mail, return receipt requested.

Committee of Investigation and Recommendation
The Committee of Investigation and Recommendation shall extend to the degree holder due process which shall, at a minimum, include the following:

- Notice of the nature of the complaint;
- Notice of the evidence supporting the complaint;
- Notice of the hearing;
- The opportunity to present evidence, including testimony;
- The opportunity to hear the testimony against the degree holder;
- The opportunity to ask questions of all witnesses.

The opportunity to have an attorney or advisor present at the hearing; however, the role of the attorney or advisor shall be solely to assist the party, and the attorney or advisor shall not be permitted to participate actively in the proceedings.

The degree holder shall not be entitled to know the identity of the person(s) who originally made the complaint unless that person agrees that his/her identity can be revealed.

The chair of the Committee of Investigation and Recommendation shall inform
the degree holder of the time and date of the hearing.

The dean or his/her designee shall present the accusation against the degree holder at the hearing and may have one additional representative present during the hearing. Under this section the term “Dean” is understood to include the dean’s designee, if such a designation is made.

The degree holder and the dean may submit written materials to the Committee of Investigation and Recommendation prior to the hearing. The chair of the Committee of Investigation and Recommendation shall make available the materials received to the other party and to all committee members.

The hearing before the Committee of Investigation and Recommendation shall be held no sooner than thirty (30) calendar days and no later than ninety (90) calendar days after receipt of the report of the Committee of Inquiry unless the degree holder and the dean agree to a different date. All matters pertaining to the hearing shall be kept as confidential as possible, and the hearing shall be closed to the public. A verbatim record of the hearing will be taken and a type-written copy thereof transcribed and made a part of the hearing record.

The degree holder and the dean shall be responsible for having any witnesses they wish to testify in attendance at the hearing. Witnesses will be present only while testifying.

The chair of the Committee of Investigation and Recommendation shall take whatever action is necessary during the hearing to ensure a fair, orderly and expeditious hearing. No formal rules of evidence will be followed. If any objection is made to any evidence being offered, the decision of the majority of the committee shall govern. Irrelevant, immaterial or unduly repetitious evidence shall be excluded.

The degree holder and the dean shall be permitted to offer evidence and witnesses pertinent to the issues.

The dean shall present the case against the accused first. The accused shall then present his/her response.

The chair will allow each party to ask questions of the other party and will allow each party to ask questions of the other party’s witnesses at the appropriate time during the hearing as determined by the chair. Members of the committee may ask questions of any party or any witness at any time during the hearing.

Within fifteen (15) calendar days of the conclusion of the hearing, the Committee of Investigation and Recommendation shall submit a written report to the vice president for academic affairs and provost.

Vice President for Academic Affairs and Provost

If the Committee of Investigation and Recommendation recommends that the degree be revoked, the vice president for academic affairs and provost shall review the hearing record and the report of the Committee of Investigation and Recommendation. If the vice president for academic affairs and provost decides that the degree holder’s degree should not be revoked, he/she shall notify the degree holder, the dean, the Committee of Investigation and Recommendation and other appropriate persons involved in the process, in writing, within twenty-one (21) calendar days of receipt of the transcript of the hearing, and the matter shall be closed. If the vice president for academic affairs and provost decides to recommend that the degree holder’s degree should be revoked, the vice president for academic affairs and provost shall send that recommendation in writing to the president of the University within twenty-one (21) calendar days of receipt of the transcript of the hearing.

The vice president for academic affairs and provost shall send a copy of his/her recommendation to the degree holder, the dean, the Committee of Investigation and Recommendation’s report and the hearing record. The vice president for academic affairs and provost is disqualified from reviewing the case, the senior vice provost for research and graduate studies and chief research officer shall be substituted for the vice president for academic affairs and provost.

President

If the vice president for academic affairs and provost recommends to the president that the degree holder’s degree should be revoked, the president shall transmit that recommendation along with the report of the Committee of Investigation and Recommendation and the hearing record to the executive secretary of the Board of Trustees within thirty (30) calendar days of receipt. If the president wishes to make a recommendation, he/she shall review the recommendation of the vice president for academic affairs and provost, the report of the Committee of Investigation and Recommendation, and the hearing record and forward his/her recommendation to the executive secretary of the Board of Trustees within thirty (30) calendar days of receiving the recommendation of the vice president of academic affairs and provost.

Board of Trustees

The Executive Secretary of the Board of Trustees shall send to all Trustees the hearing record, the recommendation of the vice president for academic affairs and provost, the report of the Committee of Investigation and Recommendation, and the recommendation of the president, if any. A majority vote by the Board of Trustees, at a duly constituted Board meeting, is required to revoke an academic degree.
The decision of the Board of Trustees shall be final.

Guiding Principles
All actions taken by committees shall be effective by a majority vote.

All investigations, hearings and actions shall be kept as confidential as possible except for notice of any revocation approved by the Board of Trustees.

A decision not to proceed at any stage of the proceedings set forth in this policy does not necessarily mean that the original complaint was groundless.

For good cause shown, at the request of either party and the approval of the other, the vice president of academic affairs and provost may extend any time limit set forth in this policy. Any such time extension shall be communicated in writing to all appropriate parties.

Administrative Action if Degree is Revoked
If a degree is revoked by the Board of Trustees, the former student's transcript will be modified to reflect that the degree was revoked, and the former student will be informed of the revocation and requested to return the diploma. If the former student was enrolled in a program requiring a thesis or dissertation, all bound copies will be removed from the Clemson University Library. In addition, for doctoral students, University Microfilms, Inc., will be notified and requested to take appropriate action.

Students whose degrees have been revoked may be eligible to reapply for admission according to normal University procedures and policies in effect at the time of reapplication.

INTERNATIONAL SERVICES

The Office of International Services and Diversity Programs (ISDP), formerly the Office of International Programs and Services (OIPS), provides support services to all international students and exchange visitors in academic, financial, social and personal matters relating to their nonresident visa status. It also serves as the official liaison between Clemson University and the U.S. Immigration and Naturalization Service (INS) and the U.S. Information Agency (USIA). Upon arrival at Clemson University, international students and exchange visitors should immediately contact ISDP. The office is located in E-208 Martin Hall, telephone (864) 656-2357.

SERVICES TO STUDENTS
Among the primary services provided to international students are (1) preparing and issuing documents (Immigration Form I-20 and USIA Form IAP-66) for securing visas before students come to the United States; (2) advising students on immigration regulations and procedures; (3) assisting with completion of paperwork to maintain legal status while enrolled at Clemson; (4) providing registration assistance; (5) determining employment and practical training eligibility; (6) generally interpreting University policy and procedures; and (7) facilitating a smooth adjustment to Clemson University and the city through initial orientations and on-going workshops.

The International Office is staffed with two international student advisors, who provide advice to students on matters pertaining to immigration issues, and a director of international student affairs, who acts as the liaison between the Graduate School and University student affairs offices including, but not limited to, Redfern Health Center, Counseling Center, Housing Office, Office of Student Financial Aid, Career Center, Placement Office, University Food Service and University Union. The director of international student affairs also serves as the liaison to the English as a Second Language (ESL) coordinator.

The staff of the International Office work closely with members of the community organization, Clemson Area International Friendship (CAIF), to help students become familiar with American customs and traditions. Students needing support in learning how to negotiate the local environment or who simply want to make friends with American families can seek assistance with these matters from staff in the International Office.

SERVICES TO THE COMMUNITY
The International Office provides services to the broader community by developing and participating in cultural learning opportunities and programs that engage U.S. and international students, faculty and staff. The first week of April has been designated as International Awareness Week at Clemson University and in the city of Clemson. During this week, concentrated focus on world issues generates cultural, political and educational programs of a variety of types across the campus. The International Festival, now in its eleventh year, is a culminating event which draws on average 5,000 visitors.

SERVICES TO EXCHANGE VISITORS AND STUDY ABROAD STUDENTS
International students who attend Clemson as short-term, nondegree-seeking students or who visit the University for other short-term objectives are known as "exchange visitors." These individuals are also supported by staff in the International Office. The responsible officer for the Exchange Visitor Program issues the USIA Form IAP-66 and serves as the official contact at the University for all matters pertaining to the Exchange Visitor Program. The responsible officer also assists the visitor with USIA requirements, with securing insurance and with issues that may involve the sponsoring department or visitor's government.

The study abroad advisor provides the same types of services as delineated above to the individuals who come to Clemson under the auspices of the various study abroad programs in which Clemson participates. Assistance with academic and personal matters is given as well to students from Clemson University who choose to study abroad.
STUDENT SERVICES

REDFERN HEALTH CENTER
Health Services

Redfern Health Center consists of three divisions: Medical Services, Counseling and Psychological Services (CAPS), and Health Education/Alcohol and Drug Education.

Medical Services

Redfern Health Center, an outpatient facility, operates Monday through Friday, 7:30 a.m. until 5:00 p.m. (summer hours 8:00 a.m. to 4:30 p.m.). Students without an appointment are seen in the Nurses Clinic. ASK-A-NURSE telephone services are also available. The student health center offers outpatient ambulatory care for illnesses and injury, pharmacy, lab, X-ray and specialty clinics including orthopedics and women’s health.

A completed medical history questionnaire is required of all students entering the University for the first time. Documentation of two red measles (rubella) vaccines since the student’s first birthday is required. Students born prior to January 1, 1957, are exempt from the measles requirements. A tuberculin skin test (PPD) is required within the past year. Students with a history of a positive skin test are required to have a chest X-ray within the past year. Students not in compliance with immunization requirements will not be allowed to complete registration.

Counseling and Psychological Services

CAPS strives to provide quality counseling and mental health services to enhance students’ intellectual, social and personal growth. Counselors work with students to improve self-awareness, understanding and coping skills. All information is kept confidential and separate from medical and academic records. CAPS offers individual and group counseling for a range of personal problems, including anxiety, depression, coping, sexual concerns, relationship problems, substance abuse and adult children of alcoholics. Testing and counseling groups are also offered for students with learning disabilities and attention deficit hyperactive disorder. Testing is also provided to aid in the diagnosis of problems. Some testing services require a fee, but most are free of charge.

Health Education

Health Education provides information and wellness challenges on a variety of subjects: alcohol and other drugs, sexual-ity, leadership, nutrition and stress management. Health Education provides the opportunity to develop leadership skills through peer education programs. Alcohol and Drug Education offers social host training, on-campus party registration and OCTAA (On-Campus Talking About Alcohol course).

Health Fee

University policy requires that all students registered for seven or more credit hours during the fall or spring semester or four or more credit hours during a summer session pay the University health fee. The health fee provides access to the professional services of University physicians/nurse practitioners, counselors and health educators at no additional cost; reduced costs for medical diagnostics; and an after-hours urgent care excess insurance benefit. Students pay for pharmaceuticals, orthopedic equipment, specialty clinics and psychological testing. Payment is expected at the time of service. Students may pay in cash, check, MasterCard, Visa or Tiger Stripe.

Health Insurance

The University offers an accident and sickness insurance plan to help cover major medical expenses. Information is sent to all students prior to the fall semester. Students are strongly encouraged to have comprehensive health insurance coverage during their tenure at the University.

After Hours

Students may call ASK-A-NURSE Sunday through Thursday, 4:00 to 8:00 p.m. A registered nurse is available to answer questions, provide health information and schedule appointments.

Students requiring the care of a physician after hours may choose from area emergency rooms and urgent care facilities including Clemson Health Center, Oconee Memorial Hospital, Anderson Area Medical Center, Baptist Medical Center and Greenville Memorial Medical Center. Medical costs incurred are the student’s responsibility. Students should contact Redfern the next business day for follow-up care.

On-campus medical emergencies are transported by the University ambulance to the closest community medical resource. The University ambulance is staffed with licensed emergency medical personnel 24 hours a day. Students are required to pay for off-campus ambulance transportation except for those medical resources within the city of Clemson for after-hours urgent care.

HOUSING

Single Student Housing

University housing provides a “home away from home” for approximately 6,500 single students in 20 residence halls, three apartment complexes and the Clemson House. Most rooms are double occupancy with a limited number of single rooms available. The two-bedroom apartments each accommodate four students. All University housing is air conditioned and furnished to meet the needs of today’s college student.

Graduate Student Housing

Apartment-style housing designed for the specific needs and lifestyle of graduate students is available on a 9- or 12-month lease. Each apartment is double occupancy, thus allowing space for privacy in an area conducive to studying. Graduate and former students interested in on-campus housing should contact the Housing Office, Assignments, 200 Mell Hall, Box 344075, Clemson, SC 29634-4075. Refunds are made according to the Housing contract.

Family/Faculty Housing

Clemson provides comfortable and economical housing with 100 apartments, conveniently located on campus, for married and single-parent students. Only students with graduate assistantships or fellowships are given priority for this housing. Brochures and application forms are available from the Family Housing Office, 101 Mell Hall, Box 344075, Clemson, SC 29634-4075.

FOOD SERVICE

The University provides several economical meal plans. Harcombe and Schilletter dining halls feature an unlimited seconds policy, except on selected entrees, while Clemson House dining rooms, Canteen and Fernow Street Café serve meals on an à la carte basis. Students dining at the Clemson House may use the meal card as a cash equivalency or for a predesignated meal at no additional cost. Meals may also be purchased on a cash basis or with the Tiger Stripe account (declining balance account). The “branding” concept in dining facilities is available on the Clemson campus. Li’ll Dino Subs and Taco Bell Express
are located at the East Campus Convenience Store; Chick-fil-A is located at the Union Canteen; and the Pizza Hut Express is at the Fernow Street Cafe. All of these dining facilities accept the Tiger Stripe Account and cash.

Students may choose one of several meal plans. These are outlined in the Clemson Dining Service brochure. Meal plans begin immediately after a student obtains a meal plan at the beginning of the semester and end after the evening meal on the day of graduation at the end of each semester.

All students must choose a meal plan on a semester basis or pay for individual meals. Meal plans include: Unlimited Access, Any Fifteen, Five Day or Any Ten. Graduate students may terminate this agreement for any reason. Failure to participate in a meal plan does not automatically release a student from the meal contract. Students may change meal plans at the billing of spring semester fees with no service charge. Students may change meal plans after the first two weeks and prior to the last six weeks of the semester by paying a $25 service charge. Changes may be made at the Tiger 1 Card Office in Harcombe Dining Hall on Mondays only. All adjustments will be prorated, except for students withdrawing from the University. Students may upgrade during the registration period. Contracts canceled for any reason after service of the first meal will result in a refund of advance payment minus a $50 termination charge and a weekly charge for meals available. The meals available charge applies to the meals that have been served, not those that have been eaten by the individual student. No refunds will be made the last six weeks of any semester. Requests for refunds may be made at the Tiger 1 Card Office in Harcombe Dining Hall.

**DISABILITY SERVICES**

Clemson University is committed to providing educational opportunities for all students and assisting them in making their college experience successful. In compliance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990, Clemson University recognizes a student with a disability as anyone who has a physical or mental impairment that substantially limits one or more major life activities. Student Disability Services coordinates the provision of reasonable accommodations for students with disabilities. Accommodations are individualized, flexible and confidential, and based on the nature of the disability and the academic environment.

Students requesting accommodations must provide current documentation of their disability from a physician or licensed professional to the Office of Orientation, Leadership and Disability Services.

2. submission to or rejection of such conduct by an individual is used as a basis for employment or for arriving at academic decisions affecting an individual; or
3. such conduct unreasonably interferes with an individual’s work or academic performance, or creates an intimidating, hostile, or offensive working or academic environment.

Sexual harassment of University faculty, staff or students is prohibited and shall subject the offender to dismissal or other sanctions after compliance with procedural due process requirements. In the event of sexual harassment, the claimant may use University grievance procedures that have been established for faculty, staff and students as appropriate. This policy also prohibits an employee from sexually harassing a superior and a student from sexually harassing a faculty member. Employees or students who feel they are victims of this form of discrimination are encouraged to consult the Office of Access and Equity, E-103 Martin Hall, 656-3181, for advice and assistance in resolving complaints.

**COMPLIANCE OF CLEMSON UNIVERSITY WITH THE ENGLISH FLUENCY IN HIGHER EDUCATION ACT OF SOUTH CAROLINA**

Clemson University has established a policy to assure that all instructional activities are conducted by individuals possessing appropriate proficiency in written and oral use of the English language. Instructional activities include lectures, recitation or discussion sessions, and laboratories. The individuals to be certified include full-time and part-time faculty, graduate teachers of record, graduate teaching assistants and graduate laboratory assistants for whom English is not the first language. The policy also addresses the avenues available to undergraduate and graduate students who experience difficulties associated with English usage by those individuals delivering the instructional ac-
FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT (ANNUAL NOTICE TO STUDENTS)

The Family Educational Rights and Privacy Act of 1974 (FERPA) affords eligible students certain rights with respect to their education records. They are:

1. The right to inspect and review the student's education records (provided the student has not waived this right) within 45 days of the day the University receives a request for access.

Students should submit to the registrar, dean, head of the academic department or other appropriate official, a written request identifying the record(s) they wish to inspect. The University official will make arrangements for access and notify the student of the time and place where the records may be inspected. If the records are not maintained by the University official to whom the request was submitted, that official shall advise the student of the correct official to whom the request should be addressed.

2. The right to request the amendment of the student's education records that the student believes are inaccurate or misleading.

Students may ask the University to amend a record that they believe is inaccurate or misleading. To challenge the accuracy of an education record, the student should write to the registrar or other University official responsible for the record, and clearly identify the part of the record he/she wants changed and specify why it is inaccurate or misleading. If the University official decides not to amend the record as requested by the student, the University official will notify his/her vice president. The vice president will then notify the student of his/her right to a hearing regarding the request for an amendment. Additional information regarding the hearing procedures will be provided to the student when notified of a right to a hearing. Note: The challenge of a student under this paragraph is limited to information which relates directly to the student and which the student asserts is inaccurate or misleading. With regard to a student's grade, this right does not permit the student to contest a grade on the grounds that a higher grade is deserved, but only to show that the grade has been inaccurately recorded.

3. The right to consent to the disclosure of personally identifiable information contained in the student's education records, except to the extent that FERPA authorizes disclosure without consent.

One exception which permits disclosure without consent is disclosure to school officials with legitimate educational interest if the official needs to fulfill his/her professional responsibilities. Upon request, the University discloses education records without consent to officials of another school in which a student seeks or intends to enroll.

4. The right to refuse to permit the designation of any or all of the following categories of personally identifiable information as directory information, which is not subject to the above restrictions on disclosure: student's full name, home address and telephone number, campus address and telephone number, campus e-mail address, state of residence, age, date and place of birth, sex and marital status, parents' names and addresses, academic class, class schedule and class roster, name of advisor, major field of study, including the college, division, department or program in which the student is enrolled, participation in officially recognized activities and sports, weight and height of members of athletic teams, dates of attendance and graduation, degrees and honors and awards received including selection to a dean's list or honorary organization and the grade point average of students selected, and the most previous educational institution attended. Photographic, video or electronic images of students taken and maintained by the University are also considered directory information.

Directory information may be disclosed by the University for any purpose, at its discretion. Any student wishing to exercise his/her right to refuse to permit the designation of any or all of the above categories as directory information must give written notification to the Registration Services Office, E203 Martin Hall by the last day to register for the enrollment period concerned as published in the Clemson University calendar.

5. The right to file a complaint with the U.S. Department of Education concerning alleged failures by Clemson University to comply with the requirements of FERPA. The name and address of the office that administers FERPA is Family Policy Compliance Office, U.S. Department of Education, 600 Independence Avenue SW, Washington, DC 20202-4605.
RACIAL HARASSMENT POLICY

It is the policy of Clemson University to conduct and provide programs, activities and services to students, faculty and staff in an atmosphere free from racial harassment. Racial harassment is any behavior that would verbally or physically threaten, torment, badger, heckle or persecute an individual because of his or her race.

Racial harassment of University faculty, staff, students or visitors is prohibited and shall subject the offender to appropriate disciplinary action.

Students who feel that they have been subjected to racial harassment can seek advice from the Office of Access and Equity, E-103 Martin Hall, phone: 656-3181.

GRADUATE PROGRAMS AND COURSE OFFERINGS

EXPLANATION OF COURSE LISTINGS

Programs are listed alphabetically within the college that offers them. In certain departments which offer more than one course sequence, the secondary courses (not leading to a major or a minor) are listed immediately after those normally associated with the degree program or departmental name.

The list of courses offered under each program includes for each course the catalog number, title of course, credit in semester hours, class and laboratory hours per week and the description of the course. The designation F, S, SS or N following the class and laboratory hours indicates whether the course is offered in the fall, spring, summer session or as needed. No such designation indicates that the course is taught at least every year, but not necessarily during the same term. These designations are projections of the teaching schedules, and many factors can cause a change. It is the responsibility of the student to check with his or her department for verification of the scheduled offerings.

Graduate credit can be earned only for courses numbered 600 or above. Each 600 level course carries a 400-series undergraduate level course. 400/600 series courses are taught concurrently in the same classroom setting.

Courses numbered in the 300 and 400 sequence are primarily for advanced undergraduates but are offered also for graduate credit when they carry the corresponding 600-level number. Students who receive graduate credit in such courses must do extra work of an appropriate nature as determined by the department and are graded according to graduate standards.

Courses numbered 700 or above are restricted to graduate students and certain qualified Clemson University seniors.

The 700-level courses are designed primarily for the degrees that emphasize professional practice rather than research.

A secondary listing of a course in parentheses implies that this course is cross-listed with another program.

SPECIAL COURSES

These courses serve special needs for graduate students. They do not count toward a graduate degree, and no letter grades are given.

G S 799: Comprehensive Studies, 1-15 cr. (1-15 and 0)

Independent studies in preparation for comprehensive examinations; credit hours to be determined by the department head or program chair. A letter grade is not given, but satisfactory completion is indicated by a grade of "Credit."

G S 800: Research Proposal Development Seminar, 1 cr. (1 and 0)

Principles and techniques for the preparation of research proposals. Graded on a credit/no credit basis. Will not count toward a graduate degree. Prerequisite: Second year or graduate standing in current major.

COURSE PREFIXES

This list of course offerings is arranged alphabetically and includes the course prefix used in the Clemson University Graduate School Announcements.

Accounting ........... ACCT
Agricultural and Applied Economics ........... AP EC
Agricultural Education ........... AG ED
Agricultural Mechanization ........... AG M
Agriculture ........... AGRIC
Crop and Soil Environmental Sciences (Agronomy) ........... AGRON
Animal and Veterinary Sciences ........... AVS
Animal Physiology ........... AN PH
Applied Psychology ........... PSYCH
Applied Sociology ........... SOC
Aquaculture, Fisheries and Wildlife Biology ........... W FB
Architecture ........... ARCH
Art ........... ART
Art and Architectural History ........... A AH
Astronomy ........... ASTR
Biochemistry ........... BIOCH
Bioengineering ........... BIO E
Biological Sciences ........... BIOSC
Biology ........... BIOL
Biosystems Engineering ........... BE

Botany .................. BOT
Business Administration ........... MBA
Ceramic and Materials Engineering ........... CME
Chemical Engineering ........... CHE
Chemistry ........... CH
City and Regional Planning ........... C RP
Civil Engineering ........... CE
Coaching Education ........... CE
Community and Rural Development ........... C RD
Computer Engineering ........... C E
Computer Science ........... CP SC
Construction Science and Management ........... CSM
Economics ........... ECON
Education ........... ED
Educational Counseling ........... EDC
Educational Foundations ........... EDF
Educational Leadership ........... EDL
Electrical Engineering ........... E CE
Engineering Graphics ........... E G
Engineering Mechanics ........... E M
English ........... ENGL
Entomology ........... ENT
Environmental Science and Policy ........... EN SP
Environmental Engineering and Science ........... EE&S
Environmental Toxicology ........... ENTOX
Experimental Statistics ........... EX ST
Finance ........... FIN
Fisheries Biology ........... W FB
Food Science ........... FD SC
Food Technology ........... FD TH
Forest Resources ........... FOR
French ........... FR
Genetics ........... GEN
Geography ........... GEOG
Geology ........... GEO
German ........... GER
Government and International Studies ........... GINT
Graduate Studies ........... GS
Graphic Communications ........... GC
Health ........... HLTH
Health Administration ........... MHA
History ........... HIST
Horticulture ........... HORT
Human Resource Development ........... HRD
Hydrogeology ........... GEOL
Industrial Education ........... I ED
Industrial Engineering ........... I E
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<th>Program</th>
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<tr>
<td>Industrial Management</td>
<td>MGT</td>
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<td>Industrial/Organizational Psychology</td>
<td>PSYCH</td>
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<td>Law</td>
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<tr>
<td>Management</td>
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<td>Microbiology</td>
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<td>Nutrition</td>
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<td>Packaging Science</td>
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<td>Parks, Recreation and Tourism</td>
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<td>Performing Arts</td>
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<td>Philosophy</td>
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<td>Plant Pathology</td>
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<td>Plant Physiology</td>
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<td>Psychology</td>
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<td>Public Administration</td>
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<td>Rural Sociology</td>
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<td>Sociology</td>
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<td>Spanish</td>
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<td>Special Education</td>
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<td>Speech</td>
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<td>Technology and Human Resource</td>
<td>THRD</td>
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<tr>
<td>Textiles, Fiber and Polymer Science</td>
<td>TEXT</td>
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<td>Textile Chemistry</td>
<td>TC</td>
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<td>Visual Arts</td>
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<tr>
<td>Vocational/Technical Education</td>
<td>VT ED</td>
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<td>Wildlife Biology</td>
<td>W F B</td>
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<td>Women's Studies</td>
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<td>Zoology</td>
<td>ZOOL</td>
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## College of Agriculture, Forestry and Life Sciences

### School of Animal, Biomedical and Biological Sciences • 48
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The College of Agriculture, Forestry and Life Sciences offers advanced degrees in these areas of study; concentrations within a major area are listed under the degree-granting program.

- Agricultural and Applied Economics
- Agricultural Education
- Agriculture
- Animal and Food Industries
- Animal and Veterinary Sciences
- Animal Physiology
- Applied Economics *
- Aquaculture, Fisheries and Wildlife Biology
- Biochemistry
- Biosystems Engineering **
- Botany
- Crop and Soil Environmental Sciences
- Entomology
- Environmental Toxicology ***
- Food Science
- Food Technology
- Forest Resources
- Genetics
- Horticulture
- Microbiology
- Nutrition
- Packaging Science
- Plant Pathology
- Plant Physiology
- Zoology

Courses are offered in experimental statistics and agricultural mechanization to provide minors for students in other areas, and in biological sciences, biology instruction, community and rural development, integrated pest management and rural sociology to provide electives for students in other areas. The College of Agriculture, Forestry and Life Sciences offers graduate programs in 25 traditional disciplines in agriculture, forestry and a wide variety of biological sciences, from the fundamental to the applied. The college awards the M.S. and Ph.D. degrees as well as the Master of Agricultural Education, Master of Agriculture and Master of Forest Resources professional degrees. These postbaccalaureate degree programs are designed primarily to provide continuing education for individuals whose interests lie outside a research-oriented profession.

Through cooperative programs with state, federal and private agencies, students can extend their research off campus to the Greenwood Genetics Center, agricultural experiment stations spanning South Carolina and state and national forests of the Savannah River Basin. Proximity to the Blue Ridge Mountains provides access to one of the most biologically diverse regions of the world.

* This program is a cooperative effort between the Department of Agricultural and Applied Economics and the Department of Economics (College of Business and Public Affairs). The Department of Agricultural and Applied Economics is responsible administratively for the Ph.D. program, and the degree is awarded by the College of Agriculture, Forestry and Life Sciences.

** This program is administered jointly by the College of Agriculture, Forestry and Life Sciences and the College of Engineering and Science. The M.S. and Ph.D. degrees are awarded by the College of Engineering and Science.

*** This program is administered jointly by the College of Agriculture, Forestry and Life Sciences and the College of Engineering and Science. The M.S. and Ph.D. degrees are awarded by the College of Agriculture, Forestry and Life Sciences.

AG ED 610: History, Philosophy and Future of the Land-Grant System, 3 cr. (3 and 0)
Broad perspective of the American land-grant system; examination of assumptions and investigation of the concepts, paradigms, issues, strategies and programs of the system; organizational structures, research methodologies, change processes and adoption-diffusion strategies. Prerequisite: Junior standing or permission of instructor.

AG ED 623: Curriculum, 2 cr. (2 and 0) S
Curriculum goals and related planning for career and continuing education programs.

AG ED 625: Teaching Agricultural Mechanics, 2 cr. (1 and 3) S
Organizing course content, conducting and managing an agricultural mechanics laboratory, shop safety, microteaching demonstrations of psychomotor skills and methods of teaching manipulative abilities.

AG ED 628: Special Studies in Agricultural Education, 1-3 cr. (1-3 and 0)
Individual or collective study of selected topics and/or problems in agricultural education to meet the particular needs of
the clientele enrolled. May be taken for a maximum of six semester hours credit.

AG ED 631: Methods in Environmental Education, 3 cr. (3 and 0) SS
Various techniques appropriate for teaching environmental education. Applicable to elementary, high school and adult-level teachers.

AG ED 632: Visual Media for Agribusiness, 3 cr. (2 and 3) S
Theoretical and practical course for professionals in agriculture with major emphasis on visual communications.

AG ED 640: Program Development in Adult/Extension Education, 3 cr. (3 and 0)
Principles, theory and practice in planning and conducting educational programs in adult/extension settings. Prerequisite: Junior standing or permission of instructor.

AG ED 645: Evaluation of Adult/Extension Education Programs, 3 cr. (3 and 0)
Philosophy and methodology of conducting evaluations of adult educational programs such as extension or adult continuing education programs; designing and conducting different types of program evaluations including appropriate data collection methods. Prerequisite: Junior standing or permission of instructor.

AG ED 650: Modern Topics and Issues, 3 cr. (3 and 0)
A major area of concern to teachers of agriculture and county agents will be selected for intensive study at least one semester prior to offering the course. Team teaching with faculty from other departments in the College of Agriculture, Forestry and Life Sciences will be utilized when feasible. Prerequisite: Senior standing or relevant experience.

AG ED 680 (THRD 680) (EDF 680): Educational Applications of Microcomputers, 3 cr. (3 and 0)
Fundamentals of computer applications for teachers; competency in general computer applications such as word processing and database management; educational uses of the Internet and computer-assisted instruction; legal and ethical issues and the impact of computer technology upon society. Prerequisites: Admission to a teacher education program; graduate standing.

AG ED 682 (THRD 682) (THRD 682): Advanced Educational Applications of Microcomputers, 3 cr. (2 and 2)
Knowledge and skills needed to apply microcomputer technology to the utilization and generation of educational software in accordance with sound educational principles. Prerequisite: ED F (AG ED, THRD) 480.

ED 736: Internship: Teaching, 3 cr. (1 and 6) S
Professional competency and program development through classroom and practical experiences in planning, conducting and evaluating educational programs.

AG ED 737: Internship in Agribusiness Firms, 3 cr. (1 and 6) SS
Classroom and practical experiences in selected agricultural businesses and industries. Students identify and practice entry-level competencies required in selected agribusiness and natural resource management enterprises.

AG ED 750: Special Institute Course: Selected Topics in Agricultural Education, 1-3 cr. (1-3 and 0)
Subject areas organized according to institute needs. Topics vary from course to course. May be repeated for a maximum of nine credits. Prerequisite: Permission of instructor.

AG ED 801: Systems for Technology Transfer, 3 cr. (3 and 0)
Development of a philosophical foundation and utilization of cooperative learning strategies and techniques to disseminate effectively technological change for expanding clientele and diverse socioeconomic environments.

AG ED 803: Evaluation of Instructional Programs, 3 cr. (2 and 3) F (odd numbered years)
Measurement and evaluation in general and as applied to agricultural and vocational education; selection and/or development and use of instruments for assessing educational outcomes of student achievement and total programs. Prerequisite: Permission of instructor.

AG ED 804: Special Problems, 3 cr. (2 and 3)
Planning, conducting and reporting a special problem in agricultural and vocational education appropriate to students' needs.

AG ED 805: Administration and Supervision in Agricultural Education, 3 cr. (3 and 0) S (even numbered years)
Developing a philosophy of education including application of administrative concepts in supervising agricultural education programs. Prerequisite: Experience in agricultural education.

AG ED 815: Teaching Agricultural and Power Mechanics, 3 cr. (2 and 3) SS (odd numbered years)
Methods of determining course content, organizing teaching modules in logical sequence, equipping shop teaching agricultural and power mechanics to farm and agribusiness clientele, providing individualized instruction, and developing off-farm experience programs.

AG ED 821: Theories and Practices of Adult Education, 3 cr. (3 and 0) S
Recent research on adult learning; a comparison of the assumptions supporting pedagogy and andragogy; teaching adults through formal classes and community organizations. Prerequisite: PSYCH 201 or ED 302 or equivalent.

AG ED 869: Seminar, 1-3 cr. (1-3 and 0)
Students and faculty review current topics in agricultural education.

AG ED 889 (ED 889) (IN ED 889): Research in Education, 3 cr. (3 and 0)
Problem selection; types of educational research and techniques employed; use of ERIC system and computer program packages; interpretation of research findings.

Animal and Food Industries

Carl E. Thompson, Program Coordinator, Department of Animal and Veterinary Sciences

<table>
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<tr>
<th>Major</th>
<th>Degree</th>
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<tr>
<td>Animal and Food Industries</td>
<td>M.S.</td>
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Students may concentrate in animal science, dairy science, food science or poultry science. See departmental listings in animal and veterinary sciences; food science; and poultry science for course descriptions. Candidates for the M.S. degree are required to complete a thesis.

Animal and Veterinary Sciences

Donald Henricks, Chair, Department of Animal and Veterinary Sciences

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<tr>
<th>Majors</th>
<th>Degrees</th>
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<tr>
<td>Animal and Food Industries</td>
<td>M.S.</td>
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<tr>
<td>Animal Physiology</td>
<td>M.S., Ph.D.</td>
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<td>Nutrition</td>
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A specific degree is not offered by this department, but the above degrees are granted through interdepartmental, interdisciplinary programs. Studies in animal production, nutrition, reproduction, meat and milk products, health and microbiology are offered. Excellent animal and laboratory facilities are available for graduate student research. Candidates must complete a research project and submit a thesis or dissertation. The department also participates in the animal industries option of the Master of Agriculture degree.

AVS 600: Avian Physiology, 2 cr. (2 and 0) F (even numbered years)
Structure and function of organ systems of avian species with emphasis on digestion and reproduction. Students are given an opportunity to study organs system(s) of their choice using quantitative physiological techniques. Prerequisites: AN PH 301, AVS 201 or permission of instructor.
AVS 601: Beef Production, 4 cr. (3 and 2) F
Breeding, feeding, reproduction and management of beef cattle with emphasis on production systems integrating disciplines of animal agriculture into management plans and alternatives; practical applications of beef production and management practices. Prerequisites: AVS 202 and 370.

AVS 602: Poultry Management, 4 cr. (3 and 2) S (odd numbered years)
Continuation of AVS 201 emphasizing management, decision-making and application of technology to the commercial production of poultry and poultry products. Prerequisite: AVS 201 or permission of instructor.

AVS 603: Laboratory Techniques, 3 cr. (2 and 3) F
Research and quality control techniques commonly used in dairy science and related agri-sciences. Prerequisites: CH 101 and 102.

AVS 604: Dairy Cattle Feeding and Management, 4 cr. (3 and 2) F (alternate years)
Fundamental principles in the care, feeding and management of dairy cattle of all ages. Topics include general consideration in selecting a breed and the individual cow, calf raising, growth and development of dairy heifers, care and maintenance of the milking herd and feeding for milk production. Prerequisites: AVS 202 and 370.

AVS 606: Special Problems, 1-3 cr. (0 and 3-9)
Research problems of special interest to the student; laboratory experience and concentrated study in an area not covered in depth in other courses. May be taken for a cumulative maximum of three credits. Prerequisite: Permission of instructor.

AVS 607: Equine Theriogenology, 3 cr. (2 and 3) F
Review of reproductive anatomy and physiology in the mare and stallion; induction of estrus and ovulation, practices for optimal reproductive efficiency; semen collection, preservation and transport; embryo transfer; regulatory aspects of reproduction by various breed registries; noninfectious and infectious diseases affecting reproduction; reproductive health management. Prerequisite: AVS 453.

AVS 608: Pork Production, 4 cr. (3 and 2) S
Breeding, feeding, grading, marketing and management of swine. Practical applications from all phases of the production cycle will be outlined in problem form to develop the student's problem-solving ability. Prerequisites: AVS 202 and 370.

AVS 609: Selected Topics, 1-3 cr. (1-3 and 0)
Selected topics of interest in AVS not covered in other courses. May be repeated for credit. Prerequisite: Permission of instructor coordinating the topic.

AVS 610: Dairy Processing I, 4 cr. (3 and 3) F (alternate years)
Processing and distribution of fluid milk and other dairy products with emphasis on composition, quality control, chemical, microbiological and public health aspects. Prerequisites: BIOL 103 and 104, CH 101 and 102.

AVS 611: Dairy Processing II, 4 cr. (3 and 3) S (alternate years)
Continuation of Dairy Processing I, with emphasis on processing of cultured dairy products and frozen dairy products; processing procedures, quality control, ingredients, formulations, compositional and cultural characteristics of cultured and frozen dairy products. Prerequisites: AVS 410/610.

AVS 612: Horse Production, 4 cr. (3 and 2) S
Feeding, breeding and management of the horse in relation to health, genetics, reproduction, nutrition and selection. Prerequisites: AVS 202 and 370.

AVS 618: Muscle Biology and Lean Meats, 3 cr. (2 and 2)
Biology of animal muscle, connective, fat and bone tissue with laboratory emphasis on low-fat sausages and restructured, value added meat products. Prerequisite: AVS 202.

AVS 651: Poultry Nutrition, 2 cr. (2 and 0) F (odd numbered years)
Nutrient requirements of chickens, turkeys and game birds; methods of determining these requirements; deficiencies and excesses of vitamins and minerals; effects of naturally occurring toxins; hand formulation; linear programming.

AVS 652: Poultry Nutrition Laboratory, 1 cr. (0 and 3)
Training in basic laboratory skills and common laboratory methods used in poultry nutrition.

AVS 653: Animal Reproduction, 3 cr. (2 and 2) S
Reproductive physiology and endocrinology of mammals with emphasis on farm animals and frequent reference to reproduction in laboratory animals and humans. Prerequisites: AVS 202 and AN PH 301.

AVS 355/655: Poultry Products Grading and Technology, 3 cr. (2 and 3) S (odd numbered years)
Factors important in the quality of poultry products; the effects of production, handling, packaging and storage on consumer acceptability. Quality evaluation will be considered from the standpoint of tenderness, flavor, microbiology and USDA grades.

AVS 455/655: Animal Reproductive Management, 1 cr. (0 and 3) S
Physiology and endocrinology of pregnant and nonpregnant cows; emphasis is on methods of artificial insemination, pregnancy detection and computer recordkeeping for achieving a high level of reproductive efficiency in cattle. Prerequisites: AVS 202, AN PH 301 and to be taken concurrently or to follow AVS 453.

AVS 658: Avian Microbiology and Parasitology, 3 cr. (3 and 0) F (even numbered years)
Agents causing poultry diseases; the diagnosis, prevention and treatment of specific diseases; their economic and public health significance.

AVS 661: Physiology of Lactation, 2 cr. (2 and 0) S
Anatomy and development of the mammary gland; physiological and biochemical regulation of mammary growth and milk secretion with emphasis on farm animals and reference to other mammals. Prerequisites: AVS 202 and BIOCH 210.

AVS 670: Animal Breeding, 3 cr. (3 and 0) S
Fundamental principles relating to the breeding and improvement of livestock including variation, heredity, selection, linebreeding, inbreeding, crossbreeding and other related subjects. Prerequisite: AVS 202 or permission of instructor.

AVS 801: Selected Topics, 1-3 cr. (1-3 and 0)
Current topics of special interest in animal, dairy, and veterinary sciences not covered in other courses. May be repeated for credit. Prerequisite: Permission of coordinating instructor.

AVS 802: Meat Technology, 3 cr. (3 and 0)
Biochemistry, histology and microbiology of fresh, frozen, cured, smoked and processed meats; quality of meats and meat products; processing methods; nutritive value; research techniques. Prerequisites: AVS 253 and 255.

AVS 803: Physiology of Reproduction and Milk Secretion, 3 cr. (3 and 0)
Advanced concepts of steroidogenesis, gametogenesis, fertilization, placentaion, embryogenesis, embryonic-endometrial relationships, parturition and lactation, and the influence of hormones on these processes. Students evaluate the most recent scientific literature in these areas for information, experimental methods and validity of authors' conclusions, and select a problem, review related literature and write a research proposal for solving the problem. Prerequisites: AVS 453 and 461 or permission of instructor.

AVS 804: Methods in Animal Breeding, 3 cr. (3 and 0)
Gene and zygotic frequency, system of mating, heritabilities, genetic consequences of selection, and criteria for evaluating improvement in all domestic livestock. Prerequisite: AVS 652.
AVS 808: Industrial Dairy and Meat Science, 3 cr. (1 and 6)
Managerial training for operating food plants with particular emphasis on regulations, policy and decision making for dairy plants and meat plants. **Prerequisite:** Permission of instructor.

AVS 820: Animal Veterinary Sciences Graduate Seminar, 1 cr. (1 and 0)
Ongoing research, evaluation of research needs, research techniques, critical reviews and discussions of published research in all areas of the animal, dairy and veterinary sciences. **Prerequisite:** Graduate standing.

AVS 822: Special Problems, 1-3 cr. (0 and 3-9)
Laboratory, library or field study of problems related to animal, dairy and veterinary sciences emphasizing development and testing of hypotheses and reporting of results. May be repeated for a maximum of four credits. **Prerequisite:** Permission of instructor supervising study.

AVS 825: Immunobiology, 3 cr. (3 and 0) S
Conceptual approach to immunobiology emphasizing the molecular and cellular aspects; classical and current literature is the major source for the discussion/lecture format. **Prerequisite:** Permission of instructor.

AVS 891: Master's Thesis Research, credit to be arranged

**Animal Physiology**

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<tr>
<th>Animal Physiology</th>
<th>M.S., Ph.D.</th>
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<tr>
<td>John R. Diehl, Program Coordinator, Department of Animal and Veterinary Sciences</td>
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<tr>
<td><strong>Major Degrees</strong></td>
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Animal physiology is an interdisciplinary graduate program developed and offered by faculty in the departments of Animal and Veterinary Sciences; Aquaculture, Fisheries and Wildlife; Biological Sciences; and The Clemson Institute of Environmental Toxicology. Applicants should have a strong background in the biological and physical sciences. Students with deficiencies in these sciences may be admitted provided they correct these deficiencies during the first year of their program of study.

Students enrolled in the M.S. program are required to complete BIOSC 623, EX ST 801 and BIOSC 659 and 660, except as waived by the student's graduate advisory committee if equivalent courses have been taken already. Additional course work may be taken in areas of the student's interest as approved by the graduate advisory committee. The student's program and research emphasize a study of physiological processes, particularly those relating to reproduction, endocrinology, digestion and environmental factors. A thesis or dissertation is required.

The Ph.D. degree does not have formal course work requirements, but it is recognized that students will have individual deficiencies. Therefore, it is the responsibility of the student and his or her major advisor, in consultation with the graduate advisory committee, to prescribe course work to correct these deficiencies. All students majoring in animal physiology are required to complete AN PH 851.

AN PH 802: Selected Topics, 1-3 cr. (1-3 and 0-3) F, S
Current topics of special interest in animal physiology not covered in other courses. May be repeated for a maximum of six credits. **Prerequisite:** Permission of instructor.

AN PH 806: Care and Use of Research Animals, 3 cr. (1 and 6) F
Demonstration and practice of humane use and care of animals in research; study of pain, analgesia and anesthesia; regulatory aspects of the use of animals in teaching and research; surgical techniques and sample collection. **Prerequisite:** BIOSC 659 or permission of instructor.

AN PH 807: Special Problems in Animal Physiology, 1-3 cr. (1-3 and 0)
Research not related to a thesis. May include a comprehensive review of related literature.

AN PH 808: Current Concepts in Endocrinology, 3 cr. (3 and 0) S
Advanced concepts relevant to interrelationships between the nervous and endocrine systems as they influence growth and development, body metabolism and regulatory mechanisms, reproduction and lactation. **Prerequisite:** BIOSC 659 or permission of coordinator.

AN PH 812: Digestive-Metabolic, Excretory and Respiratory Physiology, 5 cr. (4 and 3) F (even numbered years)
Advanced concepts of mechanisms and functions of gastrointestinal tract (mastication, salivation, digestion, absorption, metabolism, excretion), kidney (anatomy, filtration, secretion, reabsorption) and respiratory systems (transport, exchange and utilization of gases); the action of the nervous system, hormones and pharmacologic agents on these organ systems. **Prerequisite:** BIOSC 659 or permission of course coordinator.

AN PH 814: Membrane, Cardiovascular and Neuromuscular Physiology, 5 cr. (4 and 3) S (even numbered years)
Advanced concepts in membrane physiology (permeability, action potentials, specialized functions), cardiovascular physiology (functions of the heart, blood-vessel system in maintaining acid-base balance, clotting mechanisms, homeostasis, circulation), neuromuscular physiology (anatomy and function of the nervous system, special senses, reflexes, control of muscular activity); the action of several pharmacologic agents on muscle and nerve functions. **Prerequisite:** BIOSC 659 or permission of course coordinator.

AN PH 851: Animal Physiology Seminar, 1 cr. (1 and 0) F, S
Current research and development in animal physiology through related literature and student and faculty participation. May be repeated for a maximum of two credit hours.

AN PH 891: Master's Thesis Research, credit to be arranged

AN PH 991: Doctoral Dissertation Research, credit to be arranged

The following courses offered by various departments represent possible electives for the student in animal physiology.

AVS 600: Avian Physiology, 2 cr. (3 and 0) S (even numbered years)
Structure and function of organ systems of avian species with emphasis on digestion and reproduction. Students are given an opportunity to study organ system(s) of their choice using quantitative physiological techniques. **Prerequisite:** AN PH 301, P S 201 or permission of instructor.

AVS 653: Animal Reproduction, 3 cr. (2 and 2) S
Reproductive physiology and endocrinology of mammals with emphasis on farm animals and frequent reference to reproduction in laboratory animals and humans. **Prerequisites:** AVS 202 and AN PH 301.

AVS 655: Animal Reproductive Management, 1 cr. (0 and 3) S
Physiology and endocrinology of pregnant and nonpregnant cows; methods of artificial insemination, pregnancy detection and computer recordkeeping for achieving a high level of reproductive efficiency in cattle. **Prerequisites:** AVS 202, AN PH 301, and to be taken concurrently or to follow AVS 453.

AVS 661: Physiology of Lactation, 2 cr. (2 and 0) S
Anatomy and development of the mammary gland; physiological and biochemical regulation of mammary growth and milk secretion with emphasis on farm animals and reference to other mammals. **Prerequisites:** AVS 202 and BIOSC 210.

AVS 803: Physiology of Reproduction and Milk Secretion, 3 cr. (3 and 0)
Advanced concepts of steroidogenesis, gametogenesis, fertilization, placentation, embryogenesis, embryonic-endometrial relationships, parturition and lactation and the influence of hormones on these processes. Students evaluate the most recent scientific literature in these areas for information, experimental methods and validity of authors' conclusions, and select a problem, review related literature and write a research proposal for solving the problem. **Prerequisites:** AVS 453 and 461 or permission of instructor.
Continuation of Experiments Isolation, and associated compounds; their properties and the relationship between structural and functional equivalents. Prerequisites: CH 224 or permission of instructor.

BIOCH 660: Systems Physiology Laboratory, 2 cr. (1 and 2) Modern and classical experimental methods will be used to demonstrate fundamental physiological principles discussed in BIOSC 475. Students will be introduced to computer-aided data acquisition and manipulation as well as computer simulations of physiological function. Prerequisite or Corequisite: BIOSC 475.

BIOSC 677: Ichthyology, 3 cr. (2 and 3) Systematics, life history, distribution, ecology and current literature of fish; laboratory study of morphology; identification of U.S. genera and all Southeastern species. Field trips will be required. Prerequisite: BIOSC 303 or permission of instructor.

BIOCS 680: Vertebrate Endocrinology, 3 cr. (3 and 4) Basic principles of neuro-endocrine integration and homeostatic maintenance in vertebrates; comparative morphology and physiology of various endocrine tissues and hormone chemistry and modes of action. Prerequisite: BIOSC 303, organic chemistry or permission of instructor.

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EX ST 801: Statistical Methods, 4 cr. (3 and 3) F, S Role and application of statistics in research, estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance component analysis, simple and multiple linear regression and correlation, and nonparametric procedures. Prerequisite: Permission of instructor.

EX ST 803: Regression and Least Squares Analysis, 3 cr. (3 and 0) F Regression analysis; simple and multiple linear, curvilinear and multiple curvilinear; curve fitting; least squares and computer techniques for fitting of constants and analysis of planned experiments. Prerequisite: EX ST 801.

EX ST 805: Design and Analysis of Experiments, 3 cr. (3 and 0) F, S Basic designs and analysis; data transformations, single degree of freedom, orthogonality and responses in ANOVA; covariance; response surfaces; incomplete blocks; introduction to least squares analysis of experiments; uses of standard computer programs for selected analyses. Prerequisite: EX ST 801.
MICRO 614: Basic Immunology, 3 cr. (2 and 3) F
Nature, production and function of basic immune responses in animals; procedures and mechanisms of antigen-antibody and other immune reactions. Prerequisite: MICROS 305.

MICRO 811: Bacterial Cytology and Physiology, 4 cr. (4 and 0) S (odd numbered years)
Structure, chemistry and physiology of the various bacterial cell components; physiology of bacterial growth and reproduction in batch, continuous and synchronous cultures; economy of the bacterial cell including endogenous metabolism and maintenance requirements; physiology of bacterial death; regulation of enzyme and nucleic acids syntheses. Prerequisite: MICROS 605, BIOCH 623 and MTHSC 206 or permission of instructor.

Biochemistry

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<th>Degree</th>
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<tr>
<td>M.S. Ph.D.</td>
<td>Biochemistry</td>
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Enrollment in the biochemistry program is open to students with baccalaureate degrees in agricultural, biological or physical sciences, or engineering. Entering students must have satisfactory academic records in mathematical, physical and biological sciences. Students with deficiencies may be admitted but will be required to correct these deficiencies during the first year.

Attendance and participation in departmental seminars are mandatory for all graduate students.

Biochemistry 631, 632, 633 and 634 (10 total credit hours) constitute the core of the biochemistry program. All students are expected to complete these courses if they have not had their equivalents at another accredited institution.

In addition to core courses, the M.S. degree requires a minimum of 14 credit hours of course work. At least eight of these 800-level credits (including two credits of BIOCH 851) must be in biochemistry courses. Two of the following four courses are required: BIOCH 815, 822, 831 and 841. A minimum of six semester hours of M.S. research, culminating in a thesis, is required.

The Ph.D. degree requires, in addition to the core courses, four credits of BIOCH 851 for students coming directly from the undergraduate degree or two credits of BIOCH 851 for students already having MS degrees and three of the four courses: BIOCH 815, 822, 831 and 841. Successful completion of written and oral comprehensive examinations (before six semesters in residence) will admit the student to candidacy for the Ph.D. degree.

BIOCH 606: Physiological Chemistry, 3 cr. (3 and 0)
Chemical basis of the mammalian physiological processes of muscular contraction, nerve function, respiration, kidney function and blood homeostasis; composition of specialized tissue such as muscle, nerve, blood and bone, and regulation of water, electrolytes and acid-base balance. Prerequisite: BIOCH 210 or organic chemistry.

BIOCH 623: Principles of Biochemistry, 3 cr. (3 and 0)
Chemistry of amino acids, monosaccharides, fatty acids, purines, pyrimidines and associated compounds; their properties and the relationship between structure and function that make them important in biological processes; use of modern techniques. Prerequisite: CH 224 or equivalent.

BIOCH 631: A Physical Approach to Biochemistry, 3 cr. (3 and 0)
Chemical and physical properties of amino acids, lipids, nucleic acids, sugars and their biopolymers. Physical and mathematical analyses will be correlated with biological structure and function. Prerequisite: BIOCH 301 with a grade of C or higher or permission of instructor. Corequisite: physical chemistry.

BIOCH 632: Biochemistry of Metabolism, 3 cr. (3 and 0)
Central pathways of carbohydrate, lipid and nucleotide metabolism. Bioenergetics, limiting reactions and the regulation and integration of the metabolic pathways will be emphasized. Prerequisites: BIOCH 423/623 or 431/631 or permission of instructor.

BIOCH 633: General Biochemistry Laboratory I, 2 cr. (0 and 4)

BIOCH 634: General Biochemistry Laboratory II, 2 cr. (0 and 4)
Continuation of BIOCH 433. Corequisite: BIOCH 432.

BIOCH 636: Nucleic Acid and Protein Biosynthesis, 2 cr. (2 and 0)
Examination of how nucleic acids and proteins are synthesized in prokaryotic and eukaryotic cells. Designed for students interested in biochemistry, cell biology, molecular biology and cell physiology. Prerequisite: BIOCH 423/623, 431/631 or 432/632 or permission of instructor.

BIOCH 815: Lipids and Biomembranes, 3 cr. (3 and 0)
Isolation, chemical and physical properties, and metabolism of lipids; purification, structure, function and biosynthesis of biomembranes. Prerequisite: BIOCH 632 or permission of instructor.

BIOCH 817: Chemistry and Metabolism of Hormones, 3 cr. (3 and 0)
Isolation, assay and chemistry of the various hormones; hormonal control of metabolism and body functions; endocrineopathies of hormone imbalance. Prerequisite: BIOCH 632 or permission of instructor.

BIOCH 821: Proteins, 3 cr. (3 and 0)
Isolation, composition, structure and properties of proteins; methods of isolation, analysis and characterization; properties of "unusual" protein systems. Prerequisite: BIOCH 631 or 623 or permission of instructor.

BIOCH 822: Enzymes, 3 cr. (3 and 0)
Kinetics, mechanisms of action, inhibitions and general properties of enzymes. Prerequisite: BIOCH 631 or 623.

BIOCH 831: Physical Biochemistry, 3 cr. (3 and 0)
Description and theory of physical methods and instrumentation used in analysis of biological macromolecules. Prerequisites: BIOCH 631 or 623 and one semester of physical chemistry or permission of instructor.

BIOCH 841: Biochemical Genetics, 3 cr. (3 and 0)
Regulation of replication and transcription. Students present papers from recent literature and write a research proposal. Prerequisite: One year of biochemistry or permission of instructor.

BIOCH 851: Biochemistry Seminar, 1 cr. (1 and 0)
Current topics in biochemistry.

BIOCH 891: Master's Thesis Research, credit to be arranged

BIOCH 991: Doctoral Dissertation Research, credit to be arranged

Biological Sciences

<table>
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<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>BIOL 601: Plant Physiology, 3 cr. (3 and 0)</td>
<td>Plant physiology, 3 cr. (3 and 0)</td>
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<tr>
<td>BIOL 602: Plant Physiology Laboratory, 1 cr. (0 and 3)</td>
<td>Laboratory exercises and experiments designed to indicate the relations and processes that pertain to maintenance, growth and reproduction of plants, including absorption of matter and energy, water relations of the plant, utilization of reserve products and liberation of energy. Prerequisites: BIOL 104 or 111 or BIOL 205 and CH 102 or 112. Corequisite: BIOSC 402.</td>
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<tr>
<td>BIOSC 601: Plant Physiology, 3 cr. (3 and 0)</td>
<td>Plant physiology, 3 cr. (3 and 0)</td>
</tr>
<tr>
<td>BIOSC 602: Plant Physiology Laboratory, 1 cr. (0 and 3)</td>
<td>Laboratory exercises and experiments designed to indicate the relations and processes that pertain to maintenance, growth and reproduction of plants, including absorption of matter and energy, water relations of the plant, utilization of reserve products and liberation of energy. Corequisite: BIOSC 401.</td>
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Biology 603: Protozoology, 3 cr. (3 and 0)
Survey of the protozoa with emphasis on organization and function. Representative types of both free-living and parasitic forms will be examined for each major taxon. Prerequisite: BIOL 104 or 111.

Biology 604: Protozoology Laboratory, 2 cr. (1 and 2)
Laboratory exercises reinforce the material presented in Biology 403 and introduce techniques used in collection, preservation, and examination of protozoans. Corequisite: Biology 403.

Biology 605: Molecular Genetics of Eukaryotes, 3 cr. (3 and 0)
Molecular genetic analyses of eukaryotes in relation to mutations and repair, complex phenotypes, biochemical pathways, short- and long-term regulation of gene expression and evolution. Prerequisites: GEN 302 or equivalent and one semester of biochemistry or permission of instructor.

Biology 606: Introductory Plant Taxonomy, 3 cr. (3 and 0)
Basic principles and concepts of plant systematics with emphasis on the plants of South Carolina. Prerequisite: BIOL 104 or 111 or Biology 205. Corequisite: Biology 407.

Biology 607: Plant Taxonomy Laboratory, 1 cr. (0 and 3)
Basic techniques of plant taxonomy with laboratory and field emphasis on the flora of South Carolina. Corequisite: Biology 406.

Biology 608: Comparative Vertebrate Morphology, 3 cr. (3 and 0)
Phylogeny and diversity of vertebrates; their comparative morphology; relationships and functioning of living organisms. Prerequisite: BIOL 104 or 111. Corequisite: Biology 409.

Biology 609: Comparative Vertebrate Morphology Laboratory, 1 cr. (0 and 3)
Comparative anatomy of representative vertebrates; methods used in preparing specimens for study and display. Corequisite: Biology 408.

Biology 610: Limnology, 3 cr. (3 and 0)
Physical, chemical and biological interrelationships that characterize inland water environments. A fundamental approach to the interactions of components of the environment is developed at a theoretical level. Prerequisite: Junior standing in a life science or permission of instructor.

Biology 611: Limnological Analyses, 2 cr. (1 and 2)
Broad range of topics covered with both standing and running fresh waters. About one-third of the laboratory exercises address the major physical components of lakes and streams. The remainder provide rational and methods for quantitative analyses of biota, as well as some integrated analyses of whole ecosystems. Prerequisite or Corequisite: Biology 410 or 443.

Biology 616: Recombinant DNA (GEN 616), 3 cr. (3 and 0)
Current facts and concepts of molecular genetics; gene organization, structure, and expression in prokaryotes and eukaryotes; current technologies and research. Prerequisites: GEN 302 or its equivalent and one semester of biochemistry or permission of instructor. A developmental biology course is also strongly recommended.

Biology 618 (MICRO 618) (GEN 618): Biotechnology I: Nucleic Acids Techniques, 4 cr. (2 and 4) N
Basic training in the manipulation of genetic information using recombinant DNA technology; techniques in molecular cloning, Southern and Northern analyses, and library construction. Prerequisite: BIOCH 210 or MICRO 305 or permission of instructor.

Biology 620: Neurobiology, 3 cr. (3 and 0)
Broad background in neurobiology including neuroanatomical structure-function; conduction in the neuron; neurite growth and development; neuromuscular junction; chemistry, physiology, and pharmacology of specific neurotransmitters and receptors; visual process; axoplasmic transport; hypothalamic-pituitary regulation; theories of behavior; theories of learning and memory. Prerequisite: BIOCH 210 or 301 and MICRO 305 or permission of instructor.

Biology 625: Introductory Mycology, 3 cr. (3 and 0)
Biology of all the groups of fungi and some related organisms, with considerations of the taxonomy, morphology, development, physiology, and ecology of representative forms. Prerequisite: BIOL 104 or 111 or Biology 205.

Biology 626: Mycology Practicum, 2 cr. (1 and 2)
Principles of mycological techniques including isolation, culture, identification and microscopic study of fungi. Examples from all major groups of fungi will be included. Prerequisite or Corequisite: Biology 425.

Biology 630 (AG E 630): Engineering Modeling of Biological Systems, 3 cr. (3 and 0)
Principal mechanism of energy capture and transformation in living organisms; quantitative models of energetic reactions and associated transport processes developed according to the principles of equilibrium and nonequilibrium thermodynamics; basic cell biology, photosynthesis, respiration, chemosomatic theory, electron transport, mass and energy transport phenomena. Prerequisite: BIOCH 301, MTHSC 208 or permission of instructor. Corequisite: M E 310 or instruction in thermodynamics.

Biology 632: Animal Histology, 3 cr. (3 and 0)
Structural and functional study of the basic tissues of animals and tissue makeup of organs. Emphasis will be on light microscopy level with selected tissue studied at the electron microscope level. Prerequisite: Biology 303 or permission of instructor. Corequisite: Biology 433.

Biology 633: Animal Histology Laboratory, 2 cr. (1 and 2)
Microscopic examination of basic animal tissue types and the tissue makeup of organs which comprise systems. Corequisite: Biology 432.

Biology 640: Developmental Animal Biology, 3 cr. (3 and 0)
Events and mechanisms responsible for the development of multicellular animals. Gametogenesis, fertilization, embryonic development, cellular differentiation, morphogenesis, larval forms and metamorphosis, asexual reproduction, regeneration, malignancy, and aging will be analyzed in terms of fundamental concepts and control processes. Prerequisite: Biology 210 or 301 or permission of instructor. Corequisite: Biology 450.

Biology 641: Ecology, 3 cr. (3 and 0)
Basic ecological principles underlying the relationships between organisms and their abiotic and biotic environments including physiological, population and community ecology, with applications of each to human ecological concerns. Prerequisite: BIOL 104, 111 or Biology 205 or permission of instructor.

Biology 642: Biogeography, 3 cr. (3 and 0)
Patterns of distribution of plants and animals in space and time. Prerequisites: Biology 302 or 303 and 304 or 305 or permission of instructor.

Biology 643: Aquatic Ecology, 3 cr. (3 and 0)
Basic ecological principles and concepts as they apply to aquatic environments: rivers and streams, lakes and ponds, reservoirs, swamps, marshes, estuaries and marine systems. Prerequisite: Junior standing in a life science or permission of instructor.

Biology 645: Ecology Laboratory, 2 cr. (1 and 2)
Modern and classical approaches to the study of ecological problems discussed in Biology 441; field, laboratory and computer-based analyses of plant and animal populations and communities. Prerequisite or Corequisite: Biology 441.

Biology 646: Plant Ecology, 3 cr. (3 and 0)
Ecology of plants in relation to their biotic and abiotic environments. Individual organisms, populations and communities will be considered with an emphasis
on seed plants in terrestrial environments. **Prerequisite:** BIOL 104, 111 or BIOSC 205 or permission of instructor.

**BIOSC 647:** Plant Ecology Laboratory, 2 cr. (1 and 2)
Experimental and observational approach to addressing principles discussed in BIOSC 446; field and laboratory methods involving individual organisms, populations and communities. **Prerequisite or Corequisite:** BIOSC 446 or permission of instructor.

**BIOSC 650:** Developmental Biology Laboratory, 2 cr. (1 and 2)
A broad range of topics concerned with the development of multi-cellular animals such as gametogenesis, fertilization, embryonic development, cell differentiation, morphogenesis, larval metamorphosis and regeneration. Laboratory exercises provide the rationale and methods for the descriptive and experimental analysis of development in representative invertebrates and vertebrates. **Prerequisite or Corequisite:** BIOSC 440 or equivalent.

**BIOSC 652:** Plant Anatomy and Morphology, 3 cr. (3 and 0)
Anatomy, reproduction and phylogenetic relationships of vascular plants. **Prerequisite:** BIOL 104, 111 or BIOSC 205 or permission of instructor.

**BIOSC 653:** Plant Anatomy and Morphology Laboratory, 2 cr. (1 and 2)
Laboratory focusing on the anatomy, reproduction and phylogenetic relationships of vascular plants. **Corequisite:** BIOSC 452.

**BIOSC 656:** Medical and Veterinary Parasitology, 3 cr. (3 and 0)
Parasitism in the animal kingdom with emphasis on both basic and applied principles as they relate to economically and medically important diseases. Classical and experimental approaches to the study of parasitism are examined in reference to protozoa, helminths and arthropods. **Prerequisite:** BIOL 104 or 111. **Corequisite:** BIOSC 457.

**BIOSC 657:** Medical and Veterinary Parasitology Laboratory, 2 cr. (1 and 2)
Laboratory exercises reinforce the material presented in BIOSC 456 and introduce students to both live and preserved human/animal parasites; techniques used in collection, preservation and examination of animal parasites. **Corequisite:** BIOSC 456.

**BIOSC 658 (AG E 658):** Cell Physiology, 3 cr. (3 and 0)
Chemical and physical principles of cell function emphasizing bioenergetics and membrane phenomena. **Prerequisite:** BIOCH 210 or 301 or permission of instructor.

**BIOSC 659:** Systems Physiology, 3 cr. (3 and 0)
Physiological systems of vertebrates and their homeostatic controls. Function of the major physiological systems is described in terms of anatomical structure and chemical and physical principles. **Prerequisite:** One year each of biology, chemistry and physics or permission of instructor.

**BIOSC 660:** Systems Physiology Laboratory, 2 cr. (1 and 2)
Modern and classical experimental methods demonstrate fundamental physiological principles discussed in BIOSC 459; introduction to computer-aided data acquisition and computer simulations of physiological function. **Prerequisite or Corequisite:** BIOSC 459.

**BIOSC 661:** Cell Biology, 3 cr. (3 and 0)
In-depth analysis of how and where intracellular and extracellular molecules control general and specific cellular functions such as gene expression, secretion, motility, signaling, cell-cycle control and differentiation. Taught and graded at a level where students are expected to infer from and integrate cellular events. **Prerequisite:** BIOCH 301 or permission of instructor.

**BIOSC 662:** Cell Biology Laboratory, 2 cr. (1 and 2)
Accompanies BIOSC 461. Focus on molecular and microscopic analysis of eukaryotic cells. **Corequisite:** BIOSC 461.

**BIOSC 664:** Mammalogy, 3 cr. (2 and 3)
Origin, evolution, distribution, structure and function of mammals; laboratory emphasis on the mammals of South Carolina. Field collection required. **Prerequisite:** BIOSC 303 or permission of instructor.

**BIOSC 665 (HORT 665):** Plant Molecular Biology, 3 cr. (3 and 0)
Fundamental plant processes at both the cellular and molecular levels including genome structure and organization (both nuclear and organellar); regulation of gene expression and its role in cellular and whole-plant processes; transposable genetic elements; applications for biotechnology. **Prerequisites:** Junior standing or permission of instructor and BIOSC 304 or 305 and GEN 302.

**BIOSC 666:** Herpetology, 3 cr. (2 and 3)
Systematics, life history, distribution, ecology and current literature of amphibians and reptiles; laboratory study of morphology and identification of world families, U.S. genera and all Southeastern species. Field trips required. **Prerequisite:** BIOSC 303 or permission of instructor.

**BIOSC 670:** Animal Behavior, 3 cr. (3 and 0)
Historical and modern developments in animal behavior emphasizing the evolutionary and ecological determinants of behavior; synthesis of ethology and comparative psychology. **Prerequisite:** BIOSC 302 or 303 or permission of instructor.

**BIOSC 671:** Animal Behavior Laboratory, 1 cr. (0 and 3)
Laboratory exercises that explore the behavior of animals. Emphasis is on behavioral observation and analysis and presentation of findings in a report format. **Prerequisite or Corequisite:** BIOSC 470 or permission of instructor.

**BIOSC 672:** Ornithology, 4 cr. (3 and 3)
Biology of birds: their origin and diversification, adaptations, phylogeny, classification, structure and function, behavior, ecology and biogeography. Field identification is emphasized, and field trips are required. **Prerequisite:** BIOSC 303 or permission of instructor.

**BIOSC 675:** Comparative Physiology, 3 cr. (3 and 0)
Physiological systems of invertebrates and vertebrates with emphasis on environmental adaptation; physiological principles as they relate to metabolism, thermoregulation, osmoregulation, respiration, and neural and integrative physiology. **Prerequisite:** One year each of biology, chemistry and physics or permission of instructor.

**BIOSC 676:** Comparative Physiology Laboratory, 2 cr. (1 and 2)
Modern classical experimental methods demonstrate fundamental physiological principles discussed in BIOSC 476; introduction to computer-aided data acquisition and manipulation as well as computer simulations of physiological function. **Prerequisite or Corequisite:** BIOSC 475.

**BIOSC 677:** Ichthyology, 3 cr. (2 and 3)
Systematics, life history, distribution, ecology and current literature of fish; laboratory study of morphology and identification of U.S. genera and all Southeastern species. Field trips required. **Prerequisite:** BIOSC 303 or permission of instructor.

**BIOSC 680:** Vertebrate Endocrinology, 3 cr. (3 and 0)
Basic principles of neuro-endocrine integration and homeostatic maintenance in vertebrates; comparative morphology and physiology of various endocrine tissues and hormone chemistry and modes of action. **Prerequisite:** BIOSC 303, organic chemistry or permission of instructor.

**BIOSC 730:** SC Life: Topics for Teachers, 3 cr. (2 and 2)
Topics relating to the SC Life curriculum. Lectures, laboratories and extensive field studies focus on the natural history and biodiversity of South Carolina. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered. **Prerequisite:** Permission of instructor.
**BIOLICAL SCIENCES**

**BIOSC 801:** Electron Microscopy of Biological Specimens, 3 cr. (1 and 6) F, S

Concepts and practice in preparing biological specimens for electron microscopy: fixing, embedding, thin-sectioning, staining, operating microscopes and photographing, developing, printing and interpreting micrographs. Each student must achieve proficiency with a selected specimen including writing a brief research proposal, preparing specimen, studying specimen with electron microscope and interpreting micrographs. Prerequisite: Permission of instructor.

**BIOSC 815:** Developmental Genetics, 3 cr. (3 and 0)

Current research in developmental genetics including model systems, homeotic genes of Drosophila, primary induction, adhesion molecules and cancer, axis formation, global pattern mutants in plants, homeobox genes in plants and photo regulation. Prerequisites: A semester of biochemistry and a semester of genetics.

**BIOSC 871:** Selected Topics, 1-4 cr. (1-4 and 0)

Cellular and developmental biology, ecology, behavior, evolutionary biology, molecular biology, physiology, systematics and other topics of interest to graduate students in the biological sciences. May be repeated for credit, but only if different topics are covered. Prerequisite: Permission of instructor.

**BIOSC 872:** Selected Topics Laboratory, 1-4 cr. (0 and 2-8)

Specialized laboratory experiences in cellular and developmental biology, ecology, behavior, evolutionary biology, molecular biology, physiology, systematics and other topics of interest to graduate students in the biological sciences. May be repeated for credit, but only if different topics are covered. Prerequisite: Permission of instructor.

**Botany**

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<tr>
<td>Botany</td>
<td>M.S.</td>
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<tr>
<td>Plant Physiology</td>
<td>Ph.D.</td>
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Candidates for graduate work in botany or plant physiology should have a strong undergraduate background in the biological and physical sciences. Undergraduate curricula which may provide this background are botany, biology or chemistry, or one of the agricultural plant sciences such as agronomy, forest resources or horticulture.

All candidates for the Master of Science degree must complete 24 semester hours of course work and six hours of research, and must present and defend a thesis based on original research. Research topics generally are selected from one of the following areas: taxonomy/biosystems, cytology, development, ecology, medical, physiology or physiological. In addition to the Master of Science degree in botany, the department participates in an interdepartmental program awarding the Doctor of Philosophy degree with a major in plant physiology. This program offers considerable opportunity for doctoral research in botany. It is described under Plant Physiology.

**BOT 821:** Inorganic Plant Metabolism, 3 cr. (3 and 0) F (odd numbered years)

Plant, soil, water and nutrient relations; permeability; uptake and translocation; transpiration; mineral nutrition. Prerequisites: BIOSC 601 and 602 or permission of instructor.

**BOT 822:** Organic Plant Metabolism, 3 cr. (3 and 0) S (even numbered years)

Respiration and photosynthesis; synthesis, translocation, storage, transformation and degradation of organic materials, fats, carbohydrates, proteins, pigments and nucleic acids. Prerequisites: BIOSC 601 and 602 and BIOCH 623 or permission of instructor.

**BOT 823:** Plant Growth and Development, 3 cr. (3 and 0) F (even numbered years)

Vegetative and reproductive growth and development from seed to maturity, flowering, fruiting and senescence; natural and synthetic growth regulators; morphogenesis. Prerequisites: BIOSC 601 and 602 and organic chemistry or permission of instructor.

**BOT 824:** Mode of Action of Growth Substances, 4 cr. (3 and 3) S (odd numbered years)

Physiology and biochemistry of both natural and synthetic growth regulators, hormones, growth retardants, herbicides and other inhibitors; methodology and mechanism of action. Prerequisites: BIOSC 601 and 602 and general biochemistry or BOT 822 or permission of instructor.

**BOT 831:** Advanced Plant Taxonomy, 4 cr. (3 and 3) S (odd numbered years)

Principles of plant classification; relationships and characteristics of major groups of vascular plants; student collects and identifies spring flora of area. Prerequisite: BIOSC 606 or permission of instructor.

**BOT 846:** Plant Ecology, 4 cr. (3 and 3) F

Effects of environmental factors upon plants and the influence of plants upon the environment; identification and analysis of interrelated biotic and physical factors that affect the structure, distribution and dynamics of individual plants, plant populations and ecosystems. Prerequisite: BIOSC 641 or permission of instructor.

**BOT 847:** Plant-Animal Interactions, 3 cr. (3 and 0)

Examination of plant-animal interactions from an ecological and evolutionary perspective. Topics include herbivory, pollination and seed dispersal as well as effects of animals on plant populations and influence of plants on animal diversity and abundance. Prerequisite: BIOSC 641 or BIOSC 646 or permission of instructor.

**BOT 850:** Plant Tissue and Cell Culture, 3 cr. (2 and 3) F (odd numbered years)

Methods and principles of plant tissue and cell culture: cloning, embryogenesis, protoplast fusion, plant regeneration, potential of plant genetic engineering. Prerequisite: Introductory plant physiology or permission of instructor.

**BOT 851 (HORT 851):** Plant Anatomy, 3 cr. (2 and 3) S (odd numbered years)

Origin, development and comparative structures of tissues, systems and organs of higher plants. Prerequisite: BIOSC 652 or permission of instructor.

**BOT 861 (HORT 861):** Plant Cell Biology, 3 cr. (3 and 0) F (odd numbered years)

Structure, development and activities of plant cells; ultrastructural organization uniquely associated with dynamics of cellular growth and development in plants. Prerequisites: BIOSC 601 and 602 or permission of instructor.

**BOT 891:** Master's Thesis Research, credit to be arranged

**BOT 921 (HORT 921):** Plant Cell Physiology Colloquium, 1 cr. (1 and 0)

Topics from current plant physiology literature provide a forum for criticizing research, conceiving new research ideas, developing research outlines and proposals, and integrating knowledge from various subdisciplines of plant physiology. May be repeated for credit. Prerequisites: BIOSC 601 and 602 or permission of instructor.
BOT 991: Doctoral Dissertation Research, credit to be arranged

Genetics
William V. Baird, Program Coordinator, Department of Horticulture

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<tr>
<th>Major</th>
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<tr>
<td>Genetics</td>
<td>M.S., Ph.D.</td>
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The M.S. and Ph.D. degrees in genetics are offered through an interdepartmental program. Applied and basic research emphasis areas include animal, plant, molecular, microbial, biotechnological, and environmental bioremediation genetics.

Applicants to the program must have a bachelor’s or master’s degree in any area: chemistry through organic or biochemistry; a minimum of four credits of physics; mathematics through calculus; and biology including introductory genetics. Students with more than 18 hours of deficiency for graduate status is attained. GEN 616 and 651 are required of all students. In addition, four of the following eight courses must be completed for the M.S. or Ph.D. degree: GEN/BIOSC/MICRO 618, MICRO 615, AGRON 605, ADVSC 652, BIOSC 665, GEN 812, BIOCH 815 and BIOCH 841. Other 800-level courses pertinent to the program of study and research are planned by the student and advisory committee to provide the student with a comprehensive knowledge of genetics.

The M.S. degree requires completion of 30 semester hours including 24 hours of course work, six hours of research and a research thesis. Twelve of the required 24 hours of course work must be 800-level courses. The Ph.D. degree requires 18 hours of doctoral research credit, a research dissertation and a minimum of 24 hours of course work beyond the bachelor's degree. The course work is specified by the student’s advisory committee with concurrence of the Genetics Program Committee.

GEN 616 (BIOSC 616): Recombinant DNA, 3 cr. (3 and 0) F
Current facts and concepts of molecular genetics focusing on gene organization, structure, and expression in prokaryotes and eukaryotes; current technologies and research in these areas. Prerequisites: GEN 302 or its equivalent and one semester of biochemistry or permission of instructor. A developmental biology course is also strongly recommended.

GEN 618 (MICRO 618) (BIOSC 618): Biotechnology I: Nucleic Acids Techniques, 4 cr. (2 and 4) N
Basic training in the manipulation of genetic information using recombinant DNA technology including techniques in molecular cloning, Southern and Northern analyses, clone library construction. Prerequisite: BIOCH 210 or 301 and MICRO 305 or permission of instructor.

GEN 651: Advanced Genetics, 3 cr. (3 and 0) F
Principles of general genetics emphasizing variations in chromosome number and structure, natural and induced mutations, extranuclear inheritance, recombination, control of gene activity, gene and development, genetics of behavior patterns, population genetics, systems of mating, genetics and man. Prerequisite: GEN 302 or equivalent.

GEN 695 (ENT 695): Insect Biotechnology, 3 cr. (3 and 0) F
Unique features exhibited by insects; applications of biotechnology to enhance useful products from insects and to affect the control of destructive insects. Prerequisites: ENT 301 and GEN 302.

GEN 801: Cytogenetics, 3 cr. (2 and 3) S (odd numbered years)
Classical and contemporary problems of chromosome structure, behavior and transmission; recombination; interspecific hybridization; euchromatin and heterochromatin; polyploidy; mutable genetic systems; structural and numerical aberrations of chromosomes and their effects upon breeding systems of plants and animals. Prerequisite: GEN 302 or equivalent.

GEN 803: Biometrical Genetics, 3 cr. (3 and 0) S
Statistical methodology in the study of population genetics; probability as applied to genetic systems, gene and zygotic frequencies, derivation of genetic expectations, forces that change gene frequency, inbreeding, estimation and testing of genetic parameters, partition of variance, responses to selection and other statistical aspects of continuous variation. Prerequisites: GEN 651 and EX ST 801 or equivalent.

GEN 806: Special Problems in Genetics, 1-3 cr. (0 and 3-9)
Research not related to a thesis.

GEN 812: Physiological Genetics, 3 cr. (3 and 0) F
Advanced topics in the molecular aspects of physiological genetics including genes and metabolism, genes and signal transduction, oncogenes and growth, chromosomal aberrations, immunogenetics and others. Prerequisites: A semester of biochemistry and introductory genetics.

GEN 825: Genetics Seminar, 1 cr. (1 and 0)
Special topics and original research in genetics reviewed by students, faculty and invited lecturers. May be repeated for credit. Prerequisite: One semester of genetics.

GEN 890: Special Topics in Genetics, 1-3 cr. (1-3 and 0)
Group discussion of recent developments in genetic research. May be repeated for a maximum of six credit hours. Prerequisites: GEN 302 and permission of instructor.

GEN 891: Master's Thesis Research, credit to be arranged

Microbiology

Steven S. Hayasaka, Chair, Department of Microbiology

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<tr>
<th>Major</th>
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<tr>
<td>Microbiology</td>
<td>M.S., Ph.D.</td>
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</table>

Graduate work in microbiology requires sound undergraduate training in the biological and physical sciences. This training may be received in an undergraduate program in biology (botany, microbiology or zoology), chemistry or in one of the agricultural sciences. Undergraduate work in bacteriology or microbiology is desirable but not necessary. All students complete a curriculum which assures a sound knowledge of the basic areas of microbiology including at least three of the following: bacterial physiology and metabolism, molecular genetics, pathogenic microbiology, virology, immunology and molecular medicine or applied and environmental microbiology. The program is selected by the student with the guidance and approval of an advisory committee.

Candidates for the M.S. degree must complete 30 hours of graduate credit including six hours of research, and present and defend a thesis based on original research. Candidates for the Ph.D. degree must complete 18 hours of dissertation research, complete a core curriculum and present and defend a dissertation based on original research. Research disciplines include biomedical research (pathogenic microbiology, immunology, gene therapy, cancer, endocrinology); food safety (molecular biology and production of bacteriocins); and environmental microbiology (bioremediation, rhizosphere microbiology).

MICRO 600: Public Health Microbiology, 3 cr. (3 and 0) S
Epidemiology of transmissible diseases including pathogenic characteristics of the infectious organism, modes of transmission, mechanism of infection, diagnostic aids, effective treatments, immunizing procedures and methods of preventing infection. Prerequisite: MICRO 305.

MICRO 601: Advanced Bacteriology, 4 cr. (2 and 6) F
Metabolism, nutrition, growth and death of bacteria; microbiological assays and industrial fermentation. Emphasis is on laboratory procedures for the identification of the more common taxonomic groups. Prerequisite: CH 201 or 223, 227 and MICRO 305.
MICRO 603: Marine Microbiology, 3 cr. (2 and 3) N
Microbes that inhabit the marine environment, their peculiar physiological traits and contributions to the ecology of oceans. Prerequisite: MICRO 305 and organic chemistry.

MICRO 607: Food and Dairy Microbiology, 4 cr. (3 and 3) S
Physical-chemical factors limiting survival and growth of microorganisms during processing and manufacturing of food and dairy products; standard methods for enumerating and identifying indicator bacteria, yeasts, molds and microbes producing food and food-borne illness; starter cultures, fungal toxins, microbial cell injury and standards for food and dairy products. Prerequisite: BIOCH 210 or CH 201 or 223 and MICRO 305.

MICRO 610: Soil Microbiology, 3 cr. (2 and 3) N
Role of microorganisms in the decomposition of organic substances, transformation of nitrogen and mineral substances in the soil; interrelationships between higher plants and microorganisms; importance of microorganisms in soil fertility. Prerequisite: MICRO 305.

MICRO 611: Pathogenic Bacteriology, 4 cr. (3 and 3) S
Pathogenic bacteria, their morphology, cultural requirements and classification; diagnostic tests, methods of differentiation and the diseases caused. Prerequisite: MICRO 305.

MICRO 612: Bacterial Physiology, 4 cr. (3 and 3) S
Cytology, physiology, metabolism and genetics of bacteria including growth and death, reproduction and mutation, nutrition and metabolic pathways, regulatory mechanisms and effects of environment. Prerequisite: CH 224, MICRO 305 and one semester of biochemistry or permission of instructor.

MICRO 613: Industrial Microbiology, 3 cr. (2 and 3) F
Microbial aspects of large-scale processes for the production of foods, antibiotics, enzymes, fine chemicals and beverages including strain selection, culture maintenance, biosynthetic pathways, continuous cultivation and production of single cell protein. Prerequisite: MICRO 305.

MICRO 614: Basic Immunology, 3 cr. (2 and 3) F
Nature, production and function of basic immune responses in animals; procedures and mechanisms of antigen-antibody and other immune reactions. Prerequisite: MICRO 305 and organic chemistry.

MICRO 615: Microbial Genetics, 4 cr. (3 and 3) S
Cytological basis of bacterial, fungal and viral genetics; molecular aspects; mutations; mechanisms of genetic transfers; episomes and plasmids; and population changes. Prerequisite: BIOCH 301, CH 224 and MICRO 305 or permission of instructor.

MICRO 616: Introductory Virology, 3 cr. (3 and 0) F
Introduction to the field of virology including animal, bacterial and plant viruses. Topics include nomenclature and classification, biochemical and biophysical characteristics, mechanisms of replication, chemotherapy and techniques for isolation, assay and purification. Prerequisite: BIOCH 301, MICRO 305 or permission of instructor.

MICRO 617: Molecular Mechanisms of Carcinogenesis and Aging, 3 cr. (3 and 0) S
Changes that occur at the cellular and subcellular levels during transformation and aging; accumulated damage and "intrinsic clock" theories of aging; genetic and epigenetic theories of carcinogenesis; epidemiology of cancer; viral, radiation-induced and chemical carcinogenesis; the immune system and cancer. Prerequisite: BIOCH 301, MICRO 305 or permission of instructor.

MICRO 618 (BIOCS 618) (GEN 618): Biotechnology I: Nucleic Acids Techniques, 4 cr. (2 and 4) N
Basic training in the manipulation of genetic information using recombinant DNA technology including techniques in molecular cloning, Southern and Northern analyses, colony library construction. Prerequisite: BIOCH 210 or 301, MICRO 305 or permission of instructor.

MICRO 619: Molecular Medicine, 3 cr. (3 and 0) S
Introduction to various areas of molecular medicine; the latest research and developments in molecular medicine; designed for students interested in medicine and biomedical research. Prerequisite: MICRO 304, BIOCH 301 or permission of instructor.

MICRO 620: Bacteriological Technic, 4 cr. (2 and 6) F
Analytical and experimental procedures used in bacteriology including techniques for studying bacterial cytology, physiology and metabolism; experience in more advanced methods of investigation.

MICRO 621: Special Problems in Microbiology, credit to be arranged, F, S, SS
Research not related to a thesis.

MICRO 624: Selected Topics in Microbiology, 1-3 cr. (1-3 and 0) F, S, SS
Evaluation of current research literature in various areas of microbiology; critical evaluation of specific publications in terms of their scientific merit. Required of all microbiology graduate students. May be repeated for credit.

MICRO 625: Techniques of Clinical Microbiology and Immunobiology, 3 cr. (2 and 3) F
Methods for isolating, identifying and culturing different mammalian cell types; techniques used to analyze cell function and viability and for protein and DNA analysis emphasizing application to the diagnosis of disease, determination of prognosis, optimization of treatment and determination of etiology. Prerequisite: MICRO 614, 615, BIOCH 623 or equivalent, or permission of instructor.

MICRO 626: Pathogenesis and Infectious Disease, 3 cr. (3 and 0) N
Medically important host-parasite relationships at the cellular and subcellular levels with emphasis on bacterial and viral infections in man. Prerequisite: MICRO 611 or permission of instructor.

MICRO 627: Seminar, 1 cr. (1 and 0) F, S
Topics not covered in other courses; students review literature, organize and present material. May be taken twice for credit.

MICRO 628: Biotechnology and Medicine, 3 cr. (3 and 0)
Medical problems currently receiving attention due to the application of biotechnology to diagnosis or treatment; basic information essential to understanding the molecular biology of the disease and its diagnosis or treatment. Prerequisite: Permission of instructor.

MICRO 629 (HLTH 609): Epidemiological Research, 3 cr. (3 and 0)
Basic concepts of epidemiology with an emphasis on applied aspects rather than theoretical. Examples drawn from clinical practice. Use of relevant PC-based computer packages required. Prerequisite: MTHSC 405/605 or EX ST 801 or permission of instructor.

MICRO 631: Bacterial Cytology and Physiology, 4 cr. (4 and 0) S (odd numbered years)
Structure, chemistry and physiology of the various bacterial cell components; physiology of bacterial growth and reproduction in batch, continuous and synchronous cultures; economy of the bacterial cell including endogenous metabolism and maintenance requirements; physiology of bacterial death; regulation of enzyme and nucleic acids syntheses. Prerequisite: MICRO 305/605, BIOCH 423/623, MTHSC 206; or permission of instructor.

MICRO 632: Bacterial Metabolism, 3 cr. (3 and 0) S (even numbered years)
Various biochemical pathways occurring in bacterial cells; fermentations of carbohydrates and related compounds and of nitrogenous organic compounds; anaerobic and aerobic respiration including electron transport systems and oxidative phosphorylation; bacterial photosynthesis; nitrogen fixation; biosyntheses of
amino acids, purines, pyrimidines, lipids, proteins, nucleic acids and polysaccharides. Prerequisite: MICRO 305/605; BIOCH 423/623; MTHSC 206; or permission of instructor.

**NUTR 815: Advanced Microbial Genetics, 3 cr. (3 and 0) F**
Current developments in microbial genetics; integration of genetics and biochemistry; analysis of genetic fine structure in microorganisms; nature of bacterial variation and expression of mutations; population dynamics; physicochemical mechanisms of heredity; regulation of gene action in microorganisms; physiology and genetics of virulent and lycogenic bacteria. Prerequisite: MICRO 415/615.

**NUTR 891: Master's Thesis Research, credit to be arranged**

**NUTR 991: Doctoral Dissertation Research, credit to be arranged**

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<th>Major</th>
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<tr>
<td>Nutrition</td>
<td>M.S., Ph.D.</td>
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The M.S. and Ph.D. degree programs in nutrition are interdepartmental with course work and curricula developed and offered in the departments of Animal and Veterinary Sciences; Food Science; and Human Nutrition. Applicants should have a background in basic biological sciences appropriate for advanced study in the proposed area of specialization. Students with deficiencies may be admitted if their deficiencies are corrected by completing certain undergraduate courses.

A student's program of study will include a core of basic courses in nutrition, biochemistry, statistics and physiology. Additional course work may be taken in areas of special interest as approved by the advisory committee. Thesis and nonthesis options are available. The program of study for the nonthesis option includes a minimum of 30 graduate credits with at least eight credits in 800-level nutrition courses. These eight credits may not include topical problems in nutrition or credits for seminars. The M.S. degree requires a minimum of 24 credit hours of course work and six credit hours of research.

**NUTR 601: Fundamentals of Nutrition, 3 cr. (3 and 0) F**
Biochemical and physiological fundamentals of nutrition applicable to domestic animals and man; digestive processes; absorption and metabolism of carbohydrates, lipids, proteins, water, minerals and vitamins; energy metabolism and comparative anatomy and physiology of digestive systems. Prerequisite: BIOCH 210, CH 223 or permission of instructor.

**NUTR 625: Nutrition and Dietetics, 4 cr. (3 and 3) F**
Development of diets to meet human nutritional needs with emphasis on metabolic bases of dietary management of individuals with various disease states. Prerequisite: NUTR 451 or equivalent.

**NUTR 626: Community Nutrition, 3 cr. (3 and 0) F**
Fundamentals of nutrition care delivery in community programs beginning with assessment and problem identification and continuing through the development, implementation and evaluation of nutrition intervention programs. Prerequisite: NUTR 451 or equivalent or permission of instructor.

**NUTR 651: Human Nutrition, 3 cr. (3 and 0) F, S**
Essentials of nutrition and principal nutritional deficiency conditions; factors affecting adequacy of dietary intake, methods of determining nutritional status; development of nutrition standards; recent advances in human nutrition. Prerequisite: BIOCH 210/211 or equivalent or permission of instructor.

**NUTR 655: Nutrition and Metabolism, 3 cr. (3 and 0) S**
Concepts of metabolism fundamental to understanding normal and therapeutic nutrition; bioenergetics as well as metabolism of carbohydrates, lipids, amino acids, vitamins and minerals as they relate to nutrition. Prerequisites: NUTR 451 and BIOCH 210 or 423 or 406 or permission of instructor.

**NUTR 706: Nutrition for Teachers, 3 cr. (3 and 0) SS**
Principles of nutrition applied to nutrition education. Prerequisite: Permission of instructor.

**NUTR 801: Topical Problems in Nutrition, 1-3 cr. (1-3 and 0)**
Topics not covered in other courses or by thesis research. Credit varies with problems selected.

**NUTR 802: Special Topics in Nutrition, 1-3 cr. (1-3 and 0) N**
Topics of special interest or contemporary subjects not examined in other courses.

**NUTR 808: Monogastric Nutrition, 3 cr. (3 and 0) F**
Basic concepts and current research related to nutrient requirement and metabolism of poultry, swine and other monogastric species. Prerequisite: NUTR 401/601, 451/651 or P S 451/651.

**NUTR 809: Ruminal Nutrition, 3 cr. (3 and 0) F**
Microbiological, biochemical and physiological processes involved in the synthesis of amino acids, proteins and B vitamins; relation of these processes to utilization of proteins, lipids, and fibrous and nonfibrous feed ingredients; properties and functions of nutrients, nonprotein nitrogen compounds and growth-promoting substances for dairy cattle, beef cattle and sheep. Prerequisite: NUTR 401/601 or permission of instructor.

**NUTR 811: Carbohydrate Nutrition, 2 cr. (2 and 0)**
Dietary sources, chemistry, absorption/excretion and functions of carbohydrates; the aberrations of metabolism and possible role in the etiology of degenerative diseases. Prerequisites: BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 815: Lipid Nutrition, 2 cr. (2 and 0)**
Nutrition of lipids in humans and domestic animals emphasizing their source, digestion and absorption, metabolism, function, dietary needs and interrelationships. Prerequisites: BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 816: Amino Acids and Protein Nutrition, 2 cr. (2 and 0) F (odd numbered years)**
Nutrition of amino acids, nonprotein nitrogen and proteins related to humans and domestic animals; essentiality, interrelationships and metabolism of amino acids.

**NUTR 817: Mineral Nutrition, 2 cr. (2 and 0)**
Occurrence, chemistry, absorption/excretion, and general and specific physiological functions of minerals. Prerequisites: BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 819: Vitamin Nutrition, 2 cr. (2 and 0)**
Overview of the chemistry, metabolism, physiology, digestion, absorption and excretion of the vitamins as applied to the nutrition of humans and domestic animals. Prerequisites: BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 820: Nutritional Bioenergetics, 2 cr. (2 and 0)**
Quantitative approach to the losses of dietary energy during digestion and metabolism, and the factors governing the energetic efficiency of different biological functions in animals and man; regulation of energy balance, body temperature regulation and techniques of calorimetry. Prerequisites: BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or permission of instructor.

**NUTR 851: Nutrition Seminar I, 1 cr. (1 and 0) F**
Current research and developments in nutrition. Topics, selected by the instructor and students, will come from student research and nutrition literature.

**NUTR 852: Nutrition Seminar II, 1 cr. (1 and 0) S**
Continuation of NUTR 851.

**NUTR 991: Master's Thesis Research, credit to be arranged**

**NUTR 991: Doctoral Dissertation Research, credit to be arranged**
The following courses offered by various departments represent possible electives for the student in nutrition.

<table>
<thead>
<tr>
<th>Department</th>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites</th>
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<tr>
<td>BIOCH 606: Physiological Chemistry</td>
<td>3 cr.</td>
<td>3 (and 0) N</td>
<td>Chemical basis of the mammalian physiological processes of muscle contraction, nerve function, respiration, kidney function and blood homeostasis; composition of specialized tissue such as muscle, nerve, blood and bone, and regulation of water, electrolytes and acid-base balance. Prerequisite: BIOCH 210 or organic chemistry.</td>
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<tr>
<td>BIOCH 815: Lipids and Biomembranes</td>
<td>3 cr.</td>
<td>3 (and 0)</td>
<td>Isolation, chemical and physical properties and metabolism of lipids; purification, structure, function and biosynthesis of biomembranes. Prerequisite: BIOCH 432/632 or permission of instructor.</td>
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<tr>
<td>BIOCH 822: Enzymes</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
<td>kinetics, mechanisms of action, inhibitions and general properties of enzymes. Prerequisite: BIOCH 431/631 or 423/623.</td>
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<tr>
<td>ZOOL 853: Interpretive Electron Microscopy</td>
<td>3 cr.</td>
<td>(3 and 0) N</td>
<td>Cell structure as viewed through the electron microscope; characteristic structural features of cells from various tissues and from various organisms at different phylogenetic levels. Prerequisites: AN PH 801/BIOCS 801 or BIOCS 632 and 633 or permission of instructor.</td>
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<tr>
<td>ZOOL 891: Doctoral Dissertation Research, credit to be arranged</td>
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Entomology, Horticulture, and Plant Pathology and Physiology. A minimum of 36 semester hours is required, and the student must complete satisfactorily an internship and oral and written examinations.

The core courses listed below are required of all candidates for the Master of Agriculture degree.

AP EC 719: Professional Problems in Agribusiness Management, 3 cr. (3 and 0) F

Concepts and principles of agribusiness firm management; decision theory, information systems, systems analysis and organization theory applied to the organization, administration and management of agriculturally related businesses.

II, or

Elective in agricultural and applied economics or business.

AG ED 632: Visual Media for Agribusiness, 3 cr. (2 and 3) S

Theoretical and practical course for professionals in agriculture with major emphasis on visual communications.

or

ENGL 690: Advanced Technical and Business Writing, 3 cr. (3 and 0) F

Advanced work in writing proposals, manuals, reports, and publishable articles. Students will produce work individually and in groups. Prerequisite: ENGL 304 or 314 or permission of instructor.

EX ST 801: Statistical Methods, 4 cr. (3 and 3) F, S

Role and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components analysis, simple and multiple linear regression and correlation, and non-parametric procedures. Prerequisite: Permission of instructor.

In addition to the above required courses, the following courses are electives.

AGRIC 640: Microclimatology, 3 cr. (3 or 0)

Energy balance in earth's atmosphere and soil; solar and thermal radiation, air and soil temperature, humidity, evaporation and the hydrologic cycle; wind fields; weather variables to describe microclimates and the energy balance of plants, animals and insects; modification of microclimates; rural and urban climates. Prerequisite: PHYS 240 or equivalent or permission of instructor; second semester junior or senior standing.

AGRIC 700: Selected Topics, 3-6 cr. (0-3 and 0-9)

Supervised study of a selected area in agricultural science not covered in another course; content varies based on the topic being covered. May be repeated for a maximum of six credits, but only if different topics are covered. Prerequisite: Permission of instructor.

The following courses are required in the plant health option.

I P M 601: Principles of Integrated Pest Management, 3 cr. (3 and 0) F (even numbered years)

Origins, theory and practice of integrated pest management; relationships among crop production and protection practices; economics of various control strategies; integrated pest management field projects; comparison of conventional and integrated pest management approaches; multidisciplinary plant problem analysis. Prerequisite: AGRON 407, ENT 301, PL PA 401 or permission of instructor.

I P M 700: Internship in Plant Health, 1-5 cr. (0 and 8-40)

Professional employment under competent supervision in an approved agency or organization dealing with the vocational or occupational aspects of plant health. Student submits weekly reports covering his or her experiences and a terminal report. Graded on a pass/fail basis. Prerequisites: Graduate student standing for at least one semester, I P M 401/601 and permission of the plant health coordinator.

I P M 704: Seminar, 1 cr. (1 and 0) F (even numbered years)

Students and faculty review current research and development topics in integrated pest management. One or more presentations required. May be repeated for a maximum of two credits. Prerequisite: Permission of instructor.

I P M 800: Special Problems in Plant Health, 1-3 cr. (0 and 3-9)

Directed individual study of a special problem in plant health. Emphasis is on organizing, conducting and reporting on independent investigation. Prerequisite: Permission of instructor.

AGRON 603: Soil Genesis and Classification, 2 cr. (1 and 3) F

Soil morphology and characterization, pedogenic processes, soil-forming factors and classification of soils. Prerequisite: AGRON 202 or permission of instructor.

AGRON 604: Soils and Land Use, 2 cr. (1 and 3) F

Soils interpretations for nonagricultural purposes and facilities; use of modern soil surveys; properties and features of soils important in nonfarm land uses. Not open to agronomy majors or minors or to students who have taken AGRON 202.

AGRON 605: Plant Breeding, 3 cr. (2 and 2) S

Application of genetic principles to the development of improved crop plants including the genetic and cytogenetic basis of plant breeding, mode of reproduction, techniques in selfing and crossing, methods of breeding, inheritance in the major crops and biotechnical methods. Prerequisite: GEN 302 or equivalent.

AGRON 607: Weed Ecology and Management, 3 cr. (2 and 2) F

Weeds, their introduction, ecology, methods of reproduction, dissemination and management; chemistry and mode of action of herbicides; equipment and techniques of application; characterization of the common weeds of the Southeast. Prerequisite: AGRIC 104, AGRON 202 or permission of instructor.

AGRON 608 (E S E 608) (AG E 608): Land Treatment of Wastewater and Sludges, 3 cr. (3 and 0) F

Principles for designing environmentally acceptable land application systems using municipal and industrial wastewater and sludges; land-limiting constituent analysis; soil-plant interactions; system equipment and design; system operation and management; public acceptance, social and regulatory issues. Case studies and field trip(s) are planned. Prerequisite: Senior standing in agriculture or engineering or permission of instructor.

The following courses are required in the interdisciplinary Master of Agriculture degree.

Areas of specialization normally are allied with those of the major professor. The crop sciences include plant breeding and genetics; forage systems; physiology; ecology, production and management; cellular biology and molecular genetics; and weed science. The soil sciences include chemistry; physics; microbiology and biochemistry; fertility and plant nutrition; and genetics, morphology and classification.

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AGRON 621: Principles of Field Crop Production, 3 cr. (3 and 0) F
Principles for production of field crops including botany and physiology, tillage, harvesting, storage, and crop quality. Principles will be illustrated using examples from various crops. Prerequisites: AGRIC 104 or equivalent introductory plant science, AGRON 202.

AGRON 622: Major World Crops, 3 cr. (3 and 0) S
Distribution, adaptation, production and utilization of major agronomic crops of the world; crops important to U.S. agriculture including corn, wheat, rice, sorghum, soybean, cotton, tobacco and peanuts. Prerequisites: AGRIC 104 or equivalent introductory plant science, AGRON 202.

AGRON 623: Field Crops—Forages, 3 cr. (3 and 0) S
Establishment, management and utilization of forage crops in a forage-livestock agro-ecosystem context; hay, silage and pasture utilization. Computer model used to study complexity of forage-livestock production systems. Prerequisite: AGRIC 104, AGRON 202 or permission of instructor.

AGRON 625: Seed Science and Technology, 3 cr. (2 and 2) S (even-numbered years)
Seed development, germination, dormancy, pathology, storage and deterioration; seed testing and commercial production of seed; useful applications of current seed science knowledge. Prerequisites: AGRIC 104, BIOSC 205.

AGRON 626 (AP EC 626): Cropping Systems Analysis, 3 cr. (2 and 2) F
Application of agronomic and economic principles in solving problems relating to the production and marketing of agronomic crops. A major part of the course will be a case study in which a detailed analysis of a farm, agri-business or environmental situation will be made with students making formal written and oral presentations of results. Prerequisites: AP EC 202, AGRIC 104, junior or senior standing.

AGRON 633 (HORT 633): Integrated Weed Management for Agronomic and Horticultural Crops, 3 cr. (2 and 2) S
Weed management systems consisting of cultural, chemical and biological methods for the major agronomic and horticultural crops of South Carolina; problem-solving methodology and herbicide injury diagnosis. Prerequisite: AGRON 407 or equivalent introductory weed science.

AGRON 646: Soil Management, 3 cr. (3 and 0) F
Basic soil properties related to compaction, water and solute movement, and root growth; practical management problems and solutions based upon basic soil characteristics. Problems include erosion, no-tillage, compaction, irrigation, leaching, waste application, golf-green management and orchard establishment. Prerequisite: AGRON 202.

AGRON 652: Soil Fertility and Management, 3 cr. (3 and 0) S
Soil properties, climatic factors and management systems in relation to soil fertility maintenance for crop production; plant nutrition and growth in relation to crop fertilization and management. Prerequisite: AGRON 202 or permission of instructor.

AGRON 653: Soil Fertility Laboratory, 1 cr. (0 and 3) S
Evaluation and interpretation of soil fertility production. Prerequisite: AGRON 202 or permission of instructor.

AGRON 675: Soil Physics and Chemistry, 3 cr. (2 and 3) S
Principles of soil physics and chemistry and their applications including soil texture, structure, compaction, water relations, solute movement, mineral composition, adsorption phenomenon and soil acidity. Prerequisites: AGRON 202, CH 101, 112, PHYS 207.

AGRON 690: Beneficial Soil Organisms in Plant Growth, 3 cr. (3 and 0) F (odd numbered years)
Aspects of biological nitrogen fixation, mycorrhizal fungi, microbial-pesticide interactions, bioremediation, nutrient cycles and biological pest control related to plant growth, soil/environmental quality; sustainable agriculture. Students who desire laboratory experience in these topics can register for AGRON 406 after consultation with instructor. Prerequisite: AGRON 202, MICRO 305, PL PA 401, or permission of instructor.

AGRON 701: Soils and Man, 3 cr. (3 and 0)
Different kinds of soils, their properties, uses, management, conservation and relationship with the environment and other human endeavors. Not open to agronomy majors pursuing the M.S. or Ph.D. degrees.

AGRON 801: Crop Physiology and Nutrition, 3 cr. (3 and 0) F (odd numbered years)
Basic concepts and physiologic aspects of growth and culture applied to crop management practices. Prerequisites: BIOSC 401/601 and 402/602 or equivalent.

AGRON 802: Pedology, 3 cr. (3 and 0) F (odd numbered years)
Current concepts and theories in soil genesis and morphology; advanced study of soil taxonomy. Prerequisite: AGRON 403/603.

AGRON 804: Theory and Methods of Plant Breeding, 3 cr. (3 and 0) F (even numbered years)
Concepts and principles of plant breeding and genetics as applied to development and maintenance of improved crop varieties; theoretical considerations of various breeding methods. Prerequisites: AGRON 405/605 and EX ST 801 or permission of instructor.

AGRON 805: Soil Fertility, 3 cr. (3 and 0) S (even numbered years)
Soil properties affecting nutrient availability and plant growth; inventory of major soil groups with reference to plant stress features; behavior of essential elements in soils in relation to plant availability; current soil fertility research. Prerequisite: AGRON 452 or 403 or permission of instructor.

AGRON 806: Special Problems, 1-3 cr. (0 and 3-9)
Research not related to a thesis.

AGRON 807: Soil Physics, 4 cr. (3 and 3) F (even numbered years)
Principles and applications of transport of water and solutes in soils emphasizing unsaturated flow phenomenon. Prerequisite: MTHSC 108 or equivalent.

AGRON 808: Soil Chemistry, 3 cr. (2 and 3) F (odd numbered years)
Principles and theories concerning the structure and chemical properties of soil colloids, ion exchange and surface phenomena, chemical equilibria, soil acidity and oxidation-reduction reactions.

AGRON 810: Soil Microbiology, 3 cr. (3 and 0) F (even numbered years)
Biological nitrogen fixation, mycorrhizal fungi and pesticide interactions in soils with emphasis on microbial-plant-soil relationships. Prerequisites: AGRON 690 or MICRO 610 and permission of instructor.

AGRON 812: Crop Ecology and Land Use, 3 cr. (3 and 0) F (even numbered years)
Concepts and factors affecting adaptation and distribution of crop plants; microclimate and crop response to environmental factors with modifications of microclimate by agricultural operations; interactions among crop plants and between weeds and crop plants under field conditions.

AGRON 825: Seminar, 1 cr. (1 and 0) F, S
Special topics and original research in agronomy. Credit may be earned for more than one semester by doctoral candidates. Graded on a pass/fail basis.

AGRON 890: Special Topics in Agronomy, 1-3 cr. (1-3 and 0)
Group discussion of recent developments in agronomic research. May be repeated for a maximum of six credit hours. Prerequisite: Permission of instructor.

AGRON 891: Master's Thesis Research, credit to be arranged
AGRON 991: Doctoral Dissertation Research, credit to be arranged
The department is dedicated to providing leadership in environmental entomology. Research programs fall into five emphasis areas: aquatic arthropod diversity, crop-insect management, genetics and biotechnology, medical and veterinary entomology, and urban entomology. Facilities of the Agricultural Experiment Station on campus and at four Research and Education Centers located in various regions of the state are available for graduate student research. In addition to teaching and research laboratories, specialized facilities within the department include the Clemson University Arthropod Collection; laboratories for molecular genetics, tissue culture and analytical chemistry/toxicology; wet laboratories; controlled and ambient temperature insect-rearing facilities; a free-flight butterfly facility; and greenhouses.

Candidates for the M.S. degree are required to complete a thesis. The department participates in the plant health option of the interdisciplinary Master of Agriculture degree.

ENT 601: Insect Pests of Ornamental Plants and Shade Trees, 3 cr.
(2 and 3)
Recognition, biology, damage and control of insect pests of woody and other ornamental plants and shade trees. Prerequisite: ENT 301.

ENT 604: Urban Entomology, 3 cr.
(2 and 3) (even-numbered years)
Pests common to the urban environment with emphasis on biology, damage, control and identification of household, structural, stored products and food pests; theoretical and practical aspects of urban pest management and the pest-control industry. Prerequisite: ENT 301.

ENT 605: Insect Morphology, 4 cr.
(3 and 3)
Insect structure in relation to function and the variation of form in insects. Prerequisite: ENT 301.

ENT 606 (PL PA 606): Diseases and Insects of Turfgrasses, 3 cr.
(2 and 2)
Host-parasite relationships, symptomatology, diagnosis, economics and control of infectious and noninfectious diseases of turfgrasses; life histories, diagnosis and control of important insect pests of turfgrasses. Prerequisites: ENT 301 and PL PA 401 or equivalent.

ENT 607: Applied Agricultural Entomology, 4 cr.
(3 and 3)
Recognition, biology, damage and control of economically important insects and mites found on major Southeastern field crops, fruit, nut and vegetable crops; principles and practices of crop protection including pesticide application, economic basis for decision making and development of scouting programs. Prerequisite: ENT 301 or equivalent.

ENT 610: Insect Taxonomy, 3 cr.
(1 and 6)
The identification of the principal families of the major orders of adult insects. Laboratory work consists of intensive practice of such identification. Lecture material deals with theoretical discussion of taxonomic features observed in the laboratory. Prerequisite: ENT 405 or permission of instructor.

ENT 612: Field and Museum Entomology, 3 cr. (0 and 9)
Practical aspects of gathering, sorting and curating insects. Students participate in intensive overnight insect-collecting expeditions to various parts of the Southeastern States, becoming acquainted with insect habitats and collecting methods. Remainder of the summer session will be devoted to training in specimen preparation and preservation. Prerequisite: Permission of instructor.

ENT 620: Toxicology of Insecticides, 3 cr.
(2 and 2)
Concepts of insecticide toxicity; principles of insecticide action; toxicological and pharmacological effects in insects and higher animals; safety; current regulations governing the use of insecticides. Prerequisite: ENT 301.

ENT 630 (ENTOX 630): Toxicology, 3 cr.
(3 and 0)
Basic principles of toxicity including quantitation of toxicity, toxicokinetics, biochemical action of poisons and environmental toxicology; acute and chronic effects of various classes of poisons (e.g., pesticides, drugs, metals, and industrial pollutants) in relation to typical routes of exposure and regulatory testing methods. Prerequisites: Organic chemistry, one year of general biology or permission of instructor.

ENT 640: Insect Behavior, 3 cr.
(2 and 3)
Fundamentals of insect behavior in an evolutionary and ecological perspective. Laboratories emphasize generation and testing of hypotheses and observation, description and quantification of insect behavior. Prerequisite: ENT 301 or permission of instructor.

ENT 655: Medical and Veterinary Entomology, 3 cr.
(2 and 2)
Insects and their arthropod relatives of economic importance in their effect on man and animals. Prerequisite: ENT 301 or permission of instructor.

ENT 662: Seminar Presentation, 1 cr.
(1 and 0)
Advanced instruction and practice in delivering oral seminar presentations of scientific information emphasizing preparing visual aids, organization, content and practice in speaking to a specialized scientific audience.

ENT 663: Insect Pathology, 3 cr.
(2 and 3) (odd numbered years)
Insect diseases, their etiology, symptomatology and epizootiology; infectious diseases caused by viruses, bacteria, fungi and protozoa; ecological significance of these pathogens; their practical applications in medicine and agriculture. Prerequisites: ENT 301 or permission of the instructor.
ENT 853: Applied Systematics, 3 cr. (2 and 3) S (even numbered years) Application of evolutionary principles to resolution of contemporary zoological problems; legal issues and technical skills for efficient operation of international zoological information storage and retrieval system. Prerequisite:Permission of department.

ENT 860: Insect Pest Management, 3 cr. (3 and 0) S (even numbered years) Application of ecological principles to the management or control of insect populations; major factors influencing insect population fluctuations; integrated systems including biological, cultural, physical, chemical and other techniques forming a unified multifaceted approach based on applied ecology.

ENT 863: Special Problems in Entomology, 1-3 cr. (0 and 3-9) An entomological research project not related to a thesis. Prerequisite: Permission of instructor.

ENT 870: Insect Physiology and Molecular Biology, 4 cr. (3 and 3) Advanced instruction on the structure and function of insect physiological processes at the molecular, cellular and tissue levels; physiological and molecular mechanisms underlying the various internal systems of insects. The laboratory emphasizes hands-on experimentation and the scientific writing technique to report experimental findings. Prerequisites: EN 301, CH 223, and BIOL 111 or permission of instructor.

ENT 891: Master's Thesis Research, credit to be arranged

ENT 991: Doctoral Dissertation Research, credit to be arranged

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**Experimental Statistics**

Hoke S. Hill, Jr., Chair, Department of Experimental Statistics

Advanced degrees in experimental statistics are not awarded. A minor is offered at the master's and doctoral levels. Courses are offered for students majoring in other disciplines. Courses to be used to satisfy a minor should be approved by this department at the beginning of the student's program. At the master's level, minimum requirements are eight credit hours of 600-level courses with one hour of EX ST 811 acceptable. At the doctoral level, minimum requirements are 12 credit hours of 800-level courses with up to four hours of EX ST 811 acceptable.

EX ST 611: Statistical Methods for Process Development and Control, 3 cr. (3 and 0) F, S Experimental design techniques for use in process development; application of screening experiments and response surface experiments; techniques for process control with implications for product quality control; use of statistical computer analyses and interpretations including computer generated graphics. Prerequisite: MTHSC 206 or permission of instructor.

EX ST 662: Statistics Applied to Economics, 3 cr. (3 and 0) F Continuation of EX ST 301 with emphasis on statistical methods used in the collection, analysis, presentation and interpretation of economic data; time series analysis; construction of index numbers; gathering samples for surveys in the social sciences. Prerequisite: EX ST 301.

EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, S Study and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components analysis, simple and multiple linear regression and correlation, and nonparametric procedures. Prerequisite: Permission of instructor.

EX ST 802: Statistical Methods II, 3 cr. (3 and 0) F, S, SS Extended coverage of several methods introduced in EX ST 801: multiple regression model building and diagnostics, experiment design and analysis, and nonparametric methods; mixed models and repeated measures analyses; categorical data analysis; multivariate methods and sampling designs; appropriate use of statistical software. Prerequisite: EX ST 801.

EX ST 803: Regression and Least Squares Analysis, 3 cr. (3 and 0) S Regression analysis: simple and multiple linear, curvilinear and multiple curvilinear; curve fitting; least squares and computer techniques for fitting of constants and analysis of planned experiments. Prerequisite: EX ST 801.

EX ST 804: Sampling, 3 cr. (3 and 0) F Principles of scientific sampling; finite population sampling; simple random, stratified, multistage and systematic sampling; optimum allocation; methods of obtaining, processing and reporting survey information; sampling as related to the environment, natural resources, and social and economic problems. Prerequisite: EX ST 801.

EX ST 805: Design and Analysis of Experiments, 3 cr. (3 and 0) F, S Basic designs and analysis; data transformations; single degree of freedom, orthogonality and responses in ANOVA; covariance; response surfaces; incomplete blocks; introduction to least squares analysis of experiments; uses of standard computer programs for selected analyses. Prerequisite: EX ST 801.

EX ST 811: Special Problems in Experimental Statistics, 1-3 cr. (0 and 2-6) F, S, SS Statistical aspects of an individualized research problem; determining an appropriate experimental design; performing proper analyses and generating effective reports. Prerequisite: EX ST 801 or permission of department.

EX ST 812: Selected Topics, 1-3 cr. (1-3 and 0) N Topics in advanced statistics not covered in other courses. May be repeated for different topics.

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**Horticulture**

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The Master of Science degree is offered in floriculture, horticulture, vegetable crops, pomology, and turfgrass management. Candidates are required to conduct original research leading to a thesis. The department participates in the plant health option of the interdisciplinary Master of Agriculture degree and in interdepartmental programs leading to the Doctor of Philosophy degree with a major in plant physiology, genetics, and food technology. The Ph.D. program requires the performance of original research leading to a dissertation. Research concentrations are offered in molecular biology, plant breeding and genetics, tissue culture, weed science, phytomorphogenesis, postharvest physiology, stress physiology, crop production physiology, landscape design, and plant nutrition. Each student's degree program is tailored to his or her professional goals with the guidance of an advisor and graduate committee. All graduate students in horticulture must select an advisor before admission. Graduate students in both the M.S. and Ph.D. degree programs are required to enroll in HORT 809 (fall semester) and 810 (spring semester). Current information can be found on our Internet Web page: http://agweb.clemson.edu/hort/hortmain.htm.

HORT 606: Nursery Technology, 3 cr. (2 and 3) S Principles and techniques in handling nursery crops. Prerequisites: HORT 303, 305.

HORT 612: Turf Management, 3 cr. (2 and 3) F Warm and cool season turfgrasses in relation to value, use, regional adaptation, establishment, soils and cultural practices; influence of environmental, cultural and genetic factors on turf quality and serviceability; identification of grass and weed species and discussion of programs for the management of lawns, parks, roadways, and golf courses. Prerequisite: BIOL 103 or equivalent.

HORT 615: Foliage Plants for Interior Utilization, 3 cr. (2 and 3) F (odd numbered years) Application of foliage plant requirements for their selection and maintenance in interior environments. Laboratories in-
Weed management systems consisting of cultural, chemical and biological methods for the major agronomic and horticultural crops of South Carolina; problem-solving methodology and herbicide injury diagnosis. Prerequisite: AGRON 407 or equivalent introductory weed science.

HORT 652: Tree Fruit Culture and Physiology, 3 cr. (2 and 2) F (even numbered years)
Fruit bud formation, rest period and water relations of fruit plants, soils, fruit setting; orchard soil management and responses of various fruits to fertilizers; principles of pruning, effect of climatic differences, freezing injuries, and means of avoiding injury; harvesting, transportation and storage. Prerequisite: HORT 101 or consent of instructor.

HORT 655: Small Fruit Crops, 3 cr. (2 and 2) F (even numbered years)
T axonomical, morphological and physiological characteristics of small fruit crops as they relate to the study of horticultural characteristics, culture, production, harvesting and handling of both commercial and home-grown grapes, blueberries, strawberries, brambles and kiwifruit. Prerequisite: HORT 101 or permission of instructor.

HORT 656: Vegetable Crops, 4 cr. (3 and 3) F
Principles and practices employed in the commercial growing and marketing of vegetable crops; with emphasis on plant characteristics, cultivars, management practices, harvest, quality factors and grading, storage, economic importance and areas of production.

HORT 661: Problems in Landscape Design, 4 cr. (3 and 3) S
Landscape planning for larger residential properties, schools, industrial plants, real estate developments; detailed finished plans; further study of materials used; original problems; field study. Prerequisite: HORT 308, 407 or permission of instructor.

HORT 665 (BIOSC 665): Plant Molecular Biology, 3 cr. (3 and 0)
Fundamental plant processes at both the cellular and molecular levels including genome structure and organization (both nuclear and organelar); regulation of gene expression and its role in cellular and whole-plant processes; transposable genetic elements; applications for biotechnology. Prerequisites: Junior standing or permission of instructor and BIOSC 304 or 305 and GEN 302.

HORT 670: Horticulture and Human Well-Being, 3 cr. (2 and 3) S
Role of horticulture in human well-being (physical and mental); adaptive horticultural techniques and activities suitable for individuals with special needs (impaired, disabled, handicapped). Students will plan, perform and report on supervised and independent horticultural activities with selected special individuals or groups.

HORT 671: Advanced Internship, 1-6 cr. (0 and 2-12)
Preplanned work experience under competent supervision in approved agency dealing with horticultural endeavors. Designed to give advanced students on-the-job learning opportunities to apply acquired knowledge and skills. Monthly reports and final departmental seminar required. Undergraduates may accumulate a maximum of six credits for participation in HORT 271 and/or 471. Prerequisites: Junior standing and permission of instructor.

HORT 672: Garden Experiences in Youth Development, 2 cr. (1 and 3) F
Role of gardening and related outdoor experiences in enhancement of educational development, self-esteem and pro-social behavior in elementary school children. Prerequisites: Senior standing and permission of instructor.

HORT 701: H orticulture : Plant and Environmental Science, 3 cr. (2 and 3) SS
Scope of South Carolina horticulture and how it affects the quality of life economically and aesthetically; environmental responsibilities; methods of teaching plant principles. Three-day statewide field trip to horticultural industries included. Not to be taken for credit by graduate students in horticulture.

HORT 800: Topics in Horticultural Science, 1 cr. (1 and 0)
Timely topics in horticultural science. May be repeated for a total of four credits, as topics and instructors vary. Prerequisite: Permission of instructor.

HORT 802: Research Systems in Horticulture, 3 cr. (2 and 3) F (even numbered years)
Current trends, developments and techniques in horticultural research. Prerequisites: CH 223 and 227, or CH 201 and PHYS 207, or BI0CH 210.

HORT 806: Postharvest Physiology and Handling of Horticultural Crops, 3 cr. (3 and 0) S (even numbered years)
Principles, developments and research findings dealing with physiological and biochemical changes and processes occurring in horticultural plant organs after harvest; biological aspects of methods and practices relating to harvesting, handling, transportation and storage of horticultural commodities for fresh market. Prerequisites: BIOSC 401/601 and 402/602 or equivalent.

HORT 809: Seminar I, 1 cr. (1 and 0) F
Current topics in horticulture prepared and presented by the student.

HORT 810: Seminar II, 1 cr. (1 and 0) S
Continuation of HORT 809.

HORT 812: Special Problems in Horticulture, 1-4 cr. (1-4 and 0)
Research not related to a thesis. Course may be repeated for credit, but total credit may not exceed four hours. Prerequisite: Permission of instructor.

HORT 813: Photomorphogenesis, 3 cr. (2 and 2)
Regulatory role of light quality in plant development (photomorphogenesis) and its consequences in applications for crop production. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor; BOT 823 preferred.

HORT 814: Environmental Plant Stress Physiology, 3 cr. (2 and 2) F
Environmental stresses associated with water (drought, waterlogging), temperature, light and air pollution with quantitative treatment of stress effects on plants; mechanisms by which plants may avoid, tolerate or modify stress effects on plant growth and function at the molecular, cellular and whole-plant levels. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

HORT 851 (BOT 851): Plant Anatomy, 3 cr. (2 and 3) S (odd numbered years)
Origin, development and comparative structures of tissues, systems and organs of higher plants. Prerequisite: BIOSC 652 or permission of instructor.

HORT 861 (BOT 861): Plant Cell Biology, 3 cr. (3 and 0) F (odd numbered years)
Structure, development and activities of plant cells; ultrastructural organization uniquely associated with dynamics of cellular growth and development in plants. Prerequisites: BIOSC 601 and 602 or permission of instructor.

HORT 891: Master's Thesis Research, credit to be arranged

HORT 921: Plant Physiology Colloquium (B OT 921), 1 cr. (1 and 0)
Topics from current plant physiology literature provide a forum for criticizing research, conceiving new research ideas, developing research outlines and proposals, and integrating knowledge from various subdisciplines of plant physiology. May be repeated for credit. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

HORT 991: Doctoral Dissertation Research, credit to be arranged
Graduate training in plant pathology is designed to help students understand principles and techniques used to diagnose plant problems; prevent and control diseases of plants; develop integrated pest management programs; engage in research involving plant disease, causal agents, and host-pathogen interactions; and teach plant pathology. Current research interests include microbial ecology; molecular genetics as applied to diseases of plants; nematology and virology; diseases of field, fruit, and vegetable crops; biological, integrated pest management and agrochemical approaches to plant disease control.

Candidates for the M.S. degree are required to complete research presented in a thesis form. A minimum of 24 semester hours of course work is required. Research presented as a dissertation is required of Ph.D. candidates. No specific number of credit hours of course work is required. Research option of the interdisciplinary Master of Physiology participates in the plant health option of the interdisciplinary Master of Agriculture degree.

Undergraduate programs in a crop science or general biology provide a good background for graduate work in plant pathology.

PL PA 601: Plant Pathology, 3 cr. (2 and 3) F
Interrelationships among fungi, nematodes, bacteria, viruses and mycoplasmas as causal agents of plant diseases, their hosts, and the environment. Diseases caused by abiotic factors, symptom development, diagnosis, economics, control and relationship of plant diseases to human welfare are studied using examples of economically important diseases. Prerequisite: BIOL 103, 104 or equivalents.

PL PA 602: Diseases of Ornamental Plants, 3 cr. (2 and 2) S (odd numbered years)
Survival mechanisms, life cycles, host-parasite relationships, symptomatology, diagnosis, economics and integrated control of infectious diseases; causal factors, diagnosis and control strategies of noninfectious diseases of ornamental plants. Prerequisite: PL PA 401 or equivalent.

PL PA 606 (ENT 606): Diseases and Insects of Turfgrass, 3 cr. (2 and 2) F
Host-parasite relationships, symptomatology, diagnosis, economics, and control of infectious and noninfectious diseases of turfgrasses; life histories, diagnosis and control of important insect pests of turfgrasses. Prerequisite: ENT 301 and PL PA 401 or equivalent.

PL PA 611: Plant Disease Diagnosis, 2 cr. (1 and 2) SS (odd numbered years)
Methods and procedures used in the diagnosis of plant diseases, especially late spring and early summer seasons; basic techniques of pure culture and identification of plant pathogens and Koch's postulates; diagnosis of a wide variety of diseases of cultivated and wild plants. Prerequisite: PL PA 401 or equivalent.

PL PA 651: Bacterial Plant Pathogens, 3 cr. (2 and 3) F (odd numbered years)
Nature, development and control of plant diseases caused by bacteria; taxonomic considerations, host-parasite relations and techniques used in isolating, identifying and preserving bacterial plant pathogens. Prerequisite: MICRO 305, PL PA 401 or permission of instructor.

PL PA 656: Plant Virology, 3 cr. (2 and 3) S (odd numbered years)
Plant viruses with emphasis on their morphology, biochemistry, purification and transmission; symptoms resulting from virus infection; virus-vector relationships; serological procedures; importance and control of plant virus diseases. Prerequisites: BIOL 103 and any biochemistry or plant physiology course.

PL PA 658: Plant Parasitic Nematodes, 3 cr. (2 and 3) F (even numbered years)
Morphology and taxonomy of stylet-bearing nematodes and their relationship with plant diseases. Prerequisites: BIOL 103, 104 or 110, 111.

PL PA 800: Advanced Plant Pathology, 3 cr. (3 and 0) F (odd numbered years)
Economic and social significance and history of plant pathology, host-parasite interactions (host defense mechanisms, mycotoxins, pathotoxins, mycoplasmas), ecology (mycorrhizae, pollution, soilborne plant pathogens), and disease loss and appraisal. Selected pathogens illustrate concepts and principles. Outside assignments introduce topics not covered in class. Prerequisite: PL PA 401.

PL PA 801: Epidemiology and Control of Plant Diseases, 3 cr. (3 and 0) S (even numbered years)
Epidemiology and control of plant diseases including practical and theoretical coverage of chemical, physical and biological means of plant disease control. Prerequisites: PL PA 401 and organic chemistry.

PL PA 802: Selected Topics, 1-3 cr. (1-3 and 0-6)
Current advances in phytopathology and physiology, diseases of specific crops and specialized laboratory protocol. May be repeated for credit. Prerequisite: Permission of instructor.

PL PA 803: Fungal Plant Pathogens, 3 cr. (1 and 6) S (odd numbered years)
Plant pathogenic fungi including recognition of fungus disease symptoms, isolation of fungi that cause diseases, cultural features of fungi, morphological characteristics, physiological reactions to environment, disease cycles and management of pathogens and diseases. Prerequisites: BIOL 104 or equivalent, PL PA 401 and BIOSCI 425/625.

PL PA 804: Plant-Microbe Interactions, 3 cr. (3 and 0) F (even numbered years)
Physiology, biochemistry and genetics of plant-microbe interactions; molecular mechanisms involved in plant-microbe communication, plant colonization and penetration; development of the microbe within the plant; induction of plant defense responses. Prerequisites: BIOSCI 401/601 and 402/602 or PL PA 401 or permission of instructor.

PL PA 805: Special Problems in Plant Pathology, credit to be arranged
Research not related to a thesis. Prerequisite: PL PA 411/611 or equivalent, and permission of instructor.

PL PA 807: Seminar, 1 cr. (1 and 0) F, S
Topics of plant pathology and plant physiology not covered by formal courses. Relevant literature is reviewed. Material is organized and presented by students. Graded on a pass/fail basis.

PL PA 809: Physiological Techniques in Plant Pathology, 2 cr. (1 and 3) S (even numbered years)
Techniques in separation science; qualitative and quantitative analysis of concern to students in plant pathology and plant physiology. Prerequisite: Organic chemistry or permission of instructor.

PL PA 856: Plant Virology, 3 cr. (2 and 3) F
Plant viruses their morphology, biochemistry, purification and transmission; symptoms resulting from virus infection; vector relationships. Diagnosis of viral diseases and the identification of causal agents. Replication of plant viruses, the interaction between viral host and plant genome.

PL PA 891: Master's Thesis Research, credit to be arranged

PL PA 991: Doctoral Dissertation Research, credit to be arranged
The graduate program in plant physiology is interdisciplinary. Students may select courses and a major area of research from the departments of Crop and Soil Environmental Sciences, Biological Sciences, Forest Resources, Horticulture, and Plant Pathology and Physiology. Dissertation projects are available in the Food Science Department.

The following courses offered by various departments represent possible electives for the student in plant physiology.

**AGRON 690: Beneficial Soil Organisms in Plant Growth,** 3 cr. (3 and 0) F (odd numbered years)
Aspects of biological nitrogen fixation, mycorrhizal fungi, microbial-pesticide interactions, bioremediation, nutrient cycles and biological pest control related to plant growth, soil/environmental quality, and sustainable agriculture. Students who desire laboratory experience in these topics can register for AGRON 406 after consultation with instructor. Prerequisites: AGRON 202, MICRO 305, PL PA 401 or permission of instructor.

**AGRON 801: Crop Physiology and Nutrition,** 3 cr. (3 and 0) F (odd numbered years)
Basic concepts and physiologic aspects of growth and culture applied to crop management practices. Prerequisites: BIOSC 401/601 and 402/602 or equivalent.

**AGRON 802: Crop Ecology and Land Use,** 3 cr. (3 and 0) F (even numbered years)
Concepts and factors affecting adaptation and distribution of crop plants; microclimate and crop response to environmental factors with modifications of microclimate by agricultural operations; interactions among crop plants and between weeds and crop plants under field conditions.

**AGRON 991: Doctoral Dissertation Research,** credit to be arranged

**BIOSC 618 (MICRO 618) (GEN 618): Biotechnology I: Nucleic Acids Techniques,** 4 cr. (2 and 4) N
Basic training in the manipulation of genetic information using recombinant DNA technology; techniques in molecular cloning, Southern and Northern analyses, clone library construction. Prerequisite: BIOCH 210 or 301, MICRO 305 or permission of instructor.

**BOT 821: Inorganic Plant Metabolism,** 3 cr. (3 and 0) F (odd numbered years)
Plant, soil, water and nutrient relations; permeability; uptake and translocation; transpiration; mineral nutrition. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

**BOT 822: Organic Plant Metabolism,** 3 cr. (3 and 0) S (even numbered years)
Respiration and photosynthesis; synthesis, translocation, storage, transformation and degradation of organic materials, fats, carbohydrates, proteins, pigments and nucleic acids. Prerequisites: BIOSC 601 and 602 and BIOCH 623 or permission of instructor.

**BOT 823: Plant Growth and Development,** 3 cr. (3 and 0) F (even numbered years)
Vegetative and reproductive growth and development from seed to maturity, flowering, fruiting and senescence; natural and synthetic growth regulators; morphogenesis. Prerequisites: BIOSC 401/601 and 402/602, organic chemistry or permission of instructor.

**BOT 824: Mode of Action of Growth Substances,** 4 cr. (3 and 3) S (odd numbered years)
Physiology and biochemistry of both natural and synthetic growth regulators, hormones, growth retardants, herbicides and other inhibitors; methodology and mechanism of action. Prerequisite: BIOSC 401/601 and 402/602 and general biochemistry, or BOT 822 or permission of instructor.

**BOT 850: Plant Tissue and Cell Culture,** 3 cr. (2 and 3) F (odd numbered years)
Methods and principles of plant tissue and cell culture; cloning, embryogenesis, protoplast fusion, plant regeneration, potential of plant genetic engineering. Prerequisite: Introductory plant physiology or permission of instructor.

**BOT 861: Plant Cell Biology,** 3 cr. (3 and 0) F (odd numbered years)
Structure, development and activities of plant cells; ultrastructural organization uniquely associated with dynamics of cellular growth and development in plants. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

**BOT 921 (HORT 921): Plant Physiology Colloquium,** 1 cr. (1 and 0)
Topics from current plant physiology literature provide a forum for criticizing research, conceiving new research ideas, developing research outlines and proposals, and integrating knowledge from various subdisciplines of plant physiology. May be repeated for credit. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

**FOR 806: Advanced Silviculture — Forest Tree Growth and Development,** 3 cr. (3 and 0) F (odd numbered years)
Growth and development of economically important forest tree species; structure, function, phenology and wood formation related under forest stand conditions, emphasizing manipulation of forest tree growth by cultural practice; current research in growth and culture of forest trees and stands. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

**HORT 802: Research Systems in Horticulture,** 3 cr. (2 and 3) F (even numbered years)
Current trends, developments and techniques in horticultural research. Prerequisites: CH 223 and 227, or CH 201 and PHYS 207, or BIOCH 210.

**HORT 806: Postharvest Physiology and Handling of Horticultural Crops,** 3 cr. (3 and 0) S (even numbered years)
Principles, developments and research findings dealing with physiological and biochemical changes and processes occurring in horticultural plant organs after harvest, biological aspects of methods and practices relating to harvesting, handling, transportation and storage of horticultural commodities for fresh market. Prerequisites: BIOSC 401/601 and 402/602 or equivalent.

**HORT 813: Photomorphogenesis,** 3 cr. (2 and 2)
Regulatory role of light quality in plant development (photomorphogenesis) and its consequences in and applications for crop production. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor; BOT 823 preferred.
HORT 814: Environmental Plant Stress Physiology, 3 cr. (2 and 2)
Environmental stresses associated with water (drought, waterlogging), temperature, light and air pollution with quantitative treatment of stress effects on plants; mechanisms by which plants may avoid, tolerate or modify stress effects on plant growth and function at the molecular, cellular and whole-plant levels. Prerequisite: BIOSC 401/601 and 402/602 or permission of instructor.

HORT 991: Doctoral Dissertation Research, credit to be arranged

PL PA 804: Physiological Plant Pathology, 3 cr. (3 and 0) F (even numbered years)
Interaction of pathogen and host in development of plant diseases; factors influencing infection; development of pathogen within host. Prerequisite: BIOSC 401/601 and 402/602, PL PA 401 and organic chemistry.

PL PA 809: Physiological Techniques in Plant Pathology, 2 cr. (1 and 3) S (odd numbered years)
Techniques in separation science; qualitative and quantitative analysis of concern to students in plant pathology and plant physiology. Prerequisite: Organic chemistry or permission of instructor.

PL PA 856: Plant Virology, 3 cr. (2 and 3)
Morphology, biochemistry, purification and transmission of plant viruses; symptoms resulting from virus infection; virus vector relationships. Serological and nucleic acid hybridization procedures. Diagnosis of viral diseases and the identification of causal agents. Replication of plant viruses, the interaction between viral host and plant genome.

PL PA 991: Doctoral Dissertation Research, credit to be arranged

PL PH 991: Doctoral Dissertation Research, credit to be arranged

SCHOOL OF NATURAL RESOURCES
B. Allen Dunn, Director

Aquaculture, Fisheries and Wildlife Biology
John R. Sweeney, Chair, Department of Aquaculture, Fisheries and Wildlife

Major Degree
Aquaculture, Fisheries and M.S., Ph.D.
Wildlife Biology

Those who are interested in pursuing a graduate degree in aquaculture, fisheries or wildlife should have sound undergraduate training in the biological sciences or related sciences. Initially, applicants should contact the faculty members whose research interests are closest to their own. Programs of study are designed to emphasize relationships between wild animals and their changing environments and production of aquatic organisms. Admission to either the master's program or the doctoral program will require acceptance by the Graduate School and the Graduate Student Admission Committee of AFW. The Graduate Student Admission Committee of AFW will base its recommendation to the Graduate School on previous course work, GRE scores, letters of recommendation, undergraduate background and current research interests. Students are required to have completed a B.S./B.A. degree, preferably in a natural science, with a minimum of 30 semester hours in natural sciences. In addition, an M.S. in natural resource biology or related area usually is preferred, but not required, for acceptance into the doctoral program. Students approved for acceptance without the appropriate course background will be required to make up these deficiencies as outlined by the Graduate Student Admission Committee and consistent with Graduate School admission policies.

Requirements for the M.S. in aquaculture, fisheries and wildlife include 24 semester hours of course work, six hours of research credits (WFB 891), an acceptable thesis based on original research, and a final oral examination. Additional course work usually includes subjects such as experimental statistics, biological sciences and forestry. Thesis research areas include aquaculture, conservation biology, upland and wetland wildlife biology, endangered species biology, freshwater fisheries science and marine fisheries science.

There are no specific credit hour requirements beyond 30 semester hours of post-baccalaureate course work and 19 hours of doctoral dissertation research for the Ph.D. in fisheries and wildlife science. However, the student's advisory committee will insist on a rigorous and appropriate program of study and research. Students will be required to take, or have taken, at least two semesters of graduate statistics and two semesters of 800 level seminars in fisheries and wildlife science or related areas. Students must also have a minimum of one semester's experience, which will be evaluated by the student's advisory committee. Examples of appropriate professional experience are teaching assistantships, internships or cooperative study program participants, or natural resource agency employees. Other course requirements will be identified by the student's advisory committee and will include specific courses according to the elected emphasis area. The three emphasis areas are: fisheries biology, wildlife biology and conservation biology.

Research opportunities for graduate students are enhanced by cooperative programs with the S.C. Wildlife and Marine Resources Department, U.S. Fish and Wildlife Service's Cooperative Research Unit at Clemson, Savannah River Ecology Laboratory, Webb Wildlife Research Center and Waddell Mariculture Center. The department also is associated with the Institute of Wildlife and Environmental Toxicology and the National Council for Air and Stream Improvement Eastern Wildlife Program. The graduate program in wildlife biology is accredited by the Southeastern Section of The Wildlife Society.

WFB 612: Wildlife Management, 3 cr. (2 and 3) S
Basic principles and general practices of wildlife management and conservation; major problems concerning the management of wildlife resources with emphasis on upland game species. Laboratory includes practical work on the Clemson University woodlands and field trips to areas where wildlife management is being practiced.

WFB 614: Wildlife Nutritional Ecology, 3 cr. (3 and 0) N
Concepts of how terrestrial wildlife obtains and utilizes energy and nutrients in wild ecosystems; energy and nutrient availability in the ecological context of distribution, flow and cycling in natural and modified foraging areas; physiology of digestion for major homeotherms. Prerequisite: FOR 415 or WFB 412.

WFB 616: Fishery Biology, 3 cr. (2 and 3) F
Principles underlying freshwater fish production, major groups of freshwater fishes and their habitats, age, growth, fecundity, food habits, populations estimation, environmental evaluation, management practices and fish culture. Prerequisite: One year of introductory biology and junior standing.

WFB 630: Wildlife Conservation Policy, 3 cr. (3 and 0)
Ecological rationale and management implications of public policy designed for the conservation of American wildlife resources. Emphasis is on managed-land issues. Prerequisite: WFB 350 or permission of the instructor.

WFB 650: Aquaculture, 3 cr. (3 and 0) S
Basic aquacultural techniques applied to freshwater and marine organisms; past and present culture of finfishes and shellfishes around the world; principles underlying fish production; water quality, feeding and nutrition as they influence production of cultured aquatic organisms. Prerequisite: One year of general biology and junior standing.

WFB 651: Fish Hatchery Management, 3 cr. (3 and 0) F
Principles of fish hatchery management including hatchery design, water-quality management, fish-health monitoring, fry and fingerling production, genetics and transport techniques; hatchery management techniques for sport-fish enhancement and endangered species recovery programs. Prerequisite: One year of general chemistry and one year of general biology.

WFB 660: Warmwater Fish Diseases, 2 cr. (2 and 0) SS (even numbered years)
Diseases in warmwater fish including infectious and noninfectious processes. Prerequisite: One year of general biology, junior standing and permission of instructor.
W F B 662: Wetland Wildlife Biology, 3 cr. (3 and 0) F
Wetland wildlife habitats emphasizing classification by physical, chemical and biological characteristics; the importance of wetland habitat for management and production of wetland wildlife species. Prerequisites: BIOL 103 and 104; or 110/111.

W F B 669 (ENT 669): Aquatic Insects, 3 cr. (1 and 6) S
Identification, life history, habitats and interrelationships of aquatic insects; techniques of qualitative field collecting; important literature and research workers. Prerequisite: ENT 301 or permission of instructor.

W F B 712: Wildlife Conservation for Teachers, 2-3 cr. (2-3 and 0)
Principles and practices of wildlife conservation providing an overview of wildlife diversity, ecology and management in the state; population census, wildlife identification, capture and habitat management of game and nongame species. For in-service teachers only. Prerequisite: Permission of instructor.

W F B 716: Biology of Fishes for Teachers, 3 cr. (3 and 0) SS
Biology of fishes for in-service science teachers: overview of fish diversity, ecology, conservation and management. Prerequisite: Permission of instructor.

W F B 809: Seminar in Wildlife and Fisheries Science, 1 cr. (1 and 0) S
Current literature and research in fisheries and wildlife sciences. One or more presentations required. May be repeated for a maximum of four credits.

W F B 810: Publishing in Natural Resource Journals, 2 cr. (2 and 0) S
Principles of preparing research manuscripts for publication in natural resource journals including searching the literature, communicating with editors, responding to reviews, publication ethics and performing peer reviews.

W F B 812: Conservation and Ecology of Endangered Species, 3 cr.
(3 and 0) F (even numbered years)
Processes by which species become endangered or extinct; state, federal and international strategies for species recovery. Students write a species recovery plan. Prerequisite: Graduate standing in a life science major or permission of instructor.

W F B 813: Conservation and Ecology of Wildlife in the Tropics, 3 cr.
(3 and 0) N
Tropical ecosystems emphasizing the ecology and conservation of wildlife species in the neotropics; special problems associated with tropical conservation. Prerequisite: BIOSC 441 or equivalent.

W F B 815: Principles of Wildlife Biology, 3 cr. (2 and 3) F (even numbered years)
Theories and principles applicable to wildlife biology emphasizing upland game species.

W F B 816: Applied Wildlife Biology, 3 cr. (2 and 3) S (even numbered years)
Techniques and practices involved in management of wildlife species emphasizing upland game.

W F B 818: Waterfowl Ecology and Management, 3 cr. (2 and 3) F
Identification, ecology and management of waterfowl. Laboratory work includes demonstration and application of relevant waterfowl management techniques, current literature topics and field trips. Prerequisite: BIOSC 441/641 or W F B 412/612 or permission of instructor.

W F B 820: Seminar in Avian Ecology, 1 cr. (1 and 0) N
Current issues in avian ecology. Students read extensively from recent literature in avian ecology and are responsible for leading and participating in discussions of current research. May be repeated for credit. Prerequisite: Graduate standing in a life science or related course of study.

(2 and 3) S
Techniques for sampling and estimation of parameters of free-ranging fish and wildlife populations such as size, density, survival, natality and movement patterns; underlying assumptions, statistical properties and proper interpretation of contemporary quantitative methodology. Prerequisite: EX ST 801.

W F B 840: Fish Management, 3 cr.
(2 and 3) F (odd numbered years)
Principles and techniques of managing aquatic systems for recreational and/or commercial fishing emphasizing streams, rivers, estuaries and impoundments. Laboratory work includes demonstration and application of management techniques and field trips to observe management practices. Prerequisite: W F B 416/616 or ZOOL 463/663 or permission of instructor.

W F B 860: Diagnostic Procedures of Warmwater Fish Diseases, 2 cr.
(1 and 2) SS (odd numbered years)
Warmwater fish disease diagnostic procedures employing proper protocol and procedures to be followed by a fish disease diagnostician. Corequisite: W F B 460/660 or permission of instructor.

W F B 861: Selected Topics, 1-4 cr.
(1-4 and 0)
Current areas of aquaculture, fisheries and wildlife management and research. May be repeated for credit. Prerequisite: Permission of instructor.

W F B 863: Special Problems in Wildlife and Fisheries Biology, 1-3 cr. (0 and 3-9)
Research not related to a thesis. Credit varies with problems selected. Prerequisite: Permission of instructor.

W F B 891: Master's Thesis Research, credit to be arranged

W F B 991: Doctoral Dissertation Research, credit to be arranged

Environmental Toxicology

Environmental Toxicology

John Rodgers, Chair, Department of Environmental Toxicology

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Environmental toxicology is the study of toxic substances in the environment and the effects of these substances and various contaminants and stressors on living systems and the physical environment. Major emphasis is placed on the metabolism of contaminants, their breakdown, fate and movement in the environment, and ecological risk assessment. The interdisciplinary program provides a strong background in basic toxicology. The program is administered jointly with the College of Engineering and Science.

Students with a baccalaureate degree in the basic and life sciences, agriculture or engineering may be admitted. Strong faculty expertise and areas of student specialization are available in wildlife toxicology, analytical toxicology and environmental chemistry, biochemical and behavioral toxicology, aquatic toxicology, ecological modeling, ecological risk assessment and biological control. Each student's research program is designed to meet his or her professional goals.

Candidates for the M.S. degree must complete 30 hours of graduate credit, including six hours of research, and write a thesis. Candidates for the Ph.D. degree must complete 18 hours of dissertation research and write a dissertation.

Graduate research programs are conducted in conjunction with the Clemson Institute of Environmental Toxicology, providing a unique and innovative environment for graduate education. Collaborative research opportunities exist nationally and internationally with other universities, state and federal agencies, and industrial groups.

ENTOX 600: Environment and Wildlife Toxicology, 3 cr. (3 and 0)
Assessment of impacts of toxic substances on reproduction, health and well-being of wildlife species; acute and chronic effects of agricultural chemicals, pesticides, hazardous waste, industrial waste and oil releases. Prerequisites: BIOCH 210 or organic chemistry, one year of general biology, W F B 350 or permission of instructor.
ENTOX 621: Chemical Sources and Fate in Environmental Systems, 3 cr. (3 and 0)
Chemical cycles in the environment on global and microcosm scales; dependence of fate processes on physical and chemical properties and environmental conditions; breakdown, movement, and transport of selected toxics illustrate the mechanisms that govern chemical fate. Prerequisite: Organic and analytical chemistry or permission of instructor.

ENTOX 630 (ENT 630): Toxicology, 3 cr. (3 and 0)
Basic principles of toxicology including quantitation of toxicity, toxicoekinesics, biochemical action of poisons and environmental toxicology; acute and chronic effects of various classes of poisons (e.g. pesticides, drugs, metals, and industrial pollutants) in relation to typical routes of exposure and regulatory testing methods. Prerequisite: Organic chemistry, one year of general biology or permission of instructor.

ENTOX 801: Advanced Wildlife Toxicology, 3 cr. (3 and 0)
Interactions between chemical contaminants and wildlife species focusing on mechanisms of differential toxicities between chemicals and among species. Pesticide and chemical contaminant impacts are developed with emphasis on chemical, biochemical and physiological underpinnings and assessed in terms of organismal, species, and trophic responses. Prerequisites: ENTOX 430/630 and 421/621; or permission of instructor.

ENTOX 806: Advanced Environmental Toxicology, 3 cr. (3 and 0)
Impacts of chemical contaminants upon ecosystems; description and prediction of ecological changes resulting from a variety of human activities which involve release of xenobiotic and other chemicals into the environment. Prerequisites: Organic chemistry, ENTOX 430/630 and analytical chemistry; or permission of instructor.

ENTOX 822: Analytical Toxicology Laboratory, 3 cr. (1 and 5)
Laboratory instrumentation, procedures and experimental methods used for identification and quantitation of toxic substances and their transformation products in environmental and biological samples; application of these procedures in the isolation, detection and quantitation of toxics in authentic samples. Prerequisites: Organic and analytical chemistry or permission of instructor; instrumental analysis recommended.

ENTOX 830: Mechanistic Toxicology, 3 cr. (3 and 0)
Detailed biochemical toxicology: control, regulation and activity of metabolic enzymes; molecular and cellular mechanisms of toxic action; proposed mechanisms for initiation and development of cancer; mode of action and kinetics of cholinesterase inhibitors; structure/activity relationships of ion channel blockers; bio-

chemical and molecular biomarkers. Prerequisite: ENTOX 430/630.

ENTOX 831: Biomarkers in Toxicology, 3 cr. (1 and 6)
Methodology used in biomarker identification and evaluation of the effects of toxic substances on living systems using biomarkers in sentinel organisms and surrogate biomarkers. Prerequisites: Organic chemistry and biochemistry with laboratory; ENTOX 430/630 or 400/600; or permission of instructor.

ENTOX 841: Procedures and Techniques in Ecological Risk Assessment, 2 cr. (1 and 3)
Evaluation and application of the procedures and techniques used in ecological risk assessments, including laboratory and field methods, to determine, measure and evaluate the risks to aquatic, terrestrial and avian species; impacts to biota within, and resulting from, chemical waste disposal facilities and hazardous waste sites. Prerequisites: CH 223, 224 and 313, EX ST 804 or 805, and ENTOX 630; or permission of instructor.

ENTOX 852: Ecological Models, 3 cr. (2 and 3) N
Systems analysis applied to ecology; construction of models which predict ecological consequences of stresses to the environment; frequency response analysis, energy models, information flow and transfer functions for population interactions. Prerequisite: A course in ecology and in computer programming or permission of instructor.

ENTOX 854: Aquatic Toxicology, 3 cr. (3 and 0)
Concepts and practices in aquatic toxicology including physiological responses to toxic substances, bioconcentration, biomagnification, toxicity testing (algal, invertebrate and fish) and criterion development; basic concepts of toxicology as applied to aquatic environments. Prerequisites: One year of general biology, one year of general chemistry and introductory biochemistry.

ENTOX 860: Graduate Seminar, 1 cr. (1 and 0)
Recent research in environmental toxicology; presentation, review and discussion of current issues by graduate students in an area of specialization selected by the instructor. May be repeated four times for credit. Graded on a pass/fail basis.

ENTOX 861: Departmental Seminar, 1 cr. (1 and 0)
Presentation of current research by Department of Environmental Toxicology faculty, staff, finishing graduate students and invited speakers; students improve skills in evaluation of research plans and oral presentations, and increase awareness of literature resources and employment opportunities within the field. May be repeated four times for credit.

ENTOX 863: Selected Topics, 1-4 cr. (0-4 and 0-6)
A topic in environmental toxicology not covered in another course. Topics vary with current developments in the discipline. Course may be repeated if topic and content are different. Prerequisite: Permission of instructor.

ENTOX 891: Master's Thesis Research, credit to be arranged

ENTOX 991: Doctoral Dissertation Research, credit to be arranged
FOR 607: Forest Operations, 3 cr. (2 and 3) F
Theory and practice of conducting forest operations emphasizing methods, analysis of associated cost and productive rates for timber harvesting and other mechanized field operations. Prerequisite: Senior standing or permission of instructor.

FOR 608: Aerial Photographs in Forestry, 3 cr. (2 and 3) S
Photographic measurements, aerial photointerpretations, mapping and timber estimating. Prerequisite: Forestry summer camp or consent of instructor.

FOR 609: Multiple-Use Forestry, 2 cr. (2 and 0) S
The demand placed on forests for a variety of products and uses; how these can and must be reconciled in planning the management of each forest. Prerequisite: Forestry summer camp or consent of instructor.

FOR 610: Harvesting Forest Products, 3 cr. (2 and 3) S
Application of engineering and cost-analysis techniques to the evaluation of the forest transport system and various harvesting situations. Prerequisite: FOR 407 or permission of instructor.

FOR 611: Forest Protection, 2 cr. (2 and 0) S
Prevention and suppression of forest fires; their effect upon the environment and people; factors affecting fire behavior; use of fire in resource management. Prerequisite: Senior standing or permission of instructor.

FOR 613: Integrated Forest Pest Management, 3 cr. (3 and 0) F
Nature and control of pests of forest trees and products focusing on the relation of pests to silviculture, management and natural forest ecosystems. Prerequisite: Junior standing in forest resource management.

FOR 614: Forest Management Plans, 2 cr. (2 and 0) S
Analysis of factors entering into forest working plans of several forestry organizations; preparation of a preliminary management plan of a sample area. Prerequisite: FOR 417.

FOR 615: Forest Wildlife Management, 3 cr. (2 and 3) S
Principles, practices and problems of wildlife management with emphasis on upland forest game species; habitat manipulation through use of appropriate silvicultural practices in association with other techniques. Prerequisite: FOR 310 or permission of instructor.

FOR 616: Forest Policy and Administration, 2 cr. (2 and 0) F
Development, principles and legal provisions of forest policy in the United States; administrative and executive management in forestry.

FOR 617: Forest Resource Management and Regulation, 3 cr. (3 and 0) F
Fundamental principles and analytical techniques in planning, management and optimization of forest operations. Prerequisite: FOR 302, 304, 306, 310 and forestry summer camp.

FOR 618: Forest Resource Valuation, 2 cr. (2 and 0) F
Capital investment tools and their application to decision making among forestry investment alternatives; valuation of land, timber and other resources associated with forestry, including the impact of inflation and taxes. Prerequisite: FOR 304 or permission of instructor.

FOR 620: Forest Products, 3 cr. (2 and 3) S
Primary forest products including lumber, poles and piles, veneers and plywood, secondary wood products; chemically derived products from wood including pulp and paper, distillation products, wood hydrolysis; miscellaneous and minor forest products. Prerequisite: FOR 306, forestry summer camp or permission of instructor.

FOR 621: Biology and Silviculture of Hardwood Forests, 2 cr. (1 and 2) F
Silvics, growth and development of major hardwood species of North America that will relate these biological characteristics to the ecology, silviculture and utilization of the hardwood forests of the United States. Prerequisite: FOR 205, 206, 306, 310 or permission of instructor.

FOR 622: Forest Products International Trade, 3 cr. (3 and 0) F
Major supply regions, major trade flows, international demand, trade patterns, and industry structure and practices involved in international trade of forest products. Prerequisite: FOR 306, forestry summer camp or permission of instructor.

FOR 623: Current Issues in Natural Resources, 2 cr. (2 and 0) F, S
Lectures in various fields of forestry delivered by selected representatives from forest industries, consultants, agencies, associations, and other forest operations. Course will not be taught when enrollment is less than 15. To be taken pass/fail only. Prerequisite: Junior standing or permission of instructor.

FOR 629: Wood Design, 3 cr. (2 and 3) F
Technical mechanical properties of wood; load analysis and design criteria; design of structural elements in wood. Prerequisite: FOR 328 or permission of instructor.

FOR 631: Recreation Resource Planning in Forest Management, 2 cr. (1 and 3) S
Forest recreation as a component of multiple-use forest management; techniques of planning; physical and biological effects on forests; forest site, user and facility management.

FOR 632: Forest Site Capability, 2 cr. (2 and 0) S
Analysis of use pressures on the forest land base and their effects on the capability of the forest to satisfy resource demands; productivity and sensitivity of sites. Prerequisite: Senior standing in forestry or permission of instructor.

FOR 641: Properties of Wood Products, 3 cr. (3 and 0) S
Basic properties of wood including the hygroscopic, thermal, electrical, mechanical and chemical properties; standard testing procedures for wood. Prerequisite: Junior standing or permission of instructor.

FOR 642: Manufacture of Wood Products I, 3 cr. (3 and 0) S
Manufacture of lumber, plywood, millwork, poles, piles and railroad ties; drying and preservation of wood products; product classifications, grades and uses. Prerequisite: FOR 221 or permission of instructor.

FOR 643: Manufacture of Wood Products II, 3 cr. (3 and 0) S
Manufacture of particleboard, flake-board, oriented-strand board, fiberboard and paper products; their physical, mechanical and chemical properties; their applications. Prerequisite: FOR 221 or permission of instructor.

FOR 644: Forest Products Marketing and International Trade, 3 cr. (3 and 0) S
Marketing and international trade practices currently employed by the forest products industry and the application of basic marketing principles and global trade concepts in the industry's current and future environment. Prerequisite: FOR 442 or 443 or permission of instructor.

FOR 645: Forest Products and the Environment, 3 cr. (3 and 0) S
Use of wood as a basic material and its impact on the environment; environmental issues affecting wood processing, pulp and paper, and preservation industries; reuse and recycle of wood and paper wastes and the development of composites from these wastes. Prerequisite: FOR 442 or permission of instructor.

FOR 646: Wood Products Applications and Specifications, 3 cr. (3 and 0) S
Application of lumber, plywood, particleboard, waferboard, oriented-strand board and treated-wood products in building construction; proper application of load tables, allowable span and spacing. Prerequisite: FOR 442 or 443 or permission of instructor.
FOR 651 (E S E 651) (AG E 651): Newman Seminar and Lecture Series in Natural Resources Engineering, 1 cr. (0 and 2) S, F
Topics dealing with the development and protection of land, air, water and related resources will be covered by seminar with instructor and by invited lecturers. Current environmental and/or resource conservation issues will be addressed. Prerequisites: Senior or graduate standing, consent of instructor.

FOR 660: Silviculture I, 3 cr. (3 and 2)
Theory and practice of establishing, maintaining and harvesting forest stands in accordance with ecological and economic principles. Prerequisites: FOR 206 and forestry summer camp or consent of instructor.

FOR 662: Silviculture II, 3 cr. (2 and 3)
Forest management practices that affect ability of the land to produce multiple forest resources with emphasis on water, nutrients, and fire. Prerequisite: FOR 401 or permission of instructor.

FOR 707: Special Problems in Forestry, 1-3 cr. (1-3 and 0)
Directed individual study of a special problem in an applied field of forestry. Written report of study results required.

FOR 802: Advanced Mensuration, 3 cr. (2 and 3) S (even numbered years)
Continuation of FOR 602 emphasizing specialized sampling techniques and statistical methods often required only in forestry; compilation of timber volume tables, forest survey problems. Prerequisites: EX ST 301 and FOR 302/602 or permission of instructor.

FOR 804: Advanced Forest Economics, 3 cr. (2 and 3) F (even numbered years)
Examination, discussion and application of economic concepts to forestry problems in use of land, labor and capital; use of theory in problems of resource allocation and efficiency in forest management. Prerequisites: FOR 304/604 and 418/618 or permission of instructor.

FOR 805: Forest Landscape Ecosystems, 4 cr. (3 and 3) F (even numbered years)
Three basic landscape components of soils, landform and vegetation and their interrelationships in forest ecosystems emphasizing factors and processes of soils as interacting components with landform and vegetation. Prerequisite: Graduate standing or permission of instructor.

FOR 806: Advanced Silviculture—Forest Tree Growth and Development, 3 cr. (3 and 0) F (odd numbered years)
Growth and development of economically important forest tree species; structure, function, phenology and wood formation related under forest stand conditions emphasizing manipulation of forest tree growth by cultural practice; current research in growth and culture of forest trees and stands. Prerequisites: BIOSC 401/601 and 402/602 or permission of instructor.

FOR 807: Special Problems in Forestry, credit to be arranged
Special problems in forestry research methods that do not directly pertain to the candidate’s thesis.

FOR 808: Seminar, 1 cr. (1 and 0) F, S
Research and current developments in forestry; students and staff participate. May be taken up to two semesters for credit. Graded on a pass/fail basis.

FOR 809: Products Biodeterioration, 2 cr. (1 and 3) F (even numbered years)
Role of microorganisms in reducing the strength, aesthetics and value of products in service emphasizing the deterioration of wood.

FOR 810: Forest Landscape Ecosystems of the Great Smokey Mountains, 2 cr. (1 and 3) S
Observation and measurements of species composition, community structure, soil-site relationships, land use practices within the forest ecosystems of Great Smokey Mountains National Park; field data interpreted and illustrated using ordination and classification techniques common in ecological studies. Prerequisite: Permission of instructor.

FOR 811: Forest Wetland Ecology and Management, 2 cr. (2 and 0) S
Assessment of ecological processes and how they influence forest wetland productivity, management and regulation. Prerequisite: Introductory ecology or permission of instructor.

FOR 812: Fire Ecology and Management, 3 cr. (2 and 3)
Historical presence of fire in various regions of North America and its effects on forests; analysis of current fire management strategies with emphasis on usage of prescribed fire as an ecosystem management tool. Prerequisites: Graduate standing or permission of instructor.

FOR 814: Advanced Forest Resource Management and Planning, 3 cr. (3 and 0) S (odd numbered years)
Current forest resource management and planning topics; operational emphasis on application of various quantitative tools to solve economic and management problems; advanced topics in forest regulation, forest valuation, mathematical programming and harvest scheduling, simulation, multiple-use alternatives and selected areas. Prerequisite: FOR 417/617 or permission of instructor.

FOR 815: Systems Processes in Natural Resources, 3 cr. (2 and 3)
Use of system thinking and system analysis to define the issues, model, simulate and evaluate alternatives for forest landscape problems and opportunities. Prerequisite: Graduate standing.

FOR 816 (PRTM 816): Remote Sensing and GIS in Natural Resources, 3 cr. (2 and 3) S (odd numbered years)
Practical application of computer mapping, spatial analysis and natural resource inventory using remote sensing and geographical information systems. Prerequisite: Permission of instructor.

FOR 825: Wood Chemistry, 3 cr. (2 and 3) F (even numbered years)
Chemical composition of wood and related lignocellulosic substances and the chemistry of individual wood components; chemical reactions and applications of cellulose, hemicelluloses, lignin and extractives.

FOR 826: Applied Wood Mechanics, 3 cr. (3 and 0)
Stress and strain of wood and wood products, orthotropic elasticity, stiffness and compliance matrices, application of elastic theory to structural systems, creep and relaxation of wood, theories and prediction of failure, analyses of layered wood composites, determination of mechanical properties and allowable stresses.

FOR 827: Wood Physics, 3 cr. (3 and 0)
Thermodynamics and theories of moisture sorption in wood products; transport of moisture and heat. Prerequisite: Permission of instructor.

FOR 891: Master’s Thesis Research, credit to be arranged

FOR 991: Doctoral Dissertation Research, credit to be arranged

SCHOOL OF APPLIED SCIENCE AND AGRIBUSINESS

Susan F. Barefoot, Director

Agricultural and Applied Economics

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Graduate work in agricultural and applied economics enables the student to attain a higher degree of specialized professional competence and to secure a greater mastery of techniques for applying quantitative economic analysis to agricultural and natural resource problems. Industry, government and universities offer challenging opportunities in research, development, education, management and other related areas for persons with advanced training.

Special emphasis in the graduate program is placed on the economics of agricultural production and marketing, economic development, analysis of government programs and policies, and statistical techniques used in solving economic and institutional problems. Flexibility is achieved through choice of
elective courses and selection of an M.S. thesis or Ph.D. dissertation topic. A non-thESIS option is available as well. There is no language requirement for the M.S. or Ph.D. degree.

The Department of Agricultural and Applied Economics offers courses in support of the Master of Agriculture degree, a nonthesis program.

In addition to applicants with baccalaureate degrees in agricultural economics and related programs, the department encourages applications from students who have a sound background in general economics. In many cases, such students may be admitted to full graduate status without prerequisites other than those required of all graduate students.

AP EC 602: Production Economics, 3 cr. (3 and 0) F
Economic analysis of agricultural production involving the concept of the farm as a firm, principles for decision making, the quantitative nature and use of production and cost functions and their interrelations, and application of these principles to resource allocation in farms and among areas. Prerequisite: AP EC 308 and ECON 314.

AP EC 603: Land Economics, 3 cr. (3 and 0) S
Characteristics of land; physical, legal, social and economic principles and problems relating to the control and use of land resources. Prerequisite: AP EC 202 or ECON 200.

AP EC 609: Commodity Futures Markets, 3 cr. (3 and 0) F, S
Economic theory, organization and operating principles of agricultural commodity futures markets in the United States; speculating, hedging and investing in agricultural commodity futures contracts from the standpoint of the agriculture entrepreneur. Prerequisite: AP EC 202 or ECON 211.

AP EC 611 (C R D 611): Regional Impact Analysis, 2 cr. (2 and 0) F
Techniques for analysis of the growth and decline of regions including economic-base theory, shift share, regional input-output, regional econometric models and fixed impact models. Prerequisite: AP EC 202 or ECON 211 and 212.

AP EC 612 (C R D 612): Spatial Competition and Rural Development, 3 cr. (3 and 0) S
Development of rural economic activity in the context of historical, theoretical and policy aspects of friction associated with spatial separation; location factors, transfer costs, location patterns and regional-growth policy. Prerequisite: AP EC 202 or ECON 211 or equivalent.

AP EC 613: Advanced Real Estate Appraisal, 3 cr. (3 and 0) S
Highest and best use analysis, data collection and analyses; advanced appraisal procedures for income, cost and comparable sales approach to real estate valuation; eminent domain, the appraisal of property in transition and specialized property. Prerequisite: AP EC 313, FIN 307, or permission of instructor.

AP EC 620: World Agricultural Trade, 3 cr. (3 and 0) S
Practical considerations of agricultural trade and trade policy analysis; role of international institutions; concepts of agricultural trade, analysis of trade policies of major trading partners/competitors and export/import marketing of products. Prerequisite: AP EC 309, ECON 412 or permission of instructor.

AP EC 625: Aquaculture Economics, 3 cr. (3 and 0) F (alternate years)
Application of economics and business principles by firms engaged in fish farming. Basic microeconomic theory applied to aquacultural enterprises; financial management, investment analysis and marketing management; public policy affecting aquaculture; international aquaculture development. Prerequisites: AP EC 202 and 309 and W F B 350 or permission of instructor.

AP EC 626 (AGRON 626): Cropping Systems Analysis, 3 cr. (2 and 2) F
Application of agronomic and economic principles in solving problems relating to the production and marketing of agronomic crops. A major part of the course will be a case study in which a detailed analysis of a farm, agribusiness or environmental situation with students making formal written and oral presentations of results. Prerequisite: AP EC 202, AGRIC 104, junior or senior standing.

AP EC 633: Agricultural Law and Related Environmental Issues, 3 cr. (3 and 0) S
Agricultural and agricultural-related environmental legal issues; review of laws, agencies, programs, court structure, torts, taxation, biotechnology, land and water use, regulated industry and environment liabilities as they relate to agriculture and natural resources. Prerequisite: LAW 322 or permission of instructor.

AP EC 652: Agricultural Policy, 3 cr. (3 and 0) S
Public agricultural policy programs in the United States; critical examination of current and proposed government policies and programs affecting the agricultural sector of the economy; economic considerations as related to past and current farm price and income problems. Prerequisites: AP EC 302 and 309.

AP EC 656: Prices, 3 cr. (3 and 0) S
Basic theory of price under competitive conditions and various modifications; nature, measurement and causes of daily, seasonal and cyclical price fluctuations; geographical price relationships; nature, function and behavior of futures markets; government price programs. Prerequisites: AP EC 308, ECON 314, EX ST 462.

AP EC 660: Agricultural Finance, 3 cr. (3 and 0) S
Principles and technique of financing in the agricultural sector; capital situation in agriculture, concepts of farm financial management, use of credit, capital markets, lending agencies and estate planning. Prerequisites: ACCT 200 or 201, AP EC 202.

AP EC 675: Economics of Wildlife Management and Policy, 3 cr. (3 and 0)
Integrated approach to the study of the economics of wildlife; determination of market and nonmarket value, single and multiple species management, enterprise cost and returns, marketing wildlife, leasing methods, complementary and competitive with agricultural and forestry enterprises, and timber and crop damage cost estimates and control. Prerequisite: AP EC 202, ECON 200, FOR 304, W F B 306, or permission of instructor.

AP EC 719: Professional Problems in Agribusiness Management, 3 cr. (3 and 0) F
Concepts and principles of agribusiness firm management; decision theory, information systems, systems analysis and organization theory applied to the organization, administration and management of agriculturally related businesses.

AP EC 800 (ECON 800): History of Economic Thought, 3 cr. (3 and 0)
Development of economic thought from early Greek to Keynesian economics; writings of major economists such as Smith, Ricardo, Marx, Marshall and Keynes; development of major economic theories.

AP EC 801 (ECON 801): Microeconomic Theory, 3 cr. (3 and 0) F
Microeconomic theory and its use to analyze and predict the behavior of industries, firms and consumers under various market conditions.

AP EC 802 (ECON 802): Advanced Economic Concepts and Applications, 3 cr. (3 and 0) F
Rigorous development of price theory under alternative product and resource market structures. Prerequisite: Permission of instructor.

AP EC 804 (ECON 804): Applied Mathematical Economics, 3 cr. (3 and 0)
Mathematical tools needed in economic analysis; matrix algebra, differentiation, unconstrained and constrained optimization, integration and linear programming.

AP EC 806 (ECON 806): Econometrics I, 3 cr. (3 and 0)
Application of econometric techniques and stochastic models to economic problems; distribution theory, simple and multiple regression modeling, hypothesis testing and other issues in regression analysis.
AP EC 807 (ECON 807): Econometrics II, 3 cr. (3 and 0) F
Econometric models expressed as systems of equations, problems of identification, parameter estimation, measurement errors and statistical inference; techniques of simulation, forecasting, model validation and interpretation.

AP EC 808 (ECON 808): Econometrics III, 3 cr. (3 and 0) S
Continuation of ECON 807; current economic models and estimation procedures. Prerequisite: ECON 807.

AP EC 809 (ECON 809): Advanced Natural Resource Economics, 3 cr. (3 and 0) S
Applications of economic theory to problems of natural resource management; epistemological considerations; rent theory; public and private investment criteria; benefit-cost analysis and general equilibrium management models. Prerequisite: AP EC 802 or permission of instructor.

AP EC 810 (ECON 810): Natural Resources Management and Policy, 3 cr. (3 and 0) F
Economic, institutional and legal aspects of control and management of natural resources; concepts of economic science applied to public policy questions related to land and water resources. Specialized background in economics not necessary. Prerequisite: Permission of instructor.

AP EC 811 (ECON 811): Economics of Environmental Quality, 3 cr. (3 and 0) F (even numbered years)
 Pricing and distribution emphasizing effects upon economic welfare; goods allocated by government purchase for joint consumption and those distributed by rationing; alternate plans for allocating public goods. Prerequisite: ECON 314 or equivalent.

AP EC 816 (ECON 816): Labor Economics, 3 cr. (3 and 0)
Wage and employment theory; labor markets; labor history; current problems in labor and manpower economics.

AP EC 817 (ECON 817): Advanced Production Economics, 3 cr. (3 and 0) S
Production economics theory in a quantitative framework; technical and economic factor-product, factor-factor and product-product relationships in single- and multiproduct firms under conditions of perfect and imperfect competition in both factor and product markets. Prerequisite: AP EC 804 or permission of instructor.

AP EC 820 (ECON 820): Public Finance, 3 cr. (3 and 0)
Impact of government on resource allocation, income distribution and stability; role of regulation; principles of taxation.

AP EC 821 (ECON 821): Public Choice, 3 cr. (3 and 0)
Economic theory to analyze collective decisions; the pure theory of collective choice; applied analyses of democratic governments and their policy processes.

AP EC 822 (ECON 822): Contemporary Public Policy, 3 cr. (3 and 0) S
Contemporary public policy, including price and resource policy, affecting rural areas; public participation, or the lack thereof, related to programs designed to implement public policy.

AP EC 824 (ECON 824): Organization of Industry, 3 cr. (3 and 0)
Structure of markets and firms; forces that determine the size of firms and the boundaries of markets; behavior of firms, both singly and in concert, to exploit market positions.

AP EC 825 (ECON 825): Economic Theory of Government Regulation, 3 cr. (3 and 0)
Scope of governmental regulation in the economy of the United States, its evolution and development; application of the tools of economic analysis to the issues of regulated enterprise. Prerequisite: ECON 314 or equivalent.

AP EC 827 (ECON 827): Economics of Property Rights, 3 cr. (3 and 0)
Evolution and impact of various property rights institutions on individual behavior and the subsequent use of resources; importance of property rights structures in the organization of business and in managerial decision making. Prerequisite: ECON 801.

AP EC 828 (ECON 828): Market Structure in Agricultural Industries, 3 cr. (3 and 0)
Market structure and other approaches related to agricultural marketing. Individual assignments in the student's field of interest required. Prerequisite: Permission of instructor.

AP EC 831 (ECON 831): Economic Development, 3 cr. (3 and 0)
Economic analysis of development of urban areas within the system of cities; central place theory and general equilibrium models of interregional economic activity emphasizing central place systems, spatial interaction and stochastic processes; internal development of the city focusing on housing and land use patterns, transportation and urban form.

AP EC 832 (ECON 832): Community and Regional Economics, 3 cr. (3 and 0) F
Economic theory and research methods needed to understand happenings in the regional and community economy and how local and non-local decisions influence local economic change. Prerequisite: CP 612 or permission of instructor.

AP EC 840 (ECON 840): International Trade Theory, 3 cr. (3 and 0)
Theory of free trade from Ricardo to present; theory and application of optimal and second-best tariffs; recent empirical testing of trade and tariff theory. Prerequisites: ECON 314 and 802 or permission of instructor.

AP EC 841 (ECON 841): International Finance, 3 cr. (3 and 0)
Financial economics of decision-making in a multinational environment featuring autonomous governments and multiple currencies; examination of the macroeconomic problems of unemployment and inflation in an international economy, management of exchange rate risk, credit risk, political risk and taxation. Prerequisite: ECON 315 or equivalent.

AP EC 852: Research Methods for Agricultural Economists I, 2 cr. (2 and 0) S
Linear models and their application to problems related to the economics of agriculture; simplex method, developing farm planning LP models, solving LP problems using the MPSX computer program, parametric analysis techniques and other LP applications related to rural problems.

AP EC 855 (ECON 855): Financial Economics, 3 cr. (3 and 0)
Modern theory of corporate finance; basic theories of efficient markets, portfolio selection, capital asset pricing, option pricing and agency costs. Prerequisite: ECON 801 or permission of instructor.

AP EC 881: Internship in Community and Resource Development, 1-6 cr.
Supervised employment in an agency dealing with socioeconomic aspects, community development and/or natural resource management; monthly reports covering student's experience required. Prerequisite: 18 semester hours of graduate credit.

AP EC 888 (ECON 888): Directed Readings in Economics, 1-3 cr. (1-3 and 0)
Directed reading and research in the student's field of interest. May be repeated for up to three credit hours.

AP EC 891: Master's Thesis Research, credit to be arranged

AP EC 899 (ECON 899): Selected Topics, 1-3 cr. (1-3 and 0) F, S
Students study selected topics under guidance of a professor. Course may be repeated for a maximum of six credits.

AP EC 901 (ECON 901): Price Theory, 3 cr. (3 and 0)
Neoclassical paradigm of market price and quantity; rigorous consideration of consumer behavior, the theory of the firm and market equilibrium, production and resource demands, and the supply
of resources. **Prerequisite:** ECON 801 or equivalent.

**AP EC 903 (ECON 903): General Equilibrium and Welfare Theory, 3 cr. (3 and 0) S**
The second of a two-course sequence of advanced price theory. The first part of this course is the development of the theory of general equilibrium and the economics of welfare; the second is the capital theory and the determination of the rate of interest. **Prerequisite:** AP EC 901.

**AP EC 904 (ECON 904): Seminar in Resource Economics, 3 cr. (3 and 0) F**
Special problems and recent periodical literature relating to the control, management, development and use of land and water resources in the United States and in other parts of the world. **Prerequisite:** AP EC 403/603.

**AP EC 905 (ECON 905): Advanced Macroeconomic Issues, 3 cr. (3 and 0) S**
Current unsettled issues in macroeconomic analysis; disequilibrium macro models, macro models of open economies, rational expectations and its criticism, government stabilization policies and the controversy surrounding the concept of Ricardian equivalence. **Prerequisite:** ECON 805 or equivalent.

**AP EC 906 (ECON 906): Seminar in Area Economic Development, 3 cr. (3 and 0) S**
Recent research developments in economic development; review of research publications, journal articles and other literature; objectives, analytical techniques and procedures used in area or regional development efforts. **Prerequisite:** AP EC 806.

**AP EC 917 (ECON 917): Advanced Seminar in Labor Economics, 3 cr. (3 and 0) S**
Follow-up to ECON 816, bridging the gap between theory and modern empirical research in labor economics; emphasis on reading recent empirical research papers to understand the techniques of modern research in labor economics. **Prerequisite:** ECON 816.

**AP EC 950 (ECON 950): Monetary Economics, 3 cr. (3 and 0)**
Economic analysis of money in our economy and effects of monetary policy on prices, interest rates, output and employment.

**AP EC 991 (ECON 991): Doctoral Dissertation Research, credit to be arranged**

**C R D 611 (AP EC 611): Regional Impact Analysis, 2 cr. (2 and 0) F**
Techniques for analysis of the growth and decline of regions including economic-base theory, shift share, regional input-output, regional econometric models and fixed impact models. **Prerequisite:** AP EC 202 or ECON 211 and 212.

**C R D 612 (AP EC 612): Spatial Competition and Rural Development, 3 cr. (3 and 0) S**
Development of rural economic activity in the context of historical, theoretical and policy aspects of friction associated with spatial separation; location factors, transfer costs, location patterns and regional-growth policy. **Prerequisite:** AP EC 202 or ECON 211 or equivalent.

**R S 601 (SOC 601): Human Ecology, 3 cr. (3 and 0) S**
Analysis of the interrelationships among the physical world, modifications in natural environments, human settlement patterns and institutions that both encourage and regulate environmental modification. Emphasis is placed on conditions whereby natural resources become public policy concerns. **Prerequisite:** Sophomore standing.

**R S 659 (SOC 659): The Community, 3 cr. (3 and 0) F**
Analysis of the development of contemporary communities and their place in society; continuing effects of industrialization, migration and technological change on community location and structure; structural relations of social class, status and the associations among institutions.

**R S 671 (SOC 671): Demography, 3 cr. (3 and 0) F**
Demographic concepts, theory and research methods for vital statistics, migration and population distribution and projections; collection and processing of demographic data; organization of demographic data systems. **Prerequisite:** ANTH 201 or SOC 201 or R S 301.

**R S 881: Special Problems in Rural Social Research, 1-3 cr. (0 and 2-6) S**
Recent research problems and literature emphasizing research design, analysis, theoretical generalizations and application programs. May be repeated for a maximum of six credits. **Prerequisite:** Six semester hours of 600-level sociology or rural sociology courses or permission of instructor.

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**Agricultural Mechanization**

John C. Hayes, Chair, Department of Agricultural and Biological Engineering

Advanced degrees are not awarded in agricultural mechanization. Courses are offered as a minor for students majoring in other areas. The faculty participate in the agricultural mechanization and business option of the interdisciplinary Master of Agriculture degree.

**AG M 601: Environmental Control for Plants and Animals, 1 cr. (1 and 0)**
Basic concepts of environmental control for plant and animal production and human housing are presented. Elements include heat transfer, psychrometry, heating, cooling, ventilation, and heat/moisture balances. **Prerequisite:** PHYS 200 or permission of instructor.

**AG M 602: Drainage, Irrigation and Waste Management, 3 cr. (2 and 3)**
Continuation of AG M 302. Basic soil-water-plant relationships are used to determine the need for and methods of irrigation, drainage, and waste management; irrigation methods, drainage needs, drainage methods and waste-treatment methods. **Prerequisite:** AG M 302.

**AG M 603: Structures for Plants and Animals, 2 cr. (1 and 3)**
Structures for agricultural production systems are planned and designed with regard to function, materials, loads and component sizing, utilizing the approach of an engineering or construction technologist. **Prerequisite:** PHYS 200 or permission of instructor.

**AG M 606: Mechanical and Hydraulic Systems, 3 cr. (2 and 3)**
Power transmission systems for agricultural production with emphasis on mobile equipment; characteristics, requirements and design of both V-belt drive and roller-chain drives; hydraulic power transmission systems including pumps, actuators, control devices and hydraulic circuitry. **Prerequisite:** AG M 206, PHYS 207 or permission of instructor.

**AG M 652: Farm Power, 3 cr. (2 and 3)**
Study of tractors with emphasis on internal combustion engines and support systems necessary for their proper functioning; application of power, maintenance and general repair. **Prerequisite:** PHYS 207 or permission of instructor.

**AG M 660: Farm and Home Utilities, 3 cr. (2 and 3)**
Electric and other utilities on the farm and in the home; selection, installation and maintenance of wiring systems, lighting systems, motors, controls, water systems and waste disposal systems. **Prerequisites:** PHYS 208 or permission of instructor, junior standing.

**AG M 712: Farm Machinery Management, 3 cr. (2 and 3)**
Selection, functional analysis and maximum utilization of existing and developing farm machinery; computer applications to programming of field operations; available capital and labor; machine size; critical field operations; growing degree days; weather; maintenance equipment, procedures and scheduling.

**AG M 771: Selected Topics in Agricultural Mechanization, 1-3 cr. (1-3 and 0)**
Selected topics not covered in other course offerings; performance measured by oral or written reports or examinations. May be repeated for a maximum of six credits.
AG M 781: Special Problems, 1-3 cr. (1-3 and 0) Independent analysis through literature review and laboratory or field research. Requires written documentation. May be repeated for a maximum of six credits.

**Applied Economics**

<table>
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<tr>
<th>Major</th>
<th>Degree</th>
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<tbody>
<tr>
<td>Applied Economics</td>
<td>Ph.D.</td>
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</table>

The graduate program in applied economics utilizes the facilities and faculty of the Department of Agricultural and Applied Economics and the Department of Economics in the College of Business and Public Affairs. Students may carry out their dissertation research under the direction of a faculty member from either department.

**Biosystems Engineering**

<table>
<thead>
<tr>
<th>Major</th>
<th>Degrees</th>
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<tbody>
<tr>
<td>Biosystems Engineering</td>
<td>M.Eng., M.S., Ph.D.</td>
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See the College of Engineering and Science for information on this program.

**Food Science**

<table>
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<tr>
<th>Major</th>
<th>Degrees</th>
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<tbody>
<tr>
<td>Animal and Food Industries</td>
<td>M.S.</td>
</tr>
<tr>
<td>Plant Physiology</td>
<td>Ph.D.</td>
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<tr>
<td>Food Technology</td>
<td>Ph.D.</td>
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<tr>
<td>Nutrition</td>
<td>M.S., Ph.D.</td>
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</table>

A degree is not offered in this department. Degrees in the above areas with a concentration in food science are offered. Candidates for the M.S. and Ph.D. degrees must complete a research project and submit a thesis or dissertation. The M.S. degree requires a minimum of 24 credit hours of course work and six credit hours of research.

FD SC 601: Food Chemistry I, 4 cr. (3 and 3) F (even numbered years) Basic composition, structure and properties of food and the chemistry of changes occurring during processing utilization. Prerequisite: BIOCH 210 or permission of instructor.

FD SC 602: Food Chemistry II, 4 cr. (3 and 3) S (odd numbered years) Application of theory and procedures for quantitative and qualitative analysis of food ingredients and food products; methods for protein, moisture, lipid, carbohydrate, ash, fiber, rancidity, color and vitamin analyses and tests for functional properties of ingredients. Prerequisite: BIOCH 210 or permission of instructor.

FD SC 604: Food Preservation and Processing, 3 cr. (3 and 0) S (even numbered years) Principles of food preservation applied to flow processes, ingredient functions and the importance of composition and physical characteristics of foods related to their processing; product recalls and product development concepts. Prerequisites: Physics and organic chemistry or biochemistry.

FD SC 606: Food Preservation and Processing Laboratory, 1 cr. (0 and 3) S (even numbered years) Laboratory exercises on preservation methods, equipment utilized and processes followed in food manufacture. Corequisite: FD SC 404/604.

FD SC 607: Quantity Food Production, 2 cr. (1 and 3) Principles of the production of food in quantity for use in food service systems; functions of components of foods and ingredients in food on the quality of the final product on safe production of food and on proper use of equipment. Corequisite: FD SC 306 and 404.

FD SC 608: Food Process Engineering, 4 cr. (3 and 3) Basic engineering principles and their application in food processing operations; relation between engineering principles and fundamentals of food processing. Prerequisites: FD SC 214, CH 102 or 112, MTHSC 106, PHYS 207 or 200 or 122 or permission of instructor.

FD SC 664 (PKGSC 664): Food Packaging Systems, 3 cr. (3 and 0) Characteristics and application of various materials and systems used in the packaging of foods; engineering properties of the materials and methods used to measure properties; packaging systems for specific food applications. Prerequisite: Permission of instructor.

FD SC 666 (PKGSC 666): Food Packaging Systems Laboratory, 1 cr. (0 and 3) Laboratory and field exercises on food packaging operations and packaging materials; methods to evaluate the physical and chemical properties of packaging materials. Prerequisite: Permission of instructor.

FD SC 801: Biochemical Aspects of Poultry Products, 3 cr. (2 and 3) Five research areas of product texture, flavor, color (appearance), nutrition and microbiology. Texture, flavor and color will be approached from a biochemical and chemical viewpoint, dealing with the meat and egg components comprising various poultry products. Prerequisite: PS 355/655 or FD SC 401/601 or permission of instructor.

FD SC 810: Chemical and Biochemical Aspects of Foods, 4 cr. (4 and 0) Chemical, biochemical and functional properties of food components and their interactions in food emulsions, foams, colloids, and gel and solution states; the influences of processing on isolation, utilization and production of the constituent properties. Prerequisites: BIOCH 623 and FD SC 401/601 or permission of instructor.

FD SC 811: Physical and Thermophysical Properties of Foods, 3 cr. (3 and 0) Principles involved in relating physical and thermophysical properties to food quality, including standard methods and instruments to determine texture and the relationship of physical properties to sensory evaluation; interrelationships of chemical structure and physical properties in food processing operations. Prerequisite: FD SC 810 or permission of instructor.

FD SC 812: Microbiological Aspects of Food Systems, 3 cr. (3 and 0) Function and characteristics of microorganisms in the utilization and manufacture of food products; food fermentations, microbially induced chemical and physical changes, environmental aspects and production of food ingredients and resources. Prerequisite: Micro 407/607 or equivalent or permission of instructor.

FD SC 814: Shelf Life Evaluation of Foods, 3 cr. (3 and 0) Theoretical and practical aspects of the shelf life determination of foods; factors affecting food product quality and eventual product failure. Prerequisites: FD SC 601 or FD SC 810 or permission of instructor.

FD SC 820: Selected Topics in Food Science, 1-3 cr. (1-3 and 0) Special topics in food science not covered in other courses. May be repeated for up to nine credits.

FD SC 821: Selected Topics, 1-4 cr. (0 and 3-12) Independent research investigation in food science areas not conducted in other courses. May be repeated for a maximum of 12 credits. Prerequisite: Permission of instructor.

FD SC 851: Food Science Seminar, 1 cr. (1 and 0) Current research and related developments in food science reviewed by faculty, students and invited lecturers.

FD SC 852: Food Science Seminar, 1 cr. (1 and 0) Continuation of FD SC 851.

FD SC 891: Master's Thesis Research, credit to be arranged.
The interdepartmental food technology doctoral program is offered by selected faculty from the departments of Agricultural and Biological Engineering; Animal and Veterinary Sciences; Food Science; and Horticulture. Applicants must have a strong background in food science and technology and related areas.

Required courses include FD TH 851, Food Technology Seminar, and FD TH 991, Doctoral Dissertation Research. Additional courses may be selected from those offered in agricultural and applied economics; biosystems engineering; animal and veterinary sciences; experimental statistics; food science; horticulture and microbiology, as required by the student's graduate advisory committee.

FD TH 851: Food Technology Seminar, 1 cr. (1 and 0) F, S
Current and ongoing research, as well as developments in food technology reviewed by faculty, students and invited lecturers. Prerequisite: Enrollment in the food technology Ph.D. program or permission of instructor.

FD TH 991: Doctoral Dissertation Research, credit to be arranged

Packaging Science

Robert F. Testin, Chair, Department of Packaging Science

Major Degree
Packaging Science M.S.

The M.S. degree program in packaging science is designed to prepare the graduate to work independently in the research, development and application of new packaging materials and processes. Students may be accepted with backgrounds relating to chemistry, physics, mathematics, biology or engineering. Students with backgrounds in business or graphic communications or other disciplines may also be accepted after completing courses equivalent to the basic science and mathematics courses in the department's undergraduate curriculum. Each degree program is designed individually to augment the student's background to provide a broad understanding of packaging science and specialized knowledge in the area of the student's research.

The M.S. degree in packaging science requires 30 hours of course work, six of which are thesis research and the completion of an acceptable M.S. thesis. There are four core courses, which include International Packaging (PKGSC 802), Flexible Packaging (PKGSC 804), Packaging Seminar (PKGSC 851) and Master's Thesis Research (PKGSC 891). The electives that are offered within the Packaging Science Department are: Packaging Machinery (PKGSC 601), Mechanical Properties of Materials and Principles of Package Evaluation (PKGSC 604), Package Design and Development (PKGSC 620), Packaging for Distribution (PKGSC 640), Package Evaluation Laboratory (PKGSC 654), Food Packaging Systems (PKGSC 604), Food Packaging Systems Laboratory (PKGSC 666), Selected Problems (PKGSC 821) and Selected Topics (PKGSC 822).

PKGSC 601: Packaging Machinery, 3 cr. (3 and 0) Machinery used to form, fill, seal, laminate, combine and print continuous and automated packaging lines; auxiliary material handling equipment; principles of machine design, operation, selection and specification. Prerequisite: PHYS 207, PKGS 204 or permission of instructor.

PKGSC 604: Mechanical Properties of Materials and Principles of Package Evaluation, 3 cr. (3 and 0) Mechanical properties of packages; principles and standard methods (ASTM, TAPPPI) for determining these properties; evaluation of functional properties of packages including shock and vibration isolation. Prerequisite: PHYS 207, PKGS 204 or permission of instructor.

PKGSC 620: Package Design and Development, 3 cr. (3 and 0) Relationship between packaging and the marketing of consumer goods; principles and methods practiced in developing packages; methods used to coordinate package development activities including interfacing with product development, manufacturing, marketing and purchasing. Prerequisite: PHYS 207, PKGS 404 or permission of instructor.

PKGSC 640: Packaging for Distribution, 3 cr. (3 and 0) Fundamentals of distribution packaging technology, emphasizing product protection and lowest cost, including related issues of shipping methods through manufacturing to point of sale cycle. Prerequisite: Permission of instructor.

PKGSC 654: Package Evaluation Laboratory, 2 cr. (0 and 2) Laboratory experiments to determine properties of packaging materials and to evaluate the performance of packages including shipping tests (shock and vibration). Students learn how to operate standard testing apparatus and become familiar with industry-recognized test methods and standards. Prerequisite: PKGS 404 or permission of instructor.

PKGSC 664 (FD SC 664): Food Packaging Systems, 3 cr. (3 and 0) Characteristics and application of various materials and systems used in the packaging of foods; design and properties of the materials and designs used to measure properties; packaging systems for specific food applications. Prerequisite: Permission of instructor.

PKGSC 666 (FD SC 666): Food Packaging Systems Laboratory, 1 cr. (0 and 1) Laboratory and field exercises on food packaging operations and packaging materials; methods to evaluate the physical and chemical properties of packaging materials. Prerequisite: Permission of instructor.

PKGSC 802: International Packaging, 3 cr. (3 and 0) International packaging, including material, practices, machinery, marketing and regulatory compliance principles. Prerequisite: Permission of instructor.

PKGSC 804: Flexible Packaging, 3 cr. (2 and 1) Guidelines to identify quality requirements for products, determine the packaging to maintain the quality and evaluate that the requirements have been met; quality maintenance testing and prediction. Prerequisite: Permission of instructor.

PKGSC 821: Selected Topics, 1-4 cr. (0 and 1-12) Independent student research investigations in packaging science related to packaging materials, machinery, design and applications in areas not covered in other courses. May be repeated for credit. Prerequisite: Permission of instructor.

PKGSC 822: Selected Topics, 1-4 cr. (1-4 and 0) Selected topics in packaging science not covered in detail or contained in other courses. May be repeated for credit. Prerequisite: Permission of instructor.

PKGSC 851: Packaging Science Seminar, 1 cr. (1 and 0) Current research and related developments in packaging science reviewed by faculty, students and invited lecturers. May be repeated for a maximum of four credits. Prerequisite: Permission of instructor.

PKGSC 891: Master's Thesis Research, credits to be arranged Research on a master's thesis topic. Prerequisite: Graduate student status.

The following courses offered by various departments represent possible electives for the student in packaging science.

EX ST 801: Statistical Methods I, 4 cr. (3 and 3) F, S Role and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components analysis, simple and multiple linear regression and correlation, and non-parametric procedures. Prerequisite: Permission of instructor.
EX ST 802: Statistical Methods II, 3 cr.
(3 and 0) F, S, SS
Extended coverage of several methods introduced in EX ST 801: multiple regression model building and diagnostics, experiment design and analysis, and nonparametric methods; mixed models and repeated measures analyses; categorical data analysis; multivariate methods and sampling designs; appropriate use of statistical software.
Prerequisite: EX ST 801.

FD SC 601: Food Chemistry I, 4 cr.
(3 and 3) F (even numbered years)
Basic composition, structure and properties of food and the chemistry of changes occurring during processing utilization.
Prerequisite: BIOCH 210 or permission of instructor.

FD SC 602: Food Chemistry II, 4 cr.
(3 and 3) S (odd numbered years)
Application of theory and procedures for quantitative and qualitative analysis of food ingredients and food products; methods for protein, moisture, lipid, carbohydrate, ash, fiber, rancidity, color and vitamin analyses and tests for functional properties of ingredients.
Prerequisite: BIOCH 210 or permission of instructor.

FD SC 604: Food Preservation and Processing, 3 cr.
(3 and 0) S (even numbered years)
Principles of food preservation applied to flow processes, ingredient functions and the importance of composition and physical characteristics of foods related to their processing; product recalls and product development concepts.
Prerequisites:
- Physics and organic chemistry or biochemistry.

FD SC 606: Food Preservation and Processing Laboratory, 1 cr.
(0 and 3) S (even numbered years)
Lab exercises on preservation methods, equipment utilized and processes followed in food manufacture.
Corequisite: FD SC 404/604.

FD SC 608: Food Process Engineering, 4 cr.
(3 and 3)
Basic engineering principles and their application in food processing operations; relation between engineering principles and fundamentals of food processing.
Prerequisites:
- FD SC 214, CH 102 or 112, MTHSC 106, PHYS 207 or 200 or 122 or permission of instructor.

FD SC 810: Chemical and Biochemical Aspects of Foods, 4 cr.
(4 and 0)
Chemical, biochemical and functional properties of food components and their interactions in food emulsions, foams, colloids, and gel and solution states; the influences of processing on isolation, utilization and production of the constituents using techniques based on constituent properties.
Prerequisites:
- BIOCH 623 and FD SC 401/601 or permission of instructor.

FD SC 811: Physical and Thermophysical Properties of Foods, 3 cr.
(3 and 0)
Principles involved in relating physical and thermophysical properties to food quality, including standard methods and instruments to determine texture and the relationship of physical properties to sensory evaluation; interrelationships of chemical structure and physical properties in food processing operations.
Prerequisite: FD SC 810 or permission of instructor.

FD SC 812: Microbiological Aspects of Food Systems, 3 cr.
(3 and 0)
Function and characteristics of microorganisms in the utilization and manufacture of food products; food fermentations, microbially induced chemical and physical changes, environmental aspects and production of food ingredients and resources.
Prerequisite: MICRO 407/607 or equivalent or permission of instructor.

G C 606: Package and Specialty Printing Laboratory, 2 cr.
(0 and 6)
Laboratory techniques for printing and converting in package, label and specialty printing industries. Experiences in flexographic presswork, printing, die design, die making and diecutting for label, folding cartons and corrugated; sublimation and plastisol transfer screen printing; and glass, plastic and metal container printing.
Prerequisite or Corequisite: G C 405 or permission of instructor.

G C 607: Advanced Flexographic Methods, 4 cr.
(2 and 6)
Methods used in flexographic printing and converting porous and nonporous substrates. Theory and laboratory applications include setting standards for process color, preparation of plate systems, ink mixing and color matching, testing of films and foils, analysis of recent developments and prediction of future markets.
Prerequisites:
- G C 406 and 444 or permission of instructor.

G C 648: Planning and Controlling Printing Functions, 3 cr.
(3 and 0)
Systems for setting printing production standards, estimating, scheduling, job planning and the selection of new hardware and technologies.
Prerequisite: G C 350, 406, 440, 450.

CH E 612: Polymer Engineering, 3 cr.
(3 and 0)
Design-oriented course in synthetic polymers; reactor design used in polymer production, effect of step versus addition kinetics on reactor design, epoxy curing equations, polymer solubility, influence of polymerization and processing conditions on polymer crystallinity.
Prerequisites:
- CH 224 and 332 or permission of instructor.

CH E 804: Chemical Engineering Thermodynamics, 3 cr.
(3 and 0)
Equilibria of physical and chemical systems; generalized properties of hydrocarbons; application of thermodynamic methods in equipment design.

C M E 815: Colloidal and Surface Science, 3 cr.
(3 and 0)
Theory and application of colloidal and surface chemistry to ceramic materials and processes.

MGT 623: International Business Management, 3 cr.
(3 and 0)
The theoretical and institutional complexities of international business operations. Topics include exporting, importing, foreign investment, multinational corporations and the international payment system.
Prerequisite: Junior or senior standing.

MGT 624: International Transportation and Logistics, 3 cr.
(3 and 0)
International transportation systems and their logistics support systems. Topics include ocean shipping, international air transportation, port management and EEC and Soviet-block transport systems, and international transport legislation and policies.
Prerequisite: Senior standing or permission of instructor.

MKT 627: International Marketing, 3 cr.
(3 and 0)
Marketing from the international point of view; the necessary modification of marketing thinking and practice for foreign markets due to individual environmental differences.
Prerequisite: MKT 301.

MKT 630: Marketing Product Management, 3 cr.
(3 and 0)
Management of the firm's product or service offerings. Topics include new product screening, evaluation and development; product line and mix analysis; abandonment decisions; brand manager's role; new product development department. Emphasis is on decision making.
Prerequisites:
- MKT 301 and MA SC 310 or permission of instructor.
## College of Architecture, Arts and Humanities

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The College of Architecture, Arts and Humanities offers advanced degrees in these areas of study.

Architecture
City and Regional Planning
Construction Science and Management
English
Fine Arts in Computing
History
Professional Communication
Visual Arts

Courses are offered in art and architectural history, geography, languages, performing arts, philosophy, religion, speech and women's studies to provide electives for students in other areas. The College of Architecture, Arts and Humanities offers graduate programs in three schools: the School of Design and Building, the School of the Arts and the School of Humanities.

Graduate students in the School of Design and Building and the School of the Arts have the opportunity to study at the Charles E. Daniel Center for Building Research and Urban Studies in Genoa, Italy, which is sponsored jointly by the college and the CAF (Clemson Advancement Foundation for Design and Building). Emphasis is placed on studies related to this historic port city and the art and architectural heritage of the Italian setting. Studio and classroom work is enriched by visiting scholars and critics and complemented by scheduled field trips, both in Italy and continental Europe.

Courses of study in the Daniel Center, while under the jurisdiction of the related departments of the College of Architecture, Arts and Humanities, are administered and taught by the professors-in-residence. Studio work is the core of the Genoa program, whether in architecture, city and regional planning, construction science and management, or visual arts. All students undertake a history research project, conduct field studies and participate in a design seminar.

The School of Humanities is home to three graduate degree programs: the Master of Arts in English, History and Professional Communication. Faculty have been recipients of grants from agencies and foundations, such as the National Endowment for the Arts, the National Endowment for the Humanities and the Bingham Trust. They have also held Fullbright Senior Lectureships and Research Awards in many countries.

SCHOOL OF DESIGN AND BUILDING

Architecture

Jose R. Caban, Chair, School of Architecture

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<td>M.Arch., M.S.</td>
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The Master of Architecture is a professional degree program that develops proficiency in responding to contemporary architectural issues through a range of both practical and theoretical knowledge, while providing opportunities for creatively challenging the limits of the profession. Major emphasis is on design, accompanied in turn by complementary course work of a professional focus, as well as elective subjects. Complex studio design projects stress social awareness and contextual fit and are responsive to all aspects of the architectural process. Practical experience is a requisite part of the overall program, which is concluded with a thesis combining literary research with design synthesis.

Admission to the Master of Architecture program is based on the student's ability to respond effectively to the intellectual rigor and creative challenge integral to graduate architecture study. This potential is measured by demonstrated proficiency in prior academic work and Graduate Record Examinations (GRE) general test scores, as well as creativity of mind, motivation of spirit and maturity of purpose. Normally a personal interview is required of candidates whose application material has been reviewed favorably by the Admissions Committee. A postbaccalaureate program of preparatory study is available to qualified applicants with backgrounds in areas other than design. More detailed information concerning application procedures and requirements may be obtained by writing or calling the School of Architecture.

The course work and directed studies required of the Master of Science program may be completed in one academic year, after which a variable period of time is dedicated to the research thesis. Degree candidates elect to work within one of the following areas: architecture and health care, environmental issues in architecture, architectural human perception, or theory and philosophy of architecture. A study plan is determined in consultation with the major advisor who, along with the advisory committee, periodically reviews the student's work and evaluates the research thesis. Credit requirements for the Master of Science degree consist of 24 hours of combined course work and directed studies with a minimum grade point average of 3.00, and the acceptance of a six-hour research thesis.

Architecture Concentration

This inclusive course of study leading to the Master of Architecture degree affords the student an opportunity to pursue individual academic and career objectives within the context of a rigorous professionally directed architecture program. The focus of learning is the design studio, where the student is involved in a wide range of theoretical and real-world explorations. Advanced studies in technology, theory and professional practice complement design work and are accompanied by additional subjects determined in concert with the major advisor.

Although designated subjects in design and other professional studies constitute a major portion of work in this concentration, sufficient elective hours are available to establish a study plan responsive to individual interests. The choice of thesis subject provides a further opportunity for personal development.
ARCH 603: The Modern Architecture Movement, 3 cr. (3 and 0)
Seminar on the analysis and criticism of architectural and town building works. Course sequence includes historic and contemporary examples, literary searches, field trips, essays and oral reports. Prerequisite: Senior standing or permission of instructor.

ARCH 604: Current Directions in Architecture, 3 cr. (3 and 0)
Critical analysis of the development and current directions of modern movements in architecture. Prerequisite: Senior standing or permission of instructor.

ARCH 605: American Architectural Styles 1650-1950, 3 cr. (3 and 0)
Survey of American architectural styles and the architects responsible for them, from the Colonial period to our recent past. Emphasis is on identifying architectural elements that serve as clues in determining a building's architectural style.

ARCH 612: Architectural History Research, 3 cr. (3 and 0)
Directed investigations related to the art and architectural heritage of Italy.

ARCH 614: Design Seminar*, 3 cr. (3 and 0)
Topical issues in architecture, art, construction and planning.

ARCH 615: Field Sketching, 3 cr. (0 and 6)
Media and techniques for expression, representation and visual analysis through freehand perspective field drawing of the built and natural environment. Prerequisite: School of Design and Building students with junior standing or permission of instructor.

ARCH 616: Field Studies in Architecture and the Related Arts*, 3 cr. (0 and 9)
Documentation and analysis of architectural structures observed during European travels in graphic and written form.

ARCH 624: Product Design, 3 cr. (0 and 9)
Furniture and product system design with emphasis on ergonomics and the relationship of form and materials. Prerequisite: Senior standing and permission of instructor.

ARCH 625: Energy in Architecture, 3 cr. (3 and 0)
Climate design methodology and its influence on building energy patterns and architectural form. Prerequisites: Senior standing and permission of instructor.

ARCH 626: Architectural Color Graphics, 3 cr. (3 and 0)
Architectural color graphics by computer. Theories of color classification and interaction; application of color theories to art and architecture. Prerequisite: Permission of instructor.

ARCH 627: Advanced Color Graphics, 3 cr. (3 and 0)
Theories of color classification and interaction; three-dimensional color modeling by computer; advanced application of color theories to art and architecture. Prerequisite: ARCH 426/626 or permission of instructor.

ARCH 628: Computer-Aided Design, 3 cr. (2 and 3)
Concepts, skills and applications of computer-aided design as they relate to the practice of architecture. Prerequisite: Senior standing or approval of instructor.

ARCH 629: Architectural Graphics, 3 cr. (3 and 0)
Concepts, skills, techniques and strategies of visual presentation/graphics as they relate to the design professions—architects/landscape architects. Prerequisite: Junior, senior, graduate standing or permission of instructor.

ARCH 630: Theories and Philosophies of Technology and Architecture, 3 cr. (3 and 0)
Theoretical and practical examination of technology and architecture from premodern and modern viewpoints to study its nonneutral role in shaping and reflecting knowledge, beliefs and actions within a cultural context.

ARCH 640: New York Field Study, 3 cr. (3 and 0)
Study of architecture, art, planning and urban design of New York. Two weeks of residence is required with scheduled field trips to relevant sites in all five boroughs, with counseling to determine research interests. Guidance is provided to resources in the city. A final report is required (Maymester only).

ARCH 685: Health Care Facilities, 3 cr. (3 and 0)
Concepts, organization and direction of health and health-care services within the context of health-care delivery systems. Emphasis is on mental and physical health-care facilities concepts. Prerequisite: Permission of instructor.

ARCH 688: Health Care Programming, 3 cr. (3 and 0)
Seminar on recent research and innovations in health-care facilities programming and original investigation of assigned programming problems. Prerequisite: Permission of instructor.

ARCH 801: Architecture Seminar, 3 cr. (3 and 0)
Contemporary issues in the architectural profession.

ARCH 802: Phenomenology of Architecture, 3 cr. (3 and 0)
Basic principles of phenomenological methods as they apply to the theoretical understanding of modern architecture. Emphasis is on selected writings of Heidegger, Harries and Norberg-Schulz. Prerequisite: ARCH 803.

ARCH 803: Theories of Architecture, 3 cr. (3 and 0)
Evolution of architectural theories from Vitruvius to the present. Emphasis is on the writings of leading architects and theorists and the impact of these theories on architectural solutions. Prerequisite: Graduate status.

ARCH 804: Seminar in Modern Masters, 3 cr. (3 and 0)
In-depth examination of one or more related groups of architects of the 20th century. Content varies from semester to semester (Kahn, Scarpa, Barragan, Wright, Corbusier, etc.). Prerequisite: Graduate status.

ARCH 805: Architecture and the City, 3 cr. (3 and 0)
Seminar examining contemporary theories of urban design and the design of urban buildings; real and ideal visions of cities; their representation, archaeology and iconography (Rossi, Kries, Unger, Venturi, Duane, etc.).

ARCH 821: Research Methods, 3 cr. (3 and 0)
Foundations and procedures of architectural research; alternate research methodologies and their philosophical and epistemological limits. Prerequisite: Graduate status.

ARCH 850: Architecture Studio*, 6 cr. (0 and 18)
Architectural design studies in the context of the Genoa urban setting. May be substituted for ARCH 853 or 854 and for ARCH 857 with permission of advisor.

ARCH 853: Architecture Studio, 6 cr. (0 and 18)
Architectural design studies with emphasis on selected problem issues.

ARCH 854: Architecture Studio, 6 cr. (0 and 18)
Architectural design studies involving structured and situational problems. Prerequisite: ARCH 853.

Architectural and Health Care Concentration
Master of Architecture students in this specialized area of study examine issues of programming, planning and design associated with a comprehensive approach to physical and mental health care delivery systems. Studio work emphasizes the integration of physical design systems with patient care techniques. Theoretical design projects, as well as those that lead to built projects, employ both investigative research and architectural synthesis. These design studies are complemented by lectures and seminars that deal with various aspects of health care, hospital administration and the environment.

The architecture and health care concentration is demanding in the scope of its professional studies, with most of the course work designated for specific areas of learning. The thesis, which normally deals with a particular area of health care, may be project or research oriented.
ARCH 857: Architecture Studio, 6 cr. (0 and 18)
Architectural design studies dealing with comprehensive problem-solving situations. Prerequisite: ARCH 854.

ARCH 858: Thesis Research, 3 cr. (0 and 9)
Architectural predesign inventory and analysis for the thesis project. Prerequisite: ARCH 854.

ARCH 859: Thesis Manuscript, 1-3 cr. (0 and 3-9)
Architectural predesign synthesis of research for the thesis project. Prerequisite: ARCH 858.

ARCH 881: Delivery of Architecture, 3 cr. (3 and 0)
Ethical, legal and business issues in the architectural profession. Prerequisite: Professional degree program status.

ARCH 886: Health Care Components, 3 cr. (3 and 0)
Components and service functions of physical and mental health care delivery systems and facilities.

ARCH 890: Directed Studies, 1-5 cr. (1-5 and 0)
Special topics in architecture undertaken on an individual basis with faculty guidance. Prerequisite: Permission of advisor.

ARCH 891: Thesis Project, 3-9 cr. (9 and 9-27)
Complex architectural project emphasizing design exploration and independent work. Graded on a pass/fail basis. Prerequisites: ARCH 857 and 858.

City and Regional Planning

Donald L. Collins, Chair, Department of Planning and Landscape Architecture
Barry C. Nocks, Coordinator, Program in City and Regional Planning

Major Degree
City and Regional Planning M.C.R.P.

The two-year Master of City and Regional Planning program is a practice-oriented professional degree curriculum that emphasizes land-use planning and development and issues of the built and natural environment. The standard core curriculum provides a balanced approach that includes physical, social, economic, and policy considerations. While many students choose to remain generalists, more concentrated studies are available in one of these areas: development planning, environmental planning, and urban design and land-use planning. Other specialized areas of study can be tailored in conjunction with graduate programs elsewhere on campus.

Students normally choose a concentration for which their undergraduate background is best suited. No specific undergraduate area of study is required. Options are available for students with or without a design background. The result is a rich cross section of students with a variety of interests. The relatively small enrollment (approximately 20 per class) leads to intensive faculty-student interaction. Almost all of our students have received financial aid over the past five years through departmental assistantships, Public Service Assistance (PSAs), or research funding. These awards generally provide the equivalent of tuition plus $1,500 to $3,500 per year in graduate stipend. Ongoing public service and research projects provide a real-world dimension to the program. This orientation is enhanced by the summer internship requirement and PSA (work-study) opportunities. In addition, planning students are actively involved in Clemson's student American Planning Association (APA) and the SC APA chapters. Graduates are well-equipped for careers in private sector planning and development, as well as public-sector planning and administration. The Overseas Center for Urban Studies in Genoa, Italy, is a unique support element in the MCRP program. It provides the option of a one-semester overseas study experience for design oriented planners in an interdisciplinary program of planning, design, and fine arts. A dual degree program is available for students with a previous degree in architectural design. Students can receive both the MCRP and MARCH degrees in three years through an integrated curriculum.

Admission Requirements

Admission to the graduate program requires the following:
1. a bachelor's degree from an accredited college or university;
2. a satisfactory academic record particularly in the last two years of undergraduate work;
3. an on-campus interview (highly recommended);
4. three letters of recommendation with at least two from current or former professors;
5. completion of the Graduate Record Examinations; and
6. one three-credit course in statistics, economics, and computer applications (highly recommended).

Deficiencies in any of these areas may be remedied after enrollment in the graduate program. Postbaccalaureate status may be recommended in some cases.

Requirements for Degree Candidacy

The two-year Master of City and Regional Planning degree requires a minimum of 54 semester hours. Nine courses, eight of three semester hours of credit and a six-credit studio, make up the core curriculum. The remaining courses are taken from approved electives and a thesis/project/paper option. In addition, each student is required to complete an internship (or equivalent) and a terminal project/paper or thesis.

Requirements for Awarding of a Degree
1. Thesis Option*
   a. A minimum of 54 hours of course work with a B average in the student's prescribed professional curriculum, including the thesis, is required.
   b. A six- to nine-semester-hour thesis must be completed satisfactorily. Only those students who have been approved by the planning faculty and have performed satisfactorily on the comprehensive examination will be permitted this option.
2. Nonthesis Option*
   a. A minimum of 54 hours of course work with a B average in the student's prescribed professional curriculum is required.
   b. An approved six-semester-hour terminal paper sequence must be completed satisfactorily. Students must perform satisfactorily on a comprehensive examination covering the core planning courses before being permitted to write the terminal paper.
   c. The final oral examination requires satisfactory answers to questions concerning the student's terminal paper and concentration area.

C.R.P. 605: Urban Genesis and Form, 3 cr. (3 and 0) N
Origin, development, and growth of cities; ever-accelerating growth of urbanism; increasing complexity of urban organism. Prerequisite: Permission of instructor or department chair.

C.R.P. 611: Introduction to City and Regional Planning, 3 cr. (3 and 0) S
Introduces students from a variety of disciplines to city and regional planning. Spatial and nonspatial areas of discipline are explored through a wide ranging lecture seminar program. Prerequisite: Permission of instructor or department chair.

C.R.P. 672: Planning Process and Administration, 3 cr. (3 and 0) F
Conceptual framework of planning organizations and tools used in the planning process; potentials of planning and management approaches that address the relationship and integration between techniques and instruments. Prerequisite: Permission of instructor.

C.R.P. 674: Real Estate "Master Builder" Development Process, 3 cr. (3 and 0) S
Real estate and land development processes from the developer's perspective. Cases and lectures are presented by leading experts in the development industry. Emphasizes participants of the development team and how to become a developer/master builder to create a superior built environment. Prerequisite: Permission of instructor.

C.R.P. 683: Seminar on Planning Communication, 3 cr. (3 and 0) S
In-depth analysis of methods to effectively communicate planning and policy decisions and attempts to familiarize students with the various communication skills needed by planners, policy makers and other professionals to become successful communicators.

* Upon approval of the majority of the faculty, either a thesis or a terminal paper of up to nine semester hours may be permitted with a corresponding reduction in the required course work.
C R P 812: City and Regional Planning Theory, 3 cr. (3 and 0) S
Development of the planning practice and theories of planning process: historical evolution of planning practice in the U.S.; social issues in planning; theories of planning and critiques of those theories; and ethical issues in planning practice. Prerequisite: Permission of instructor or department chair.

C R P 822: Urban Systems and Design, 3 cr. (3 and 0) S
Analysis of the evolution of the physical patterns of cities through research in the historical development of urban form in Europe and America within the context of prevailing social, economic and political influences; approaches to the analysis of contemporary cities through the study of 20th century planning theorists. Prerequisite: Permission of instructor or department chair.

C R P 823: Social Policy Planning and Delivery Systems, 3 cr. (3 and 0) S
Concepts of planning social service delivery systems: basic principles, role of the public sector (at national, state and local levels), components of delivery systems, and methods for planning and evaluation. Prerequisite: Permission of instructor.

C R P 831: Physical Planning Studio, 3 cr. (3 and 0) F
Working knowledge of natural systems, infrastructure systems, land use activity, social concerns, visual/spatial topics and implementation practice.

C R P 832: Problems in Site Planning, 3 cr. (1 and 2) S
Advanced site planning and design concept studies developed through site projects; concentration on industrial, residential and recreational facilities; emphasis on on-site specific site analysis and generation of development alternatives. Prerequisite: C R P 831.

C R P 834: Geographic Information Systems for City and Regional Planning, 3 cr. (3 and 0) S
Introduction to geographic information systems for planning and related resource management disciplines. Topics include data development and management, spatial analysis techniques, critical review of GIS applications, needs analysis and institutional context, overview of GIS hardware and software, completion of hands-on application project.

C R P 835: Advanced Topics in Geographic Information Systems, 3 cr. (3 and 0) F
Seminar/laboratory devoted to development and analysis of leading edge GIS capabilities and applications; seminar focus varies from year to year, based upon developments in the GIS field and student interests. Prerequisite: C R P 834 or permission of instructor.

C R P 840: Seminar in Coastal Planning, 3 cr. (3 and 0) F
Issues relating to development and conservation of coastal environments, focusing on inherent tradeoffs between growth and environmental quality; ecology and carrying capacity of coastal areas; appropriate land and resource management approaches to balance coastal resource demand. Prerequisite: Graduate standing.

C R P 841: Seminar in Environmental Planning, 3 cr. (3 and 0) S
Current and emerging environmental issues and appropriate planning options, including population dynamics and limits to growth, entropy law, waste management and global change; students pursue individual research on an environmental issue of particular concern and report findings. Prerequisite: Graduate standing.

C R P 844: Outdoor Recreation Resource Management and Planning (PRMT 844), 3 cr. (3 and 0) S
Issues relating to planning and development of natural areas for recreational purposes; focus is on the policy-making process at the federal, state, regional and local levels. Prerequisite: Permission of instructor.

C R P 853: Planning Methods I: Theory and Technique, 3 cr. (0 and 0) F
Introduction to analytic planning methods; material is drawn principally from the fields of economics, geography, regional science, and city and regional planning. Prerequisite: An undergraduate class in micro-economics.

C R P 854: Planning Methods II: Techniques and Applications, 3 cr. (0 and 9) S
Techniques for planning analysis, including social/economic profiles and projections, impact assessment, land use planning analysis and feasibility studies; computer modeling; students apply these techniques in studio projects. Prerequisite: C R P 853.

C R P 858: Research Methods and Thesis Planning Proposal, 3 cr. (0 and 9) F, S
Preliminary analysis of data to determine most advisable form of terminal presentation within thesis or nonthesis option for Master of City and Regional Planning degree. Prerequisite: Permission of faculty.

C R P 859: Planning Terminal Project, 1-3 cr. (0 and 3-9) S
Student selects, with approval of advisor, and conducts research on an individual planning problem of suitable scope. Oral, written and, where appropriate, visual presentation of solution required. Student must enroll during final semester. Prerequisite: C R P 858.

C R P 860: Planning Studio*, 3-6 cr. (0 and 9-18) F, S
Planning studies related to the city of Genoa and its environs. May be substi-
C R P 883: Techniques for Analyzing Development Impacts, 3 cr. (3 and 0) N
Models and techniques for analyzing development impacts in urban areas and regions; economic, fiscal, social and environmental impact methods. Operational knowledge of these techniques will be developed. Prerequisites: C R P 881 and permission of instructor.

C R P 889: Selected Topics in Planning, 3 cr. (3 and 0) F, S
Topics emphasizing current literature and results of current research. May be repeated for credit. Prerequisite: Permission of instructor.

C R P 890: Directed Studies in City and Regional Planning, 1-6 cr. (0 and 3-18) F, S, SS
Student pursues individual professional interests under guidance of city and regional planning program graduate faculty.

C R P 891: Planning Thesis, 1-9 cr. (0 and 1-9) F, S
Student works individually, programs a planning problem of appropriate scope and conducts research. Oral, written and, where appropriate, visual presentation of thesis required. Prerequisite: Permission of faculty.

C R P 893: City and Regional Planning Internship, 3-6 cr. (0 and 3-18) F, S, SS
Twelve weeks of supervised professional employment in an approved planning office or agency. Monthly reports covering student’s experience required. Graded on a pass/fail basis. Prerequisite: Two semesters of city and regional planning or equivalent.

Construction Science and Management
Roger Liska, Chair, Department of Construction Science and Management

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<td>Construction Science and Management</td>
<td>M.C.S.M.</td>
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The Master of Construction Science and Management degree program is designed to provide students with a high level of skill and understanding in the technical areas of construction project administration and control. Substantial emphasis is placed on advanced study in the field of business, in new and emerging techniques for construction project delivery systems, and in the administration of the construction firm.

The total number of credit hours required for the Master of Construction Science and Management degree varies according to each student’s undergraduate degree. For those who have the required undergraduate skills and knowledge, the program is 36 semester hours, of which 12 must be from the department core (C S M 860, 861, 862, 863, 864, 865 and 891). In cases where the candidate does not have the necessary prerequisite skills and knowledge, additional course work beyond the 36 semester hours is required. Each application is evaluated as to the needed additional course work. The candidate may be placed in a postbaccalaureate status if deficient courses are noted.

These programs are also available to off-campus students through the Office of Off-Campus, Distance and Continuing Education. Call 1-888-CLEMSON (1-888-253-6766) for more information.

Admission Requirements
1. A bachelor’s degree in construction science, construction management, building construction or related areas is required. Applicants from other disciplines may be admitted but may be required to remedy any deficiencies in course work to provide the student with the needed prerequisite skills and knowledge for the construction science and management graduate program.
2. Acceptance must be granted by the Graduate School and the Department of Construction Science and Management. Graduate School acceptance is based on performance in previous undergraduate studies and a satisfactory score on the GRE. Acceptance by the department is based on performance in undergraduate studies; three letters of recommendation and acceptance by the department Graduate Admissions Committee.

Requirements for Degree Candidacy
1. The Master of Construction Science and Management degree requires a minimum of 36 semester hours. This includes 12 semester hours of course work in the department’s core and C S M 852. In cases where the candidate does not have the necessary undergraduate prerequisite skills and knowledge, additional course work beyond the 36 semester hours may be required as noted above.
2. Each student is required to have 800 hours of construction-related experience. The experience may be no older than six years from date of enrollment in the C S M graduate program.

Requirements for Awarding of a Degree
1. Thesis Option
   a. A minimum of 36 semester hours of course work with a B average in the student’s prescribed curriculum, including thesis, is required.
   b. A thesis on a construction-related topic must be completed satisfactorily. Up to nine semester hours of thesis credit may be taken. Thesis credit is included as part of the department’s core. Approval must be received from the student’s advisor prior to selecting the thesis option.
   c. Performance on a written comprehensive examination covering the student’s program of study must be satisfactory.
   d. Performance on a final oral examination relating to the student’s thesis and program of study must be satisfactory. The student must pass the written comprehensive examination prior to taking the oral examination.

2. Nonthesis Option
   a. A minimum of 36 semester hours of course work with a B average in the student’s prescribed curriculum is required.
   b. Performance on a written comprehensive examination covering the student’s program of study must be satisfactory.
   c. Performance on a final oral examination relating to the student’s program of study must be satisfactory. The student must pass the written comprehensive examination prior to taking the oral examination.

C S M 655: Reducing Adversarial Relations in Construction, 3 cr. (3 and 0)
Focus on the delivery of projects and how adversarial relations can affect the successful completion of the venture. Topics include management of human resources, understanding needs and processes of the participants, where problems lie, methods of avoiding and settling disputes. Prerequisite: Architecture and/or Construction Science and Management majors, or permission of instructor.

C S M 852: Construction Management Research, 3 cr. (3 and 0)
Research methodology applied to the construction industry. Prerequisite: Permission of instructor.

C S M 860: Financial Planning and Analysis, 3 cr. (3 and 0)
Theory of financial management as it relates to the financial problems faced by the building construction firm. Prerequisite: Permission of instructor.

C S M 861: Construction Control Systems, 3 cr. (3 and 0)
Design and administration of the quality assurance program for large and complex construction projects. Prerequisite: Permission of instructor.

C S M 862: Personnel Management and Negotiations, 3 cr. (3 and 0)
The role of management and unions in the construction industry. Topics include contract negotiation, collective bargaining, dispute resolution and management for productivity improvement. Prerequisite: Permission of instructor.

C S M 863: Advanced Planning and Scheduling, 3 cr. (3 and 0)
Analysis and control of construction projects using advanced techniques for planning, scheduling and resources control. Prerequisite: Permission of instructor.

C S M 864: Bid Strategy and Marketing, 3 cr. (3 and 0)
Advanced techniques for bid strategy and marketing of construction management, design-build or single-contract project delivery services and companies. Prerequisite: Permission of instructor.
C S M 865: Project Management, 3 cr.  
(3 and 0)  
Theory of project administration and control with special emphasis on the role and responsibilities of the resident project representative and the project manager.  
Prerequisite: Permission of instructor.

C S M 881: Professional Seminar, 3 cr.  
(3 and 0)  
New and emerging methods for management of the construction or construction-related firm.  
Prerequisite: Permission of instructor.

C S M 890: Directed Studies, 3-6 cr.  
Special topics not covered in other courses; emphasis is on field studies, research activities and current developments in building science.  
Prerequisite: Permission of instructor.

C S M 891: Master's Thesis Research, credit to be arranged  
With the approval of the advisory committee, the student carries on independent research and analysis. The thesis is presented orally and in writing and in strict compliance with the guidelines of the Graduate School.

C S M 899: Construction Science and Management Internship, no credit  
Consists of 800 hours of verifiable construction-related experience; experience may be no older than six years from date of enrollment in CSM graduate program. Graded on a credit/no credit basis; a letter grade is not given; will not count toward a graduate degree.

The Master of Fine Arts in Computing (MFAC) at Clemson University is a professional degree program aimed at producing graduates who will be sought by the growing electronic arts industry, particularly by those companies engaged in special effects production within the entertainment and commercial video and film industries. For more information on this interdisciplinary program refer to page 178.

SCHOOL OF THE ARTS
Fine Arts in Computing

Mark McKnew, Program Coordinator, Fine Arts in Computing  

Major Degrees
Fine Arts in Computing M.F.A.C.

The Master of Fine Arts degree is the terminal degree within the areas of visual arts. The program offers concentration in the studio areas of drawing, painting, printmaking, ceramics, photography and sculpture. Interdisciplinary projects are encouraged within the department and college. The primary goal of the program is the development of each student to a high degree of professional competence.

Admission Requirements
The graduate program in visual arts leading to the Master of Fine Arts degree admits a limited number of talented and creative candidates on a competitive basis as follows:
1. The candidate must have a bachelor's degree from an accredited college or university with a major in visual arts. Especially well-qualified persons may be accepted from other degree backgrounds.
2. A satisfactory academic record in the last 60 major credit hours of undergraduate work is required.
3. A portfolio documentation of candidate's creative work must be submitted. Portfolio should represent between 15-20 works, the majority of which should represent the chosen field of study. This portfolio, which may include slides, photographs, films, other documentation or the original work, is reviewed by the Admissions Committee, composed of members of the faculty of the Department of Art. Applicants are encouraged to arrange for a campus interview during the application process.
4. Letters of recommendation are preferred from former major professors, producing artists or professional acquaintances. Other letters of recommendation will be accepted.
5. A statement of intent regarding applicant's interest and direction in pursuing the graduate degree must be submitted.

Requirements for Degree Candidacy
The prospective candidate must have a review of his or her work at the end of each semester. It will be determined at this time if the student should continue or whether additional study is required at either the undergraduate or graduate level. Upon completion of 30 hours, the candidate must pass an oral review in order to determine readiness for thesis work. A Graduate Thesis Committee will be assigned at this time to assist the thesis development and concluding thesis exhibition.

The candidate must complete 30 hours and a full-time residency during the second year of study.

Requirements for Awarding of a Degree
Students are required to complete the following:
1. A minimum of 45 credit hours with a B average or above in the student's professional curriculum, including 36 hours of ART 600- and 800-level courses, and nine hours in the history of art; and
2. A 15-credit-hour thesis culminating in satisfactory completion of a written documentary of the "thesis exhibition" and an oral examination by the Graduate Faculty.

ART 605: Advanced Drawing, 3 cr.  
(0 and 6)  
Advanced level studies of drawing which explore the synthesis of refined drawing skills and philosophies of art. Student's understanding of drawing as a form of art is developed through studio practice augmented by critiques, demonstrations, lectures, field trips and independent research.  
Prerequisite: ART 305 or permission of instructor.
**ART 607:** Advanced Painting, 3 cr. (0 and 6)
Advanced studio course in painting, including study of contemporary painters and directions. Student selects painting media and is expected to develop a strong direction based on prior painting experience. **Prerequisite:** ART 307 or permission of instructor.

**ART 609:** Advanced Sculpture, 3 cr. (0 and 6)
Intensive independent studio concentration to further develop personal direction and content. Emphasis is on continued investigation of sculptural context, materials and processes and relative historical research. **Prerequisite:** ART 309 or permission of instructor.

**ART 611:** Advanced Printmaking, 3 cr. (0 and 6)
Culmination of process, techniques and individual development. Students are expected to have mastered process and technique for the benefit of the image produced. Creativity and self-expression are highly emphasized as students select a process for concentrated study. **Prerequisite:** ART 311 or permission of instructor.

**ART 613:** Advanced Photography, 3 cr. (0 and 6)
Continuation of ART 313; advanced problems in photography. **Prerequisite:** ART 313 or permission of instructor.

**ART 617:** Advanced Ceramic Arts, 3 cr. (0 and 6)
Further development of ideas and skills. Glaze calculation and firing processes are incorporated to allow for a dynamic integration of form and ideas. **Prerequisite:** ART 317 or permission of instructor.

**ART 620:** Selected Topics in Art, 1-3 cr. (0 and 6)
Intense course in studio art. May be repeated for a maximum of six credits, but only if different topics are covered. **Prerequisite:** Senior standing or permission of instructor.

**ART 690:** Directed Studies, 1-5 cr. (0 and 2-10)
Study of areas in the visual arts not included in other courses or advanced work in addition to other courses. Directed studies must be arranged with a specific professor prior to registration.

**ART 803:** Fundamentals of Visual Art, 3 cr. (0 and 6)
Intensive introduction of visual art and design fundamentals. Two and three dimensional studio work with emphasis on time based media and design.

**ART 805:** Visual Arts Seminar on Theories and Practice I, 3 cr. (3 and 0)
Issues related to the practice of the artist, emphasizing theories and criticism of contemporary art.

**ART 806:** Visual Arts Seminar on Theories and Practice II, 3 cr. (3 and 0)
Continuation of ART 805.

**ART 821:** Art with the Computer, 3 cr. (0 and 6)
Studio course using the microcomputer as an art medium. Studies in imaging systems with emphasis on the creative use of the medium for artistic expression. **Prerequisite:** Permission of instructor.

**ART 840:** Visual Arts Studio, 3-6 cr. (0 and 9-18)
Studio work in visual arts with adjunct lectures and gallery tours. May be substituted for ART 800-level visual arts studio.

**ART 850:** Visual Arts Studio, 3 cr. (0 and 9)
Concentrated and advanced work in ceramics, drawing, painting, printmaking, sculpture, photography, graphic design or multimedia. **Prerequisite:** Permission of department chair or instructor.

**ART 851:** Visual Arts Studio, 3-6 cr. (0 and 9)
Continuation of ART 850. May be repeated for maximum of six credits. **Prerequisite:** Permission of department chair or instructor.

**ART 860:** Studio Computer Research, 3-15 cr. (0 and 6-30)
Application of computer technology for the production of art. Computer research will facilitate the creative approach to self-expression. May be taken for a maximum of 27 credits. **Prerequisite:** Permission of instructor.

**ART 870:** Visual Arts Studio, 6 cr. (0 and 16)
Advanced theory; directed research in art criticism; applied work in ceramic arts, drawing, painting, sculpture, photography, graphic design or multimedia. **Prerequisite:** Permission of department chair or instructor.

**ART 871:** Visual Arts Studio, 3-6 cr. (0 and 8-16)
Continuation of ART 870. May be repeated for maximum of six credits. **Prerequisite:** Permission of department chair or instructor.

**ART 880:** Visual Arts Studio, 3-15 cr. (0 and 6-30)
Continuation of ART 871. May be repeated for maximum of 15 credits. **Prerequisite:** Permission of department chair or instructor.

**ART 891:** Master's Thesis Research, 3-15 cr. (0 and 6-30)
May be repeated for maximum of 15 credits. **Prerequisite:** Permission of department chair or instructor.

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**ART 885:** Advanced Theory and Practice in Visual Arts Seminar, 3 cr. (0 and 6)
May be repeated for a maximum of 27 credits. **Prerequisite:** Permission of instructor.

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**A A H 611:** Directed Research in Art History I, 3 cr. (0 and 6)
Comprehensive studies and research of special topics not covered in other courses. Emphasis is on field studies, research activities and current developments in art history.

**A A H 612:** Directed Research in Art History II, 3 cr. (0 and 6)
Continuation of A A H 611.

**A A H 623:** Studies in the Art and Architecture of the Renaissance I, 3 cr. (3 and 0)
Visual arts and architectural monuments of the Renaissance (Western Europe from the 15th through the 18th centuries), with a study in depth of selected examples from the period. **Prerequisite:** A A H 204 or 206 or permission of instructor.

**A A H 628:** Nineteenth Century Visual Arts, 3 cr. (3 and 0)
Visual arts of the 19th century: painting, sculpture, printmaking and ceramics, with relation to the factors that have influenced the artist and the consequence on society. **Prerequisite:** A A H 427.

**A A H 629:** Studies in the Art and Architecture of India and the Far East, 3 cr. (3 and 0)
Visual arts and architectural monuments of India and the Far East, with a study in depth of selected examples from the period. **Prerequisite:** A A H 204 or 206 or permission of instructor.

**A A H 630:** Twentieth Century Art I, 3 cr. (3 and 0)
Concentration on major artists' monuments and issues of the Modern period in art. Through lecture/discussions and the reading of primary sources, course will place the major modern movements in the context of the period (1860s–1945). **Prerequisite:** Permission of instructor.

**A A H 632:** Twentieth Century Art II, 3 cr. (3 and 0)
Trends in art and architecture since World War II. Specific artists, artworks and movements will be presented in a socio-historic context with specific emphasis on the transition from a late-modernist to a post-modern perspective. **Prerequisite:** Permission of instructor.

**A A H 635:** Studies in Precolumbian Art and Architecture, 3 cr. (3 and 0)
Familiarizes student with the art and architecture of the Western Hemisphere's Precolumbian culture in Mexico, Central and South America. **Prerequisites:** A A H 102 or 210 or permission of instructor.
A A H 815: Art and Architectural History Seminar I, 3 cr. (3 and 0)
Particular aspect of period of art/architectural history. Prerequisite: Permission of instructor.

A A H 816: Art and Architectural History Seminar II, 3 cr. (3 and 0)
Continuation of A A H 815.

SCHOOL OF HUMANITIES

English

R. Barton Palmer, Chair, Department of English
Mark J. Charney, Director of Graduate Studies

<table>
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<th>Major</th>
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<tr>
<td>English</td>
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An applicant for the M.A. degree in English must present at least 12 semester credits of undergraduate English courses beyond the sophomore level; for the M.Ed. degree in secondary education with emphasis in English, an applicant must present at least nine. Entrance credits should include one course each above the sophomore level in Shakespeare and in English and American literature; students deficient in these may seek provisional admission.

M.A. students complete 25 semester credits of approved graduate courses and write a thesis, which may be developed with the approval of the Graduate Committee, from any interest area covered by the M.A. program. The nonthesis option requires 37 credits. All English M.A. students must demonstrate a reading knowledge of an approved foreign language.

At the core of the M.A. program is a 10-hour requirement, including ENGL 800 and one course from each of the following groups:

1. British literature — ENGL 805, 808, 811, 814 or an appropriate 831;
2. American literature — ENGL 820, 823 or an appropriate 831;
3. Language and composition — ENGL 665 (required of graduate teaching assistants), 801, 802, 803, 832, 835, 837 or an appropriate 831;

M.Ed. students in secondary education with emphasis in English complete a total of 37 graduate credits, including ENGL 685 and 800.

Candidates for the M.A. and M.Ed. degrees also must demonstrate proficiency in composition and pass a comprehensive oral examination.

ENGL 600: The English Language, 3 cr. (3 and 0)
Studies in English usage and historical development of the language. Prerequisite: Sophomore literature.

ENGL 601: Grammar Survey, 3 cr. (3 and 0)
Survey of modern grammars, focusing on the impact of structural grammar on traditional grammar. Recommended for English teachers. Prerequisite: Sophomore literature.

ENGL 603: The Classics in Translation, 3 cr. (3 and 0)
Examination of Homer's Iliad and Odyssey, Virgil's Aeneid and Ovid's Metamorphoses. Shorter works by other Greek and Roman writers may also be read. Prerequisite: Sophomore literature.

ENGL 604: Classical Drama, 3 cr. (3 and 0)
Selected reading convey the dramatic literature of classical Greece and Rome. Prerequisite: Sophomore literature.

ENGL 605: Studies in English Literature to 1700, 3 cr. (3 and 0)
Selected reading covers literature from the beginnings to 1700, with emphasis on social and intellectual backgrounds. Prerequisite: Sophomore literature.

ENGL 606: Studies in English Literature Since 1700, 3 cr. (3 and 0)
Selected reading covers literature from 1700 to the present, with emphasis on social and intellectual backgrounds. Prerequisite: Sophomore literature.

ENGL 607: The Medieval Period, 3 cr. (3 and 0)
Selected works of Old and Middle English literature, excluding Chaucer. Prerequisite: Sophomore literature.

ENGL 608: Chaucer, 3 cr. (3 and 0)
Selected readings in Middle English from The Canterbury Tales and other works by Chaucer. Prerequisite: Sophomore literature.

ENGL 609: The Earlier English Renaissance, 3 cr. (3 and 0)
Tudor and Elizabethan poetry, prose, fiction, translations, essays and criticism. Prerequisite: Sophomore literature.

ENGL 610: Drama of English Renaissance, 3 cr. (3 and 0)
Selected readings in non-Shakespearean dramatic literature of the 16th and 17th centuries. Prerequisite: Sophomore literature.

ENGL 611: Shakespeare, 3 cr. (3 and 0)
Selected tragedies, comedies and history plays of Shakespeare. Required of all English majors. Prerequisite: Sophomore literature.

ENGL 613: Later English Renaissance, 3 cr. (3 and 0)
Nondramatic poetry and prose by Ben Jonson, John Donne and Francis Bacon through Andrew Marvell and John Bunyan, excluding Shakespeare and Milton. Prerequisite: Sophomore literature.

ENGL 614: Milton, 3 cr. (3 and 0)
The development of Milton's art and thought from the minor poems and selected prose through Paradise Lost, Paradise Regained and Samson Agonistes, set against the background of the late Renaissance. Prerequisite: Sophomore literature.

ENGL 615: The Restoration and Eighteenth Century, 3 cr. (3 and 0)
Readings in Dryden, Swift, Pope and Dr. Johnson. Prerequisite: Sophomore literature.

ENGL 616: The Romantic Period, 3 cr. (3 and 0)
Poetry and critical prose of Blake, Wordsworth, Coleridge, Byron, Shelley, Keats and other representative figures. Prerequisite: Sophomore literature.

ENGL 617: The Victorian Period, 3 cr. (3 and 0)
Poetry and nonfiction prose of selected Victorian authors, including works of Carlyle, Tennyson, Browning, Arnold and other representative figures. Prerequisite: Sophomore literature.

ENGL 618: The English Novel, 3 cr. (3 and 0)
Study of the English novel from its 18th century beginnings through the Victorian period. Prerequisite: Sophomore literature.

ENGL 622: American Literature I, 3 cr. (3 and 0)
Major American authors and movements from the Colonial period to the Civil War. Prerequisite: Sophomore literature.

ENGL 623: American Literature II, 3 cr. (3 and 0)
Major American authors and movements from the Civil War to the early 20th century. Prerequisite: Sophomore literature.

ENGL 624: American Literature III, 3 cr. (3 and 0)
Major American authors and movements of the 20th century. Prerequisite: Sophomore literature.

ENGL 625: The American Novel, 3 cr. (3 and 0)
Survey of the most significant forms and themes of the American novel from its beginnings to 1900. Prerequisite: Sophomore literature.

ENGL 626: Southern Literature, 3 cr. (3 and 0)
Intellectual and literary achievement of the South from 1607 to the present, with emphasis upon the writers of the 19th and 20th centuries. Prerequisite: Sophomore literature.

ENGL 630: Modern Drama, 3 cr. (3 and 0)
Principles and progress of drama from Ibsen to the present; analysis of representative plays; critical reports; discussion of trends in contemporary drama. Prerequisite: Sophomore literature.

ENGL 631: Modern Poetry, 3 cr. (3 and 0)
The modern tradition in English and American poetry from Yeats to the present; relevant critical essays. Prerequisite: Sophomore literature.
ENGL 632: Modern Fiction, 3 cr. (3 and 0)
American and British novels and short stories of the 20th century. Prerequisite: Sophomore literature.

ENGL 633: The Anglo-Irish Literary Tradition, 3 cr. (3 and 0)
Exploration of the unique literary heritage and achievement of English-language Irish writers in the 19th and 20th centuries. Major figures: W.B. Yeats, James Joyce, Samuel Beckett and other writers; consideration of the Irish aspects of their works. Prerequisite: Sophomore literature.

ENGL 634: Environmental Literature, 3 cr. (3 and 0)
Survey of literature that examines the relationship between human beings and the natural world, including analysis of environmental themes in myths and legends and in selected poetry and prose of 19th and 20th century England and America. Prerequisite: Sophomore literature or permission of instructor.

ENGL 635: Literary Criticism, 3 cr. (3 and 0)
Major critical approaches to literature. Prerequisite: Sophomore literature.

ENGL 636: Feminist Literary Criticism, 3 cr. (3 and 0)
Introduction to the seminal works of feminist literary theory and criticism. Outlines the development of modern literary criticism by studying feminist versions of the major critical methodologies. Prerequisite: Sophomore literature or permission of instructor.

ENGL 637: Directed Studies, 1-3 cr. (1-3 and 0)
Class and tutorial work for students with special interests or projects in American, British or European literature outside the scope of existing courses. Applications must be approved during the early registration period of the semester preceding the one in which directed studies will occur. May be repeated by arrangement with the department. Prerequisite: Junior standing and approved registration.

ENGL 645: Fiction Workshop, 3 cr. (3 and 0)
Workshop in the creative writing of prose fiction. May be repeated once for credit. Prerequisite: ENGL 345 or permission of instructor.

ENGL 646: Poetry Workshop, 3 cr. (3 and 0)
Workshop in the creative writing of poetry. May be repeated once for credit. Prerequisite: ENGL 346 or permission of instructor.

ENGL 648: Screenwriting Workshop, 3 cr. (2 and 3)
Workshop in the creative writing of screenplays. May be repeated once for credit. Prerequisite: ENGL 348 or permission of instructor.

ENGL 647: Playwriting Workshop, 3 cr. (3 and 0)
Workshop in the creative writing of plays. May be repeated once for credit. Prerequisite: THEA (ENGL) 347.

ENGL 650: Film Genres, 3 cr. (2 and 3)
Advanced study of films that have similar subjects, themes and techniques, including such genres as the Western, horror, gangster, science fiction, musical and/or screwball comedy, nontraditional genres, screen irony, genre theory and historical evolution of genres. Topics vary. Prerequisite: ENGL 357 or permission of instructor.

ENGL 651: Film Theory and Criticism, 3 cr. (2 and 3)
Advanced study into the theory of film/video making with an emphasis on understanding a variety of critical methods to approach a film; history of film theory; defines the many schools of film criticism, including realism, formalism, feminism, semiotics, Marxism and expressionism. Prerequisite: ENGL 357 or permission of instructor.

ENGL 652: Great Directors, 3 cr. (2 and 3)
Intensive study of one to three film directors with an emphasis on understanding the entire canon of each director; similarities in techniques; shifts in thematic emphasis; critical methodologies for approaching the works of each director. Topics vary. Prerequisite: ENGL 357 or permission of instructor.

ENGL 653: Sexuality and the Cinema, 3 cr. (2 and 3)
Male/female sexual roles and their evolution in American genre films, avant-garde cinema and international films; movies in relation to cultural values and social stereotypes; feminist film theory; film pornography. Prerequisite: ENGL 357 or permission of instructor.

ENGL 655: American Humor, 3 cr. (3 and 0)
Native American humor of the 19th and 20th centuries. Prerequisite: Sophomore literature.

ENGL 656: Literature and the Holocaust, 3 cr. (3 and 0)
The Holocaust through literature, art, architecture, music and film, beginning with historical, political and economic forces that contributed to the Holocaust. Focus on highly diverse creative responses to this event—responses that often reflect the difficulties and politics of these commemorative gestures. Prerequisite: Sophomore literature or permission of the instructor.

ENGL 659: Advanced Special Topics in Language, Literature or Culture, 3 cr. (3 and 0)
Advanced studies in topics not central to other English courses, such as certain authors, works, genres, themes or areas of knowledge and culture. Specific topics will be announced when offered. May be repeated once for credit with department chair's permission. Prerequisite: Sophomore literature.

ENGL 675: Writing for Media, 3 cr. (3 and 0)
Workshop in new forms of writing and hypertextual design for interactive electronic media. May be repeated once for credit at the undergraduate level. Prerequisite: Sophomore literature or permission of instructor or graduate standing.

ENGL 682: African American Fiction and Nonfiction, 3 cr. (3 and 0)
Forms and genres of African American prose including the novel, short fiction, autobiography, nonfiction and oratory with emphasis on emerging theories about African American culture and its impact on American cultural life in general. Prerequisite: Sophomore literature.

ENGL 683: African American Poetry, Drama and Film, 3 cr. (3 and 0)
Forms, themes and genres of African American poetry, drama and film with emphasis on emerging theories about African American culture and its impact on American cultural life in general. Prerequisite: Sophomore literature.

ENGL 685: Composition for Teachers, 3 cr. (3 and 0)
Practical training in teaching composition: finding workable topics, organizing and developing observations and ideas, evaluating themes and creative writing. Prerequisite: Sophomore literature.

ENGL 690: Advanced Technical and Business Writing, 3 cr. (3 and 0)
Advanced work in writing proposals, manuals, reports and publishable articles. Students will produce work individually and in groups. Prerequisite: ENGL 304 or 314 or permission of instructor.

ENGL 691: Classical Rhetoric, 3 cr. (3 and 0)
Major texts in classical rhetoric; nature and functions of rhetoric in Greek and Roman societies; development of rhetoric from Protagoras through Isocrates, Plato, Aristotle, Cicero and Quintilian; questions essential to understanding persuasive theory and practice. Prerequisite: Sophomore literature or permission of instructor.

ENGL 692: Modern Rhetoric, 3 cr. (3 and 0)
The "new rhetorics" of the 20th century, which are grounded in classical rhetoric but include findings from biology, psychology, linguistics and anthropology, among other disciplines; theories and applications of communication. Prerequisite: Sophomore literature or permission of instructor.

ENGL 694: Writing about Science, 3 cr. (3 and 0)
Advanced work in writing and editing for peer and lay audiences. Prerequisites:
ENGL 304, 314 or permission of instructor.

ENGL 695: Technical Editing, 3 cr. (3 and 0)
Practical experience in editing and preparing technical manuscripts for publication. General introduction to the functions of the technical editor. Prerequisite: ENGL 304, 314 or permission of instructor.

ENGL 700: Children’s Literature for Teachers, 3 cr. (3 and 0)
Literature for preschool through junior high.

ENGL 702: Writing Projects, 3 cr. (3 and 0)
Exchange and development of methods for teaching writing that have a firm theoretical foundation.

ENGL 800: Introduction to Research, 1 cr. (1 and 0)
Literary history and research; use of libraries and bibliographical tools; exposition of scholarship. Required of all candidates for the Master of Arts degree and Master of Education degree with a concentration in secondary education, English.

ENGL 801: Topics in Composition, 3 cr. (3 and 0)
Principal theories and practices in modern grammar, stylistics and semantics related to teaching composition.

ENGL 802: Topics in Literary Genres, 3 cr. (3 and 0)
Principal literary genres.

ENGL 803: Topics in Rhetorical Theory, 3 cr. (3 and 0)
Major rhetorical theories, figures and historical movements.

ENGL 805: Topics in Medieval Literature, 3 cr. (3 and 0)
Principal works in verse and prose from c. 1100-1500.

ENGL 808: Topics in Renaissance and Restoration Literature, 3 cr. (3 and 0)
Principal works in verse and prose from c. 1500-1700.

ENGL 811: Topics in Neoclassic and Romantic Literature, 3 cr. (3 and 0)
Principal works in verse and prose from c. 1700-1832.

ENGL 814: Topics in Victorian and Modern British Literature, 3 cr. (3 and 0)
Principal works in verse and prose from c. 1832 to present.

ENGL 820: Topics in American Literature to 1865, 3 cr. (3 and 0)
Significant authors; works in poetry and prose; literary-intellectual movements such as Puritanism, the enlightenment, romanticism and transcendentalism from c. 1607-1865.

ENGL 823: Topics in American Literature Since 1865, 3 cr. (3 and 0)
Significant authors; works in poetry and prose; literary-intellectual movements such as realism, naturalism, modernism and postmodernism from 1865 to the present.

ENGL 831: Special Topics, 3 cr. (3 and 0)
Topics not covered in other courses.

ENGL 832: Topics in Scientific, Technical and Business Writing, 3 cr. (3 and 0)
Seminar courses in areas such as professional editing and publishing, writing for government and industry, teaching technical writing, and writing for journals, magazines and newspapers.

ENGL 833: Rhetoric of Science, 3 cr. (3 and 0)
Rhetorical approaches to understanding science and scientific rhetorics.

ENGL 834: Usability Testing Methodologies in Professional Communication, 3 cr. (3 and 0)
Research methodologies used in testing the usability of professional communication.

ENGL 835: Topics in Literary Criticism, 3 cr. (3 and 0)
Principal statements of literary critics from the classical era to the present.

ENGL 836: Digital Publishing Technologies: Theories in Practice, 3 cr. (3 and 0)
User-centered design theories applied to multimedia interfaces and online documents for professional communicators.

ENGL 838: Global Professional Communication, 3 cr. (3 and 0)
Implications of professional communication in a global economy; theories of global professional communication; research methods for studying communication in the global workplace; models for global communicative practices.

ENGL 839: Writing Proposals and Grant Applications, 3 cr. (3 and 0)
Practice in reading requests for proposals, analyzing rhetorical contexts and theories of proposals, and writing proposals and grant applications.

ENGL 840: Selected Topics, 3 cr. (3 and 0)
Tutorial work in linguistics or American, British or European literature not offered in other courses. Prerequisite: Permission of director of graduate studies.

ENGL 850: Research and Studies in Scientific, Business and Technical Writing, 3 cr. (3 and 0)
Theories of professional communication and methods of inquiry; readings and research into the ways that the writing of professionals creates new knowledge and affects the daily life of others; research methods emphasize humanistic inquiry. Prerequisite: Graduate standing.

ENGL 851: Seminar in Professional Writing, 3 cr. (3 and 0)
Advanced seminar in the principles and practice of writing and editing documents for government, industry and the sciences; students produce projects suitable for publication, typically chosen from document design, scientific and technical journals, and public policy writing. Prerequisite: Graduate standing.

ENGL 852: Rhetoric and Professional Communication, 3 cr. (3 and 0)
Theories of communication that have existed since classical times and that inform effective decision-making strategies in professional communication. Prerequisite: Graduate standing.

ENGL 853: Visual Communications, 3 cr. (3 and 0)
Understanding the language of images used in textual and extratextual communication; theories of perception, methods of visual persuasion, gender analysis, and cognitive and aesthetic philosophies of visual rhetoric. Prerequisite: Graduate standing.

ENGL 854: Teaching Professional Writing, 3 cr. (3 and 0)
Teaching professional writing and examining theories and practices of written, graphic and oral communication; students prepare course descriptions, rationales and syllabi for teaching various forms of business, scientific and technical writing. Prerequisite: Graduate standing.

ENGL 856: Theories and Practices of Workplace Communication, 3 cr. (3 and 0)
Workplace cultures and their theoretical and practical applications for professional communication. Prerequisite: Graduate standing.

ENGL 860: The Rhetoric of Web Publishing, 3 cr. (3 and 0)

ENGL 885: Composition Theory, 3 cr. (3 and 0)
Teaching college-level courses, stressing contemporary composition theory, research and practice. Prerequisite: Graduate standing.

ENGL 886: Composition Practicum, 1 cr. (1 and 0)
Problems in teaching Composition I and Composition II, with focus on translating theoretical concepts into creating assignments, designing curriculum and grading. Two-semester sequence to be taken fall and spring of teaching assistantship year. Does not count toward degree. Prerequisites: Graduate teaching assistantship and ENGL 885 or equivalent.
ENGL 891: Master's Thesis Research, credit to be arranged

ENGL 892: Master's Project, 1-3 cr.
Required for the nonthesis option of the M.A. in professional communication; completion of course requires writing a document for the professional world and keeping a log or journal as a record of the project; student presents the project to advisor(s). Credit to be arranged. A maximum of three credits may be counted toward the degree.

SPCH 664: Advanced Organizational Communication, 3 cr. (3 and 0)
Application of speech communication methodology to the analysis of organizational communication processes. Students study methods of organizational communication analysis and intervention. Prerequisite: SPCH 364 or permission of instructor.

WS 659: Selected Topics in Women's Studies, 1-3 cr. (1-3 and 0)
Selected topics in women's studies. Topics will change from semester to semester and will be announced prior to registration. May be repeated for a maximum of 6 credits but only if a different topic is covered.

HIST 600: Studies in United States History, 3 cr. (3 and 0)
Topics and problems in the history of the United States from the Colonial era to the present.

HIST 638: Problems in African Historiography and Methodology, 3 cr. (3 and 0)
Concentration on African history with focus on methodological concerns.

HIST 640: Studies in Latin American History, 3 cr. (3 and 0)
Selected and varied topics in Latin American history through readings, class discussions and individual or group projects. Special attention will be given to the use of an inquiry or problem-solving method of historical analysis and to the cultivation of a comparative perspective.

HIST 650: Studies in Ancient History, 3 cr. (3 and 0)
Selected topics in the field of ancient history ranging from pre-Biblical times to the fall of the Roman Empire.

HIST 660: Studies in British History, 3 cr. (3 and 0)
Selected themes, topics or periods in British history from Anglo-Saxon times to the present.

HIST 670: Studies in Early European History, 3 cr. (3 and 0)
Selected topics or themes in European history from the fall of the Roman Empire to the Industrial Age.

HIST 671: Studies in Modern European History, 3 cr. (3 and 0)
Selected topics or problems in European history from the end of the Old Regime to the present.

HIST 691: Studies in the History of Science and Technology, 3 cr. (3 and 0)
Selected topics in the development of science and technology, with emphasis on their social, political and economic effects.

HIST 692: Studies in Diplomatic History, 3 cr. (3 and 0)
Selected topics and problems in international conflict and conflict resolution among nations. Concentration on 20th century history.

HIST 693: Studies in Social History, 3 cr. (3 and 0)
Ways people have earned their livings and lived their lives, individually and as communities, in the confines of different societies.

HIST 694: Studies in Comparative History, 3 cr. (3 and 0)
Selected topics in comparative history, contrasting and comparing similar historical developments in different nations, geographic areas or civilizations.

HIST 695: Studies in the History of Ideas, 3 cr. (3 and 0)
Selected topics and themes in the development of ideas that have had an impact on the behavior of individuals and civilizations.

HIST 696: Studies in Legal History, 3 cr. (3 and 0)
Selected problems in the development of law and the system of criminal and civil justice.

HIST 710: United States Since 1865, 3 cr. (3 and 0)
Problems in U.S. history since 1865 with attention given to bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.

HIST 775: Europe Since the 18th Century, 3 cr. (3 and 0)
Problems in European history since 1700 with attention given to bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.

HIST 800: Seminar in United States History, 3 cr. (3 and 0)
Training in historical research and writing. May be repeated for credit with approval of graduate program director.

HIST 830: Seminar in Asian History, 3 cr. (3 and 0)
Training in historical research and writing with focus on Asian history. May be repeated for credit with approval of graduate program director.

HIST 840: Seminar in Latin American History, 3 cr. (3 and 0)
Training in historical research and writing with focus on Latin American history. May be repeated for credit with approval of graduate program director.

HIST 860: Seminar in British History, 3 cr. (3 and 0)
Training in historical research and writing. May be repeated for credit with approval of graduate program director.

HIST 870: Seminar in European History, 3 cr. (3 and 0)
Training in historical research and writing. May be repeated for credit with approval of graduate program director.

HIST 880: Special Topics in History, 3 cr. (3 and 0)
Training in historical research and writing. May be repeated for credit with approval of graduate program director.

HIST 881: Historiography, 3 cr. (3 and 0)
Seminar discussion of contemporary approaches and methodologies used by historians; exploration of current debates over major issues confronting the discipline of history.

HIST 885: Independent Study, 3 cr. (3 and 0)
Critical study of a historical topic, selected according to needs of student and with approval of graduate program director. May be repeated for credit with approval of the graduate program director.
HIST 887: Archival Management: An Introduction, 3 cr. (3 and 0)
Introduction to basic concepts of archival theory and management.

HIST 891: Master's Thesis Research, credit to be arranged

HIST 893: Practicum in Archival Management, 3 cr. (0 and 9)
Hands-on experience in the operations of an archival program, including acquisitions, arrangements, descriptions, conservation and reference service. Prerequisite: HIST 887 or permission of instructor.

HIST 894: Practicum in Historical Editing, 3 cr. (3 and 0)
Practicum for applying methodologies learned in introductory editing course to a specific body of original sources such as family correspondence, diaries or journals in order to become a historical editor. Prerequisite: HIST 888.

GEOG 601: Studies in Regional Geography, 3 cr. (3 and 0)
Geography of selected world regions, such as North America, Europe, the Middle East or the geography of a topic such as the geography of oil or the geography of underdevelopment. With departmental permission, may be repeated once for credit. Prerequisite: GEOG 101 or 103 or permission of instructor.

GEOG 610: Geography of the American South, 3 cr. (3 and 0)
Geography of the American South in its changing complexities of almost 400 years of development. Prerequisite: GEOG 101 or 103 or permission of instructor.

GEOG 620: Historical Geography of the United States, 3 cr. (3 and 0)
Survey that places the spatial concepts of geography into a time sequence with emphasis on the United States. Prerequisite: GEOG 101 or 103 or permission of instructor.

GEOG 630 (PRTM 630): World Geography of Parks and Equivalent Reserves, 3 cr. (3 and 0)
Major international patterns in the provision and use of urban and rural parks and recreation.

GEOG 710: Teaching Geography, 3 cr. (3 and 0)
Investigates world regions as a set of problems posed to teachers of geography; comparative analysis of basic geographic concepts. Oriented to public school teachers of geography.

LANG 600: Phonetics, 3 cr. (3 and 0)
Basic phonetic concepts used in the study of sounds and language.

FR 699: Selected Topics in French Literature, 3 cr. (3 and 0)
Selected topics that have characterized French literature, language and culture. May be repeated for a maximum of six credits. Prerequisite: Permission of department chair.

GER 698: Independent Study, 1-3 cr. (1-3 and 0)
Selected topics in German literature, language or culture. May be repeated for a maximum of six credits. Prerequisite: Permission of department chair.

SPAN 699: Spanish Literature, Language and Culture, 3 cr. (3 and 0)
Selected topics and themes that have characterized Spanish literature, language and culture throughout the centuries. May be repeated for a maximum of six credits. Prerequisite: Permission of department chair.

Three special courses are offered in French, German and Spanish for graduate students preparing for the language examination.

FR 151: French for Graduate Students, 3 cr. (3 and 0)
Intensive program only for graduate students preparing for the reading examination in French. A minimum grade of B on final exam will satisfy graduate school foreign language requirement. Graded on a pass/fail basis. May be repeated once for credit. Prerequisite: Graduate standing.

GER 151: German for Graduate Students, 3 cr. (3 and 0)
Intensive program only for graduate students preparing for the reading examination in German. A minimum grade of B on final exam will satisfy graduate school foreign language requirement. Graded on a pass/fail basis. May be repeated once. Prerequisite: Graduate standing.

SPAN 151: Spanish for Graduate Students, 3 cr. (3 and 0)
Intensive program only for graduate students preparing for the reading examination in Spanish. A minimum grade of B on final exam will satisfy graduate school foreign language requirement. Graded on a pass/fail basis. May be repeated once. Prerequisite: Graduate standing.

PHIL 601: Studies in the History of Philosophy, 3 cr. (3 and 0)
Selected philosopher, philosophical school or movement. Topics will vary. Course may be repeated once for credit with departmental permission. Prerequisite: Permission of instructor.

PHIL 602: Topics in Philosophy, 3 cr. (3 and 0)
Particular philosophical topic, issue or problem. Topics will vary. Course may be repeated once for credit with departmental permission. Prerequisite: Permission of instructor.

PHIL 825: Advanced Studies in the Philosophy of Science, 3 cr. (3 and 0) F
Inquiry into the conceptual foundations of empirical science, in particular, the often tacit presuppositions of substantive and methodological assumptions shared by a scientific community.

PHIL 845: Aesthetics, 3 cr. (3 and 0)
Nature and value of aesthetic experiences and objects. Attention directed to the roles of and relationships among objects, makers and audiences; interpretation, criticism and aesthetic response; the contexts and languages of art; the nature of aesthetic value; aesthetics in application -- issues in public policy.

REL 601: Studies in Biblical Literature and Religion, 3 cr. (3 and 0)
Selected topic in biblical studies. Topics will vary from year to year. May be repeated once for credit. Prerequisite: Permission of instructor.

REL 602: Studies in Religion, 3 cr. (3 and 0)
Selected topic in one or more of the religious traditions of the world or of religious life in a particular region. Topics will vary from year to year. May be repeated once for credit. Prerequisite: Permission of instructor.

Professional Communication

The Department of English offers a Master of Arts degree in professional communication. The program combines work in theory and research with a comprehensive emphasis on written, oral and visual communication. It prepares graduate students as professional and technical communicators in industry and government and as teachers of professional communication in two-year colleges. In addition, the program provides the background necessary for students who plan to pursue a Ph.D. in rhetoric or technical communication. This degree is designed for students with strong writing skills from all academic disciplines. The program accommodates students with undergraduate majors in technical and scientific fields, as well as those with humanities and business degrees.

The Campbell Chair in Technical Communication, the Pearce Center for Professional Communication and the Effective Technical Communication program in engineering constitute a network of professors enabling students to work in professional communication in a variety of academic disciplines. The pro-
gram also uses Clemson's expertise in agriculture and natural resources, architecture, city and regional planning, engineering, textiles, and basic science and technologies. The Document Design Laboratory has Macintosh and IBM capabilities, and students have access to the newest computing hardware and software, including word processing, desktop publishing and graphic design.

Requirements for Awarding of a Degree

The M.A. in professional communication requires 30 credit hours beyond the B.A. or B.S. degree, to be distributed as follows:

1. Five core courses which include Research and Studies in Scientific, Business, and Technical Writing (ENGL 850), Seminar in Professional Writing (ENGL 851), Theories of Rhetoric and Professional Communication (ENGL 852), Visual Communications (ENGL 853) and Theories and Practices of Workplace Communication (ENGL 856) or Advanced Organizational Communication (SPCH 664).

2. Two or three electives from a list of recommended courses, structuring the program to meet professional goals. Possible electives include, but are not limited to, the following: Topics in Rhetorical Theory (ENGL 803), Teaching Professional Writing (ENGL 854), Modern Rhetoric (ENGL 692) and Technical Editing (ENGL 695).

3. Two cognate courses in a related discipline to tailor the degree to meet specific career goals. Possible cognate courses include, but are not limited to, the following: Human Factors Psychology (PSYCH 635), Instructional Systems Design (HR D 647), Instructional Video Production (HR D 665), Directed Studies (ART 690) and Marketing Research (MKT 631).

4. Candidates must demonstrate a reading knowledge of a foreign language and pass a qualifying examination on a reading list before undertaking the required thesis or project.

5. Students choose either to write a thesis based on research and a thorough analysis of a problem in professional communication, offering a solution; or complete a project to write a document for the professional world and keep a log or journal as a record of the project's progress.

Admission Requirements

Applicants must hold a degree in any field from an accredited college or university, with a 3.0 GPR on a four-point scale; submit a satisfactory score on the GRE general test; submit two letters of recommendation from individuals familiar with the candidate's academic work and/or work experience; and submit a brief résumé and an autobiographical essay of not more than 500 words discussing educational goals and demonstrating proficiency for a writing program.

Courses for this program are offered by the Department of English.
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<th>College of Business and Public Affairs</th>
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</table>
The College of Business and Public Affairs offers advanced degrees in these areas of study:

Accounting
Applied Economics*
Business Administration
Economics
Industrial Management
Management Science**
Sociology
Political Science
Psychology
Public Administration

Courses are offered in finance, graphic communications, hospital administration, law and marketing to provide electives for students in other areas.

Graduate programs in the College of Business and Public Affairs provide a wide range of opportunities for professional careers in business, industry, government and education.

Several graduate programs are offered jointly or in cooperation with other departments and universities. The applied economics program is a cooperative effort with the Department of Agricultural and Applied Economics in the College of Agriculture, Forestry and Life Sciences. The Master of Public Administration is taught jointly by faculty from the Department of Political Science at Clemson University and the Department of Government and International Relations at the University of South Carolina. The Ph.D. program in management science is administered jointly by the Department of Management and the Department of Mathematical Sciences in the College of Engineering and Science.

*S This program is a cooperative effort between the Department of Agricultural and Applied Economics (College of Agriculture, Forestry and Life Sciences) and the Department of Economics. The Department of Agricultural and Applied Economics is responsible administratively for the Ph.D. program, and the degree is awarded by the College of Agriculture, Forestry and Life Sciences.

**This program is administered jointly by the Department of Management and the Department of Mathematical Sciences (College of Engineering and Science). The Ph.D. degree is awarded by the College of Business and Public Affairs.

SCHOOL OF ACCOUNTANCY AND LEGAL STUDIES

| Accounting | Ralph E. Welton, Jr., Director, School of Accountancy and Legal Studies |
| Major | Degree |
| Accounting | M.P.Acc. |

The Master of Professional Accountancy degree program prepares students for positions in industrial, commercial, governmental, financial or public accounting. The program requires 33 semester hours and is open to students with appropriate backgrounds. The program accommodates both full- and part-time students. In addition to the on-campus program, the program is offered to part-time students at the University Center in Greenville, S.C. Full-time students are able to complete the program in one calendar year. Part-time students on campus or in Greenville can complete the program in three years. The program recognizes the rapid pace of change in accounting resulting from technological advances in managing data, the theory and practice of management, and increases in the volume and scope of authoritative pronouncements from the FASB, SEC and IRS. The program is accredited by the American Assembly of Collegiate Schools of Business.

Applicants should hold a bachelor's degree from an institution whose scholastic rating is acceptable to the Graduate Admissions Committee of the School of Accountancy and Legal Studies. Admission to the program is based on academic record and score on the Graduate Management Admission Test (GMAT). Letters of recommendation and relevant work experience also may be considered. Applicants should have completed a basic business core of at least 30 semester hours, as well as the following accounting prerequisites: Intermediate Accounting (at least six semester hours), Cost Accounting (three semester hours), Tax (three semester hours), Auditing (three semester hours) and Accounting Information Systems (three semester hours). An undergraduate microcomputer applications course is highly recommended.

ACCT 604: Individual Taxation, 3 cr. (3 and 0)
Interpretation of federal income tax laws, regulations and court decisions with practice in application of these laws to the returns of individuals, partnerships and corporations. Prerequisite: ACCT 202 or 203 with permission of instructor.

ACCT 801: Contemporary Financial Accounting Theory, 3 cr. (3 and 0)
Development of accounting theory from its origin to the present; currently advocated pronouncements of professional accounting societies. Prerequisite: ACCT 302 or equivalent.

ACCT 802: Auditing Seminar, 3 cr. (3 and 0)
In-depth study of the Professional Standard for independent auditors; taught by the case method and includes a discussion of contemporary auditing problems and cases. Prerequisite: ACCT 415 or equivalent.

ACCT 803: Accounting Information Systems, 3 cr. (3 and 0)
Accounting systems including database concepts, systems design and evaluation, systems controls and systems implementation. Prerequisites: ACCT 302 and 303 or equivalent.

ACCT 804: The Environment of Accounting, 3 cr. (3 and 0)
Professional, legislative, judicial and social environments in which the accounting profession operates. Prerequisite: ACCT 415 or equivalent.

ACCT 806: Advanced Accounting Problems, 3 cr. (3 and 0)
Specialized aspects of financial accounting including business combinations accounting and reporting practices of regulated and non-regulated industries, emerging practices and developments in financial accounting, fund accounting, and corporate reorganizations and liquidations. Prerequisite: ACCT 302 or equivalent.

ACCT 807: Advanced Auditing Techniques, 3 cr. (3 and 0)
Auditing and control techniques in an EDP environment including statistical sampling techniques used by auditors and the auditor's use of microcomputers. Prerequisite: ACCT 415 or equivalent.

ACCT 814: Taxation of Business Entities, 3 cr. (3 and 0)
The interrelationship of taxation and business decisions; designed for students not specializing in taxation. Prerequisite: ACCT 404 or equivalent.

ACCT 815: Federal and State Income Taxation of Corporations, 3 cr. (3 and 0)
Tax principles and concepts involved in corporate-shareholder transactions, tax planning of corporations, Subchapter C and related provisions of the Internal Revenue Code. Prerequisite: ACCT 404 or equivalent.

ACCT 816: Taxation of Estates, Gifts and Fiduciaries, 3 cr. (3 and 0)
Federal estate and gift tax laws; federal income tax laws related to trusts and estates. Prerequisite: ACCT 404 or equivalent.

ACCT 817: Tax Research, 3 cr. (3 and 0)
Tax research methodology as applied to the solution of routine and complex tax problems emphasizing the methodology.
of solution rather than a specific tax area.  
**Prerequisite:** ACCT 404 or equivalent.

**ACCT 818: Taxation of Partnerships,** 3 cr. (3 and 0)  
Tax principles and concepts involved in partnership transactions, tax planning and tax shelters. **Prerequisite:** ACCT 404 or equivalent.

**ACCT 819: Current and Special Topics in Taxation,** 3 cr. (3 and 0)  
Specialized and contemporary topics in federal taxation and tax practice. **Prerequisite:** ACCT 404 or equivalent.

**ACCT 820: Advanced Topics and Planning in Taxation,** 3 cr. (3 and 0)  
Planning element for federal and state taxes in business decisions including current, sophisticated developments in taxation. **Prerequisite:** ACCT 819 or permission of instructor.

**ACCT 821: Controllership,** 3 cr. (3 and 0)  
Advanced internal accounting emphasizing accounting information for management decision making. **Prerequisite:** ACCT 303 or equivalent.

**ACCT 824: Advanced Managerial Accounting,** 3 cr. (3 and 0)  
Current developments in cost and managerial accounting emphasizing theories, applications, and the behavioral impact of internal accounting data; completion of a field project required. **Prerequisite:** ACCT 410 or permission of instructor.

**ACCT 830: Governmental and Not-for-Profit Accounting,** 3 cr. (3 and 0)  
Fund accounting and financial reporting for governments and other not-for-profit organizations; managerial control issues in the not-for-profit environments. **Prerequisites:** ACCT 202 or 203 and permission of instructor.

**ACCT 840: Internal Auditing Seminar,** 3 cr. (3 and 0)  
Advanced topics in internal auditing theory and practice using case studies and readings. **Prerequisite:** ACCT 340 or 415 or equivalent.

**ACCT 845: Operational Auditing Seminar,** 3 cr. (3 and 0)  
Management control and operational systems, opportunities for improvement and development of practical and cost effective solutions to managerial problems using selected readings from case studies and industry monographs provided by the Institute of Internal Auditing. **Prerequisite:** ACCT 340 or 415 or permission of instructor.

**LAW 605: Construction Law,** 3 cr. (3 and 0)  
Legal principles applied to the construction process and legal problems likely to be encountered by the practicing construction professional. Topics include construction contracting, liability, claims and warranties, documentation, and responsibilities and authority of contracting parties. **Prerequisite:** LAW 312 or 322 or permission of instructor.

**LAW 629: Environmental Law and Policy,** 3 cr. (3 and 0)  
Legal issues involving environmental law and policy, the law regarding water, land and air pollution, and other special laws such as Superfund and RCRA; consequences of existing and alternative rules for environmental protection are subject to economic analysis. **Prerequisite:** LAW 312 or 322 or permission of instructor.

**LAW 699: Selected Topics,** 1-3 cr. (1-3 and 0)  
In-depth examination of timely topics in legal studies. May be repeated for a maximum of six credits, but only if different topics are covered. **Prerequisite:** Senior standing and permission of instructor.

**SCHOOL OF BUSINESS AND LEADERSHIP**

**Applied Economics**

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<tr>
<td>Gary J. Wells, Chair</td>
<td>Ph.D.</td>
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<tr>
<td>Department of Agricultural and Applied Economics</td>
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See the College of Agriculture, Forestry and Life Sciences for information on this program.

**Business Administration**

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<th>Major</th>
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<td>Martha Duke, Associate Director*</td>
<td>M.B.A.</td>
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The Master of Business Administration degree program is designed for the study of advanced concepts in business, industry and government operations. The program is intended for both the active manager or technical supervisor, as well as the recent graduate interested in advanced business study.

Classes in the M.B.A. program are offered at the Clemson University campus as a full-time day program. Evening classes are offered at the University Center in Greenville, S.C., and Lander University in Greenwood, S.C., as part-time programs. The Clemson campus program is available only for fall entrance and is a full-time, two-year program. The evening M.B.A. programs in Greenville and Greenwood are part-time programs and require a minimum of two years of work experience beyond the bachelor's degree. Separate fee structures apply to the Greenville and Greenwood locations. (See page 17.)

Requirements for the full-time M.B.A. program include 62 semester hours of graduate courses, with two prerequisite courses required of all students: calculus and a basic computer science or computer applications class. Requirements for the evening M.B.A. program also include prerequisite courses in calculus and computer fundamentals depending upon academic background and 33-43 semester hours of graduate courses.

**M B A 802: Managerial Economics,** 3 cr. (3 and 0)  
The functioning of the market economy with emphasis on the role of prices in determining the allocation of resources, the functioning of the firm in the economy and forces governing the production of economic goods. Emphasis is on using economic analysis in managerial decision making. **Prerequisites:** M.B.A. 803 or equivalent or permission of instructor.

**M B A 803: Statistical Analysis of Business Operations,** 3 cr. (3 and 0)  
The role of statistical inference in the decision making of business managers; techniques and proper applications of modern statistical methods in business; univariate and multivariate analysis including analysis of variance, regression and covariance; sample theory and design, basic experimental designs and time series analysis. **Prerequisites:** M.B.A. 818 or equivalent or permission of instructor.

**M B A 804: Managerial Accounting and Information Systems,** 3 cr. (3 and 0)  
Preparation, analysis, interpretation and use of accounting information in the control and a business enterprise. Case material and problems are used. **Prerequisites:** M.B.A. 819 or equivalent or permission of instructor.

**M B A 805: Legal and Social Environment of Business,** 3 cr. (3 and 0)  
Interaction between business and the social, political and legal order. Through analysis of particular situations, attention is focused on the broad effects of the total environment on the administration of business enterprise.

**M B A 806: Operations Management,** 3 cr. (3 and 0)  
Examination of how firms create value and how decisions in the areas of capacity, facilities, technology, vertical integration, work force, quality, production planning/materials control and organization influence a firm's capability to add value; decisions and analysis tools used for these decisions. **Prerequisites:** M.B.A. 819 or equivalent or permission of instructor.

**M B A 807 (FIN 807): Financial Management,** 3 cr. (3 and 0)  
Theory of financial management as it relates to the financial problems faced by business concerns. Concepts developed are used to assess the validity of emerging formalized techniques for improving decision making in the financial area. Topics include financial planning, short- and long-term fund raising, capital budgeting, the administration of working capital, recapitalization, listing of securities and reorganization. Case material and problems are used. **Prerequisites:** M.B.A. 804 or 854 or equivalent and M.B.A. 803 or 853 or equivalent.

*Correspondence for the program at the University Center in Greenville should be addressed to Clemson M.B.A. Program, University Center, PO Box 5616, 216 S. Pleasantburg Dr., Greenville, S.C. 29606, or call (864) 250-8888. Correspondence for the program on the Clemson campus and for classes at Lander University should be addressed to Clemson M.B.A. Program, 124 Shirley Hall, Clemson, S.C. 29634, or call (864) 656-3973. Information on the classes at Lander University can be obtained by calling (864) 388-8787.*
MBA 810: Managerial Policy, 3 cr. (3 and 0)
Decisions involved in the establishment of managerial policy. Problems, resources and alternative courses of action are analyzed and discussed relative to the selection of company objectives and the most feasible means for achieving company goals. Integrates material and treats the coordination of the affairs of the firm as a whole. Case studies are emphasized. This course should be completed as the final course in the program. Prerequisite: MBA 806, 807, 808 and 809.

MBA 811: International Business Management, 3 cr. (3 and 0)
Survey and analysis of economic, managerial and financial aspects of U.S. firms operating abroad including the impact of U.S. and foreign government policies on management. Case studies of specific companies operating abroad are discussed. Prerequisites: MBA 802 and 807 or equivalent.

MBA 812 (FIN 812): Financial Markets and Institutions, 3 cr. (3 and 0) N
Topics critical to the proper management of financial institutions including financial regulation, financial security types and their yields, interest rate theories, interest rate risk management, foreign currency risk management, stock index futures and numerous operating functions in banking. Prerequisite: MBA A/ FIN 807 or MBA A 857 or permission of instructor.

MBA 813: Industrial Relations, 3 cr. (3 and 0) N
Relationship between management and employees, as institutions and as individuals; the role of management and unions in society; issues in labor-management relations. Topics include the issues and processes of collective bargaining, contract negotiation and administration, and dispute resolution; government regulation of labor relations.

MBA 814: Directed Research in Quantitative Analysis, 3 cr. (3 and 0) N
Prerequisite: MBA 829 or equivalent and MBA A 803, 804 and 807; or permission of instructor.

MBA 815: Directed Research in Qualitative Analysis, 3 cr. (3 and 0) N
Prerequisite: MBA 802 or equivalent.

MBA 816: Contracts, Corporate Coordination and Control, 3 cr. (3 and 0) N
Evolution and impact of various property rights institutions on individual behavior and the subsequent use of resources; the importance of property rights structures in the organization of business and in managerial decision making. Prerequisite: MBA 802 or equivalent.

MBA 817: Business Forecasting Techniques and Applications, 3 cr. (3 and 0) N
Forecasting techniques and their application for developing and assessing forecasts. Topics include economic data sources, multiple regression and time series analysis, and the interpretation of forecasts for management and other clients. Prerequisite: MBA 802, 803 or equivalent.

MBA 818: Fundamentals of Statistics and Management Science, 3 cr. (3 and 0)
Introduction to probability distributions, sampling distributions, confidence intervals and hypothesis testing. Introduction to linear programming, sensitivity analysis and simulation. Both statistics and management science applications integrated into existing software packages such as Excel. Prerequisite: Permission of M.B.A. director.

MBA 819: Introduction to Accounting and Finance, 3 cr. (3 and 0)

MBA 820: Business Communications and Ethics, 3 cr. (3 and 0) N
A case-based study of varied ethical and moral dilemmas encountered in the business environment emphasizing the student's written work; development and communication of a reasoned personal framework for the resolution of ethical issues through frequent written assignments. Prerequisite: Graduate standing.

MBA 822: Corporate Financial Reporting, 3 cr. (3 and 0) N
Current state of financial reporting practices and requirements, the ways financial statements and data affect the economic system, and the significance of these practices to users of financial statements.

MBA 823: International Accounting, 3 cr. (3 and 0) N
Technical and nontechnical issues in international accounting. Topics include the role of international bodies in developing standards, accounting issues dealing with exports and imports, and the role of accounting and MNCs in development.

MBA 824: The Management of Sales Operations, 3 cr. (3 and 0) N
The sales function as an element of marketing strategy; the field of professional sales management; concepts and tools useful to managers at different levels of the sales organization. Prerequisite: MBA 808 or 858 or permission of instructor.

MBA 825: Advertising and Promotional Management, 3 cr. (3 and 0) N
The role of promotion in the marketing mix emphasizing the types of decisions and decision areas affiliated with promotional planning. Students are exposed to and apply topics such as objective setting, budgeting, media planning and scheduling, and societal/economic impact of promotion. Prerequisite: MBA 808 or 858 or permission of instructor.

MBA 826: Strategic Marketing, 3 cr. (3 and 0) N
Strategic marketing as it applies to industrial, organizational and institutional markets; consumer marketing versus business-to-business marketing; current business marketing literature and practices. Prerequisite: MBA 808 or 858 or permission of instructor.

MBA 828: Services Marketing, 3 cr. (3 and 0) N
The nature of services marketing and the special requisites that distinguish successful services marketing from goods marketing. Topics include promoting and making the service tangible, designing optimal service operations, the ideal service worker, pricing of services and critical points of services delivery. Prerequisite: MBA 808 or 858 or permission of instructor.

MBA 829: Marketing Foundations, 2 cr. (2 and 0) N
Principles and concepts involved in the planning, pricing, promoting and distributing goods and services. Prerequisite: Permission of M.B.A. director.

MBA 832 (FIN 832): Financial Management, 3 cr. (3 and 0) N
Factors that influence the financial management of multinational corporations. Topics include international parity condi-
tions, currency exposure management, capital budgeting of international projects and political risks. Prerequisite: M B A/ FIN 807 or M B A 857 or permission of instructor.

M B A 835 (FIN 835): Investment Management, 3 cr. (3 and 0) N
Current techniques and strategies in the analysis of various investment alternatives; portfolio management with an introduction to options and futures markets. Prerequisites: Principles of Accounting and a demonstrated proficiency in basic finance.

M B A 836 (FIN 836): Real Estate Finance and Investments, 3 cr. (3 and 0) N
Practices and analysis of real estate finance and investment. Topics include real estate financing techniques, mortgage loan underwriting, real estate ownership structure and syndications, real estate taxation, estate tax, and investment risk analysis. Prerequisite: M B A 807 or M B A 857 or permission of instructor.

M B A 837: Legal Environment of Business, 2 cr. (2 and 0)
Legal and case analysis of court systems and dispute resolution, contracts, business torts, EEOC, Age Discrimination in Employment Act, Americans with Disabilities Act, Employment at Will compared to union participation and international legal considerations as these topics relate to business concerns. Cannot be used as credit toward a graduate degree. Prerequisite: Permission of M.B.A. director.

M B A 838: Law in the Business Environment, 1 cr. (1 and 0)
Legal analysis of contracts, business torts, EEOC, American Discrimination in Employment Act, the Americans with Disabilities Act, Employment at Will compared to Union participation and an overview of international legal considerations as these topics relate to business concerns. Prerequisite: Permission of M.B.A. director.

M B A 839: Business Negotiations and Legal Dispute Resolution, 3 cr. (3 and 0)
Negotiation and dispute resolution in the business environment. Negotiation techniques and practices, negotiation team building, international negotiation issues, as well as alternative dispute resolutions as applied to legal issues within the business environment. Prerequisites: M B A 837, 838 or permission of instructor.

M B A 840: World Industrial Policy, 3 cr. (3 and 0) N
Theory and institutions that form the basis for worldwide national industrial policies; examination of the balance of and effect of policies affecting mergers, consolidations, export assistance, coordination of industries and other government actions taken that affect the legal and economic environment for transnational business. Prerequisite: M B A 802.

M B A 845 (MGT 845): Technology and Innovation Management, 3 cr. (3 and 0) N
Interdisciplinary examination of problems and issues in integrating technology and innovation into processes and products; evaluating tangible and intangible aspects of new technology adoption; management research and development; and functional integration of marketing and operations.

M B A 846: Use of Derivatives in Financial Engineering, 3 cr. (3 and 0) N
Introduction to the valuation and use of basic derivative securities such as futures and options; along with the financial engineering of securities combinations such as swaps, spreads and straddles; applications of derivatives and financial engineering in managing financial risks. Prerequisite: M B A 807 or M B A 867 or permission of instructor.

M B A 850: Business Communications, 1 cr. (1 and 1)
Techniques, skills, problems and approaches for effective business communications. Strengths and weaknesses of various communications forms with concentration on informative and persuasive models. Approaches include practical experience in written work and presentations, video and verbal feedback, teamwork, problem solving and situational presentations. Prerequisite: Permission of M.B.A. director.

M B A 851: Financial Accounting, 3 cr. (3 and 0) N
Accounting as a system which provides financial information for economic decision making; accounting from the perspective of the user in debt/equity financing activities and decisions, investing activities and decisions, and operating activities and decisions; measuring, processing and reporting financial information as a basis for better user understanding. Prerequisite: Permission of the M.B.A. director.

M B A 852: Foundations of Economics, 3 cr. (3 and 0) N
Key concepts and theories in economics and how a market economy operates, concentrating on microeconomics, but also covering key macroeconomics topics. Topics include market systems, pricing mechanisms, monetary systems, inflation, employment, interest rates, consumer behavior and regulation. Prerequisite: Permission of the M.B.A. director.

M B A 853: Statistical Analysis for Business, 3 cr. (3 and 0) F
Application of modern statistical inference in business operations. Topics include testing statistical hypotheses, consequences of making decisions with incomplete information, univariate and multivariate regression with emphasis on business applications, and design of experiments and analysis of variance with special attention given to efficient and relevant data collection and interpretation. Prerequisite: Permission of the M.B.A. director.

M B A 854: Managerial Accounting, 3 cr. (3 and 0) S
Analysis, interpretation and use of accounting information for planning and control in business and nonbusiness organizations. Treats profit planning, budgeting, and standards. Introduces product and segment costing and evaluation. Employs case studies and computer-based assignments. Prerequisite: M B A 819 or equivalent or permission of instructor.

M B A 855: Operations Management, 3 cr. (3 and 0) S
Strategic and tactical issues involved in the design, planning and control of the operating system in service and manufacturing organizations. Topics include operations strategy, process choice, facility design, planning and scheduling, and methods for continuous improvement. Prerequisite: M B A 853 or permission of instructor.

M B A 857: Managerial Finance, 3 cr. (3 and 0) N
Theory of financial management as it relates to financial problems faced by business concerns. Concepts developed are used to assess the validity of emerging formalized techniques for improving decision making in the financial area. Case analysis is used to bridge the gap between theory and practice. Prerequisites: M B A 851 and 852 or permission of instructor.

M B A 858: Managerial Marketing, 3 cr. (3 and 0) F
Key marketing concepts and theories with extensive application to a broad range of business and not-for-profit situations; analysis of marketing opportunities and threats, researching and selecting target markets, and developing and comparing marketing strategies to prepare students to develop advanced marketing strategies. Prerequisite: M B A 853 or permission of instructor.

M B A 859: Management Science Applications, 3 cr. (3 and 0) N
Management science techniques and their application to a wide range of managerial decisions. Topics include queuing models, linear programming, transportation problems and simulation. Prerequisite: Permission of the M.B.A. director.

M B A 860: Advanced Marketing Strategy, 3 cr. (3 and 0) S
Advanced marketing theory and critical thinking skills applied to support strategic decision making; comprehensive case studies and advanced marketing models generally utilized with emphasis on building analysis and professional presentation skills. Prerequisite: M B A 858 or permission of instructor.
M B A 861 (MGT 861): Management Information Systems Development, 3 cr. (2 and 1) S
Overview of information technologies used by organizations for supporting operations and gaining competitive advantage; concepts and methods for modeling, analysis and design of information systems that support a business. Topics include systems analysis, object-oriented modeling and database design. Prerequisite: Basic computer skills as specified in prerequisites for the master's degree program.

M B A 862: Managerial Economics, 3 cr. (3 and 0) F
Use of economic analysis in managerial decision making. Topics include the theory of cost, production, industrial organization, coordination and control of the firm, of theoretical concepts to actual decision making. Prerequisite: Permission of M.B.A. director.

M B A 867 (FIN 867): Advanced Financial Management, 3 cr. (3 and 0) N
Students develop financial problem-solving skills through case analysis, class discussion, reading assignments and a project. Prerequisites: M.B.A/Fin 807 or M.B A 857 or permission of instructor.

M B A 870: Strategic Management, 3 cr. (3 and 0) S, SS
On-going process of positioning a firm for competitive advantage in its changing business environment focusing on the role of general managers in formulating and implementing strategies for single and multibusiness firms. Business cases, class discussions and group projects used to integrate content from previous business courses. Prerequisites: M.B.A. 805, 809, 820, 859, 860, 861 and 867 or permission of instructor.

M B A 874 (MGT 874): Managing Continuous Improvement, 3 cr. (3 and 0) N
How to initiate and lead change toward a total quality environment; basic tools of quality management; use of teams to achieve change; quality function deployment; ISO 9000; supplier development; and use of survey methods to track progress of change. Prerequisite: MGT 803 or permission of instructor.

M B A 875: Enterprise Development, 3 cr. (3 and 0) N
Entrepreneurial process from conception to birth of new venture emphasizing discovery, searching for opportunities and gathering resources to convert opportunities to businesses. Students learn how to evaluate entrepreneurs and their plans by working in teams to write a business plan for a new venture.

M B A 888: Internship in Business Administration, 0 cr. (0 and 0) N
Preplanned, preapproved, faculty-supervised internships designed to give students on-the-job learning in support of classroom education. Internships must be no less than six full-time consecutive weeks with same internship provider. May be repeated. Graded on a pass/fail basis. Prerequisites: Twenty-four semester hours of graduate credit and permission of the M.B.A. director.

M B A 890: Topics in Strategic Management, 3 cr. (3 and 0) N
Issues facing today's executive. Current relevant literature examined and discussed in a graduate seminar environment. Topics may vary with each offering.

M B A 899: Selected Topics in Business Administration, 3 cr. (3 and 0) N
Current topics in business administration as they relate to the manager. Topics may come from a single functional area or may integrate two or more functional areas (accounting, economics, finance, management or marketing). May be repeated for nine credits.

ECON 605: Introduction to Econometrics, 3 cr. (3 and 0)
Elements of time series analysis and introduction to the measurement, specification, estimation and interpretation of functional relationships through single equation least square techniques; problems of multi-collinearity, dummy variables, heteroscedasticity, autocorrelation and lagged variables in simple economic models. Prerequisites: ECON 200 or 211 and 212; MTHSC 108 or 207; and MTHSC 301 or EX ST 301.

ECON 610: Economic Development, 3 cr. (3 and 0)
Analysis of economic and related problems of underdeveloped countries; national and international programs designed to accelerate solution of these problems. Prerequisites: ECON 314 or permission of instructor.

ECON 612: International Microeconomics, 3 cr. (3 and 0)
Analysis of the principles governing trade between nations. Topics include comparative advantage, theory and practice of commercial policy, introduction to exchange rates and balance of payments. Not open to students who have taken ECON 310. Prerequisites: ECON 314 or permission of instructor.

ECON 750: Economic Concepts and Classroom Applications for Teachers, 3 cr. (3 and 0)
Economic concepts, analysis and methods emphasizing microeconomics and the market system; development of approaches to teaching economic concepts in public schools.

ECON 751: Selected Topics for Teachers, 3 cr. (3 and 0)
Current economic policy issues such as inflation, regulation, protectionism and energy policy. Emphasis is on the presentation of these topics to secondary school students. Topics vary from year to year. May be taken more than once for credit. Prerequisite: ECON 200, 211 or 750.

ECON 800 (AP EC 800): History of Economic Thought, 3 cr. (3 and 0)
Development of economic thought from early Greek to Keynesian economics; writings of major economists such as Smith, Ricardo, Marx, Marshall and Keynes; development of major economic theories.

ECON 801 (AP EC 801): Microeconomic Theory, 3 cr. (3 and 0) F
Microeconomic theory and its use to analyze and predict the behavior of industries, firms and consumers under various market conditions.

ECON 802 (AP EC 802): Advanced Econometric Concepts and Applications, 3 cr. (3 and 0) F
Rigorous development of price theory under alternative product and resource market structures. Prerequisite: Permission of instructor.
<table>
<thead>
<tr>
<th>Course Code (AP EC)</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON 804</td>
<td>Mathematical Economics</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 806 I</td>
<td>Econometrics I</td>
<td>3 cr.</td>
<td>(3 and 0) S</td>
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<tr>
<td>ECON 806 F</td>
<td>Econometrics II</td>
<td>3 cr.</td>
<td>(3 and 0) F</td>
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<tr>
<td>ECON 808</td>
<td>Econometrics III</td>
<td>3 cr.</td>
<td>(3 and 0) S</td>
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<tr>
<td>ECON 809</td>
<td>Advanced Natural Resource Economics</td>
<td>3 cr.</td>
<td>(3 and 0) S</td>
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<tr>
<td>ECON 810</td>
<td>Natural Resources Management and Policy</td>
<td>3 cr.</td>
<td>(3 and 0) F</td>
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<tr>
<td>ECON 811</td>
<td>Economics of Environmental Quality</td>
<td>3 cr.</td>
<td>(3 and 0) F (even numbered years)</td>
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<tr>
<td>ECON 816 I</td>
<td>Labor Economics</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 816 II</td>
<td>Production Economics</td>
<td>3 cr.</td>
<td>(3 and 0) S</td>
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<tr>
<td>ECON 820</td>
<td>Public Finance</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 821 I</td>
<td>Public Choice</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 822 I</td>
<td>Contemporary Public Policy</td>
<td>3 cr.</td>
<td>(3 and 0) S</td>
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<tr>
<td>ECON 824</td>
<td>Organization of Industry</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 826</td>
<td>Economic Theory of Government Regulation</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 827 II</td>
<td>Economics of Property Rights</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 828 II</td>
<td>Market Structure in Agricultural Industries</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 831</td>
<td>Economic Development</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 832 II</td>
<td>Community and Regional Economics</td>
<td>3 cr.</td>
<td>(3 and 0) F</td>
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<tr>
<td>ECON 840</td>
<td>International Trade Theory</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 841</td>
<td>International Finance</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 855</td>
<td>Financial Economics</td>
<td>3 cr.</td>
<td>(3 and 0)</td>
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<tr>
<td>ECON 888</td>
<td>Directed Reading in Economics</td>
<td>1-3 cr.</td>
<td>(1-3 and 0) F, S</td>
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<tr>
<td>ECON 891</td>
<td>Master's Thesis Research, credit to be arranged</td>
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<tr>
<td>ECON 899 II</td>
<td>Selected Topics</td>
<td>1-3 cr.</td>
<td>(1-3 and 0) F, S</td>
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<tr>
<td>ECON 900</td>
<td>Selected Topics in Economics</td>
<td>3 cr.</td>
<td>(3 and 0) F (odd numbered years)</td>
</tr>
</tbody>
</table>

Note: Prerequisites are listed as needed. Some courses may have additional or specific prerequisites.
ECON 901 (AP EC 901): Price Theory, 3 cr. (3 and 0) Neoclassical paradigm of market price and quantity; rigorous consideration of consumer behavior, the theory of the firm and market equilibrium, production and resource demands, and the supply of resources. Prerequisite: ECON 801 or equivalent.

ECON 903 (AP EC 903): General Equilibrium and Welfare Theory, 3 cr. (3 and 0) S The second of a two-course sequence of advanced price theory. The first part covers the development of the theory of general equilibrium and the economics of welfare; the second covers the capital theory and the determination of the rate of interest. Prerequisite: AP EC 901.

ECON 904 (AP EC 904): Seminar in Resource Economics, 3 cr. (3 and 0) F Special problems and recent periodical literature relating to the control, management, development and use of land and water resources in the United States and in other parts of the world. Prerequisite: AP EC 403/603.

ECON 905 (AP EC 905): Advanced Macroeconomic Issues, 3 cr. (3 and 0) S Current unsettled issues in macroeconomic analysis. Topics include disequilibrium macro models, macro models of open economies, rational expectations and its critics, government stabilization policies and the controversy surrounding the concept of Ricardian equivalence. Prerequisite: ECON 805 or equivalent.

ECON 906 (AP EC 906): Seminar in Area Economic Development, 3 cr. (3 and 0) S Recent research developments in economic development; review of research publications, journal articles and other literature; objectives, analytical techniques and procedures used in area or regional development efforts. Prerequisite: AP EC 806.

ECON 911: Problems in Price Theory, 3 cr. (3 and 0) Price theory problems and exercises in preparation for taking the comprehensive examination preliminary to admission to candidacy to the Ph.D. degree in applied economics. May be repeated up to three times.

ECON 915: Problems in Macroeconomic Theory, 3 cr. (3 and 0) Review of problems and exercises in macroeconomic theory to help integrate formal theory from advanced courses. Prerequisite: ECON 905 or permission to stand Ph.D. preliminary examination in the next semester.

ECON 917 (AP EC 917): Advanced Seminar in Labor Economics, 3 cr. (3 and 0) Follow-up to ECON 816, bridging the gap between theory and modern empirical research in labor economics. Emphasis is on reading recent empirical research papers to understand the techniques of modern research in labor economics. Prerequisite: ECON 816.

ECON 950 (AP EC 950): Monetary Economics, 3 cr. (3 and 0) Economic analysis of money in our economy and effects of monetary policy on prices, interest rates, output and employment.

ECON 980: Workshop in Applied Economics, 3 cr. (3 and 0) Forum for presentation and critical evaluation of ongoing research by candidates for the Ph.D. degree in applied economics. May be repeated for up to nine credits. Prerequisite: Permission of instructor.

ECON 991 (AP EC 991): Doctoral Dissertation Research, credit to be arranged.

Finance

Robert B. McElreath, Chair, Department of Finance

Advanced degrees are not awarded in finance. Courses are offered to meet requirements and provide electives for students in other areas.

FIN 605: Portfolio Management and Theory, 3 cr. (3 and 0) Introduction to portfolio management. Topics include the underlying theory, managing the equity and the fixed-income portfolios, portfolio evaluation, options-pricing theory, future markets and instruments. Prerequisites: FIN 305 and either 306 or 311 or permission of instructor.

FIN 606: Analysis and Use of Derivatives, 3 cr. (3 and 0) The options-valuation and strategy techniques most commonly used in the market for options; overview of the futures markets emphasizing interest-rate futures, stock-index futures and foreign-exchange futures. Prerequisite: FIN 305 or permission of instructor.

FIN 610: Research in Finance, 1-3 cr. (1-3 and 0) Directed research course with topic selected by student and approved by instructor. A formal research paper is required. Prerequisites: FIN 306 or 312 and permission of instructor.

FIN 615: Real Estate Investment, 3 cr. (3 and 0) Structure and analysis of real estate investment emphasizing financial theory and analysis technique. Case study and project-oriented homework assignments facilitate the understanding of real estate investments. Prerequisites: FIN 307 and 306 or 311.

FIN 617: Real Estate Finance, 3 cr. (3 and 0) Application of financial analysis and theory to real estate; mortgage credit analysis and current financing techniques for residential and commercial properties. Topics include financial institutions, syndications and construction financing. Prerequisites: FIN 307 and 306 or 311.

FIN 807 (M B A 807): Financial Management, 3 cr. (3 and 0) Theory of financial management as it relates to the financial problems faced by business concerns. Concepts developed are used to assess the validity of emerging formalized techniques for improving decision making in the financial area. Topics include financial planning, short- and long-term fund raising, capital budgeting, the administration of working capital, recapitalization, listing of securities and reorganization. Case material and problems are used. Prerequisites: M B A 804 or 854 or equivalent and M B A 803 or 853 or equivalent.

FIN 812 (M B A 812): Financial Markets and Institutions, 3 cr. (3 and 0) N Topics critical to the proper management of financial institutions including financial regulations, financial security types and their yields, interest rate theories, interest rate risk management, foreign currency risk management, stock index futures and numerous operating functions in banking. Prerequisite: M B A 804 or M B A 857 or permission of instructor.

FIN 832 (M B A 832): International Financial Management, 3 cr. (3 and 0) N Factors that influence the financial management of multinational corporations. Topics include international parity conditions, currency exposure management, capital budgeting of international projects and political risk. Prerequisites: M B A 831 or M B A 857 or FIN 807 or M B A 857 or permission of instructor.

FIN 835 (M B A 835): Investment Management, 3 cr. (3 and 0) N Current techniques and strategies in the analysis of various investment alternatives; portfolio management with an introduction to options and futures markets. Prerequisites: Principles of accounting and a demonstrated proficiency in basic finance.

FIN 836 (M B A 836): Real Estate Finance and Investments, 3 cr. (3 and 0) N Practices and analysis of real estate finance and investment. Topics include real estate financing techniques, mortgage loan underwriting, real estate ownership structure and syndications, real estate taxation and real estate investment risk analysis. Prerequisite: M B A 835 or M B A 857 or permission of instructor.
FIN 867 (M B A 867): Advanced Financial Management, 3 cr. (3 and 0) N
Financial problem-solving skills developed through case analysis, class discussion, reading assignments and a project. Prerequisites: M B A/FIN 807 or M B A 857 or permission of instructor.

Graphic Communications
William E. West, Chair, Department of Graphic Communications
Advanced degrees are not awarded in graphic communications. Courses are offered to meet requirements and provide electives for students in other areas.

G C 605: Package and Specialty Printing, 2 cr. (2 and 0)
Problems and processes for printing and converting in package, label and specialty printing industries; flexographic preparation, printing, die making, diecutting, transfer printing, screen container printing, pad printing and bar code production are covered; developments and trends. Corequisites: G C 406. Prerequisites: G C 310, 350, and THRD 224 or permission of instructor.

G C 606: Package and Specialty Printing Laboratory, 2 cr. (0 and 6)
Laboratory techniques for printing and converting in package, label and specialty printing industries. Experiences in flexographic press work; printing, die design, die making and diecutting for labeling, folding cartons and corrugated; sublimation and plastisol transfer screen printing; and glass, plastic and metal container printing. Prerequisite or Corequisite: G C 405 or permission of instructor.

G C 607: Advanced Flexographic Methods, 4 cr. (2 and 6)
Methods used in flexographic printing and converting processes and nonporous substrates. Theory and laboratory applications include setting standards for process color, preparation of plate systems, ink mixing and color matching, testing of films and foils, analysis of recent developments and prediction of future markets. Prerequisites: G C 406 and 444 or permission of instructor.

G C 610 (THRD 610): Selected Topics, 1-3 cr. (1-3 and 0)
Subject areas organized according to program needs. Content will be planned cooperatively by the University and the school system or agency requesting the course. May be repeated for a maximum of 18 credits, but only if different topics are covered. Prerequisite: Permission of instructor.

G C 640: Advanced Lithographic Methods, 5 cr. (2 and 9)
Advances skills learned in previous graphic communications courses and applies the knowledge to large format presses. Students work from the design conception stage through all aspects of preparation, production and finishing. Emphasis is on understanding and incorporating emerging technologies into the production workflow. Prerequisites: G C 310 and 350 or permission of instructor.

G C 644: Current Developments and Trends in Graphic Communications, 4 cr. (2 and 6)
Advanced course for graphic communications majors emphasizing the theory and technical developments that affect process and equipment selection. Topics include color theory and application, electronic color scanning, electronic prepress and communications, gravure color quality control and analysis. Prerequisites: G C 350, 406 and 440.

G C 645: Advanced Screen Printing Methods, 3 cr. (2 and 3)
The systems and materials used with the screen printing process emphasizing techniques of control and procedures for establishing screen printing methods and standards. Prerequisite: G C 207 or permission of instructor.

G C 646: Ink and Substrates, 3 cr. (2 and 3)
Components, manufacturing, process use and end use of ink and substrates used in lithography, flexography, gravure and screen printing; interrelationship among inks, substrates and the printing process. Through controlled testing and examination, the optimum conditions for improved printability will be determined. Prerequisite: G C 406 or 440 or permission of instructor.

G C 648: Planning and Controlling Printing Functions, 3 cr. (3 and 0)
Systems for setting printing production standards, estimating, scheduling, job planning and the selection of new hardware and technologies. Prerequisite: G C 350, 406, 440, 450.

G C 801: Process Control in Color Reproduction, 3 cr. (2 and 3)
Techniques and rationale for procedures used in reproducing color originals for printed media. Topics include color systems, measurement, reproduction characteristics, proofing systems, process evaluation/analysis for offset, gravure, flexographic and screen printing processes. Prerequisite: G C 444 or equivalent.

G C 811: Printing Industry Operations, 3 cr. (2 and 3)
Concepts and principles of operations and applications of technology and trends within the printing, publishing, packaging and allied industries. Twelve plant visits supplement study of the organization, management, marketing, economics, production, environmental issues and products of modern graphic communications firms.

G C 891: Master's Thesis Research, 1-6 cr. (1-6 and 0)
Student participation in a research project. Basic skills in a selected research methodology are developed. Prerequisite: G C 894.

G C 894: G C Graduate Seminar, 1 cr. (1 and 0)
Discussions on relevant topics and guidance to prepare research proposals in the graphic communications field. Students will develop and present research proposals in preparation for G C 895-896. May be repeated for credit once with a different topic. Prerequisites: Graduate standing and permission of instructor.

G C 897: Graphic Communications Research Problems I, 3 cr. (3 and 0)
Performing in-depth investigation of phenomena relative to the printing, publishing, packaging or allied industries. Prerequisites: G C 894, acceptance of a written proposal and approval of advisor.

G C 898: Graphic Communications Research Problems II, 3 cr. (3 and 0)
Performing in-depth investigation of phenomena relative to the printing, publishing, packaging or allied industries. Continuation of G C 897. Prerequisites: G C 894, 897, acceptance of a written proposal and approval of advisor.

Industrial Management
David W. Grisby, Chair, Department of Management

<table>
<thead>
<tr>
<th>Major</th>
<th>Degrees</th>
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</thead>
<tbody>
<tr>
<td>Industrial Management</td>
<td>M.S., Ph.D.</td>
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</tbody>
</table>

The Master of Science in Industrial Management (MSIM) is designed to prepare students for leadership positions in industry by focusing on the management of operations. The MSIM program also prepares students for further advanced study in the field of management. The program addresses strategic, behavioral and technical issues relevant to managing industrial and business operations in a global economy. Students in the MSIM program come from a variety of academic backgrounds including business, engineering, physical sciences, mathematics and computer science. The program builds on the educational background of undergraduate business majors by providing an important focus toward operations, the part of the organization where most assets and people are employed. For individuals with a technical undergraduate degree, the MSIM program complements their mathematics, engineering, computer and basic sciences course work by developing an integrated view of strategic, technical and behavioral issues of operations management.

The body of knowledge for the MSIM program includes emphasis in operations management, organizational theory, and behavior and information systems. Students select from an array of operations focus courses. There are five core courses and five operations
focus courses, and most full-time students should be able to complete the program in one calendar year. Students who have not completed basic course work in economics, financial accounting, marketing and statistics must complete courses in these areas as corequisites.

The Ph.D. program is a balanced program of management theory, analytical techniques and research methodology focusing on the management of operations. The goal is to produce scholars capable of (1) conducting critical and exhaustive investigation, and thus contributing to the body of knowledge and scholarly literature in industrial management, and (2) applying and sharing their knowledge through teaching for the benefit of students and society. Students entering the Ph.D. program are expected to have completed basic course work in accounting, calculus, economics, finance, marketing and statistics. Applicants who have not completed these prerequisite courses may be admitted as doctoral students but will be required to complete the necessary prerequisite work as soon as possible after matriculation.

Formal course work leading to the dissertation stage of the Ph.D. program is divided into four core courses, four scholarly methods courses and a minimum of six advanced courses. The core courses present the critical issues related to the management of operations. The scholarly methods courses expose the student to the process of research and key methodological issues, in depth study of statistical methods and college teaching. The advanced courses provide students the opportunity to explore operations related issues in management science, management information systems, strategic management or human resources management. Finally, the student must complete at least 18 credit hours of doctoral dissertation research.

MGT 616: Management of Human Resources, 3 cr. (3 and 0)
Recent developments in the management of human resources with emphasis on recent developments of research into the motivation, development of potential and full utilization of the human resources. Prerequisites: MGT 307 and 400 or permission of instructor.

MGT 623: International Business Management, 3 cr. (3 and 0)
The theoretical and institutional complexities of international business operations. Topics include exporting, importing, foreign investment, multinational corporations and the international payment system. Prerequisite: Junior or senior standing.

MGT 624: International Transportation and Logistics, 3 cr. (3 and 0)
International transportation systems and their logistics support systems. Topics include ocean shipping, international air transportation, port management and EEC and Soviet-block transport systems, and international transport legislation and policies. Prerequisite: Senior standing or permission of instructor.

MGT 625: Compensation Management, 3 cr. (3 and 0)
The compensation employees seek in exchange for their efforts and contributions. Topics include government and union influence; job content analysis, description and evaluation; developing pay structures; measuring and paying for performance; employee benefits; administration of the compensation plan; executive, managerial, professional and sales. Prerequisite: MGT 307 or permission of instructor.

MGT 801: Production and Pricing Analysis, 3 cr. (3 and 0)
Mathematical formulation of production and pricing theory as it applies to management decision making; analytical techniques of production and pricing analysis. Prerequisite: MGT 409/609 or permission of instructor.

MGT 803: Operations Management, 3 cr. (3 and 0) F
Introduction to a broad range of operations management topics; foundation for understanding the importance, relevance and significance of analytical models and tools to be introduced in subsequent courses in the MSIM program. Topics include operations strategy, process and facility design, planning and control, quality management, and continuous improvement. Prerequisite: Graduate standing.

MGT 804: Operations Strategy, 3 cr. (3 and 0) F
In-depth study, through case studies and readings, of the role operations systems and capabilities play in providing sources of competitive advantage. Topics include industry analysis, technological forecasting, formulation of organization and operations strategies, and development of operations system capabilities. Prerequisite: MGT 803 or permission of instructor.

MGT 805: Advanced Quality Control, 3 cr. (3 and 0) F
Statistical techniques employed in complex quality control schemes including recent developments in statistical quality control. Prerequisite: Permission of instructor.

MGT 807: Comparative Management Theory, 3 cr. (3 and 0)
Evolution of management theory, up to and including contemporary theories, comprehensive review of the major schools of management thought, with emphasis on the area of organization theory and design. Prerequisite: Graduate standing.

MGT 808: Manufacturing Planning and Control Systems, 3 cr. (3 and 0) F
Important components of a manufacturing planning and control system emphasizing the integration of planning and control functions in a dynamic manufacturing environment; extensive hands-on work with integrated manufacturing software. Prerequisite: MGT 803 or permission of instructor.

MGT 809 (M B A 809): Organizational Behavior and Human Resources Management, 3 cr. (3 and 0)
Theories and models of behavior, and human resources management concepts and processes as they apply to managing individual and work-group behavior in organizations. Organizational behavior topics include leadership, motivation and teamwork. Human resource management topics include human resources strategy, selection, performance evaluation, reward systems and employee development. Prerequisite: Graduate standing.

MGT 812: Business Logistics Management, 3 cr. (3 and 0) SS
Business activities related to transportation, inventory management, order processing and warehousing of raw materials and finished goods interfaces with production/operations and marketing. Prerequisite: MGT 305 or 317 or permission of instructor.

MGT 813: Business Research, 3 cr. (3 and 0) F
Business research to support management decision making. Topics include information collection and analysis and report preparation and presentation. Requires the use of integrated microcomputer software for the preparation of student reports. Prerequisites: MA SC 814 and MGT 399 or equivalent.

MGT 815: Personnel Management, 3 cr. (3 and 0)
Personnel management activities including recruitment, selection, training and development, performance appraisal, discipline, grievance handling, wage and salary administration, and employee benefit programs. Prerequisite: Graduate standing.

MGT 818: Management Support Systems, 3 cr. (3 and 0)
Computer-based management support systems.

MGT 820: Service Operations Management, 3 cr. (3 and 0)
Concepts and techniques of service operating system design and management. Topics include characteristics of services, service system performance measurement, queuing and automation, planning and control in different service environments, and international service operations. Prerequisite: MGT 803 or permission of instructor.

MGT 821: Process and Facility Design, 3 cr. (3 and 0)
Design of operating systems emphasizing the implications of technology and automation. Topics include technological core competencies, technological forecasting, process design, capacity planning, facility location and layout, and product and process development processes. Prerequisite: MGT 803 or permission of instructor.
MGT 822: International Operations Management, 3 cr. (3 and 0)
Operations management within an international business environment. Topics include the regulatory and cultural environment of international business, international business and operations strategies, global location, global sourcing and logistics decisions, international workforce management, technology transfer and configuration, and coordination of global operations activities. Prerequisite: MGT 803 or permission of instructor.

MGT 845 (MBA 845): Technology and Innovation Management, 3 cr. (3 and 0) N
Interdisciplinary examination of problems and issues in integrating technology and innovation into processes and products. Evaluating tangible and intangible aspects of new technology adoption; management research and development; and functional integration of marketing and operations.

MGT 861 (MBA 861): Management Information Systems Development, 3 cr. (2 and 1) S
Overview of information technologies used by organizations for supporting operations and gaining competitive advantage; concepts and methods for modeling, analysis and design of information systems that support a business. Topics include systems analysis, object-oriented modeling and database design. Prerequisite: Basic computer skills.

MGT 874 (MBA 874): Managing Continuous Improvement, 3 cr. (3 and 0) N
How to initiate and lead change toward a total quality environment; basic tools of quality management; use of teams to achieve change; quality function deployment; ISO 9000; supplier development; and use of survey methods to track progress of change. Prerequisite: MGT 803 or permission of instructor.

MGT 885: Industrial Scheduling, 3 cr. (3 and 0)
Examines the theoretical results for single and parallel machine, flow shop, job shop and network scheduling. Includes treatment of mathematical programming applications, scheduling algorithm design and search procedures. Prerequisites: Any one of the following courses: CEE 833; CPSC 803; MA SC 810; MB A 659; MTHSC 812 or 814 and permission of instructor.

MGT 888: International Perspectives in Industrial Management, 3-6 cr. (3-6 and 0)
International perspective to industrial management via organized plant visitations to businesses in a foreign country and lectures by, and discussions with, senior operations manager(s). Cultural visits and lectures are also organized to provide a holistic perspective to cover cultural and economic development of the host country. Prerequisite: Permission of instructor.

MGT 891: Master's Thesis Research, credit to be arranged

MGT 892: Master's Project Course, 3 cr. (0 and 9)
The field project, the capstone activity in the program, requires application of the program body of knowledge to a real-world operations management problem. A formal presentation and written report are required. May be repeated for a maximum of 12 credit hours. Graded on a pass/fail basis. Prerequisite: Permission of instructor.

MGT 899: Selected Topics in Industrial Management, 3 cr. (3 and 0)
Current topics in industrial management theory and/or practice. Topics may vary in keeping with developments in the management profession and interests of faculty. May be repeated for nine credits.

MGT 903: Seminar in Manufacturing Planning and Control Systems, 3 cr. (3 and 0)
Current research issues and developments in manufacturing planning and control systems emphasizing current research (philosophical, analytical and empirical) design and development approaches for planning and control of manufacturing operations. Prerequisite: MGT 803 or permission of instructor.

MGT 904: Seminar in Current Management Topics, 3 cr. (3 and 0)
Topics from current management literature emphasizing research from scholarly journals. Topics vary in keeping with developments in the literature. May be repeated with different faculty for a maximum of six credit hours. Prerequisite: Permission of instructor.

MGT 905: Research Methods, 3 cr. (3 and 0)
Research methods supporting scholarly research and publication in management. Topics include theory building, hypothesis specification and testing, experimental design, measurement, sampling, research ethics and related issues. Enrollment restricted to doctoral students. Prerequisite: MA SC 814 or equivalent.

MGT 907: Seminar in the Design of Operations Systems, 3 cr. (3 and 0)
Current methodologies and developments in theoretical evaluation, selection, design and installation of systems for manufacturing and service operations; empirical research dealing with the building blocks of operations such as process technology scanning, selection and installation; operations systems location and layout; and management systems selection and installation. Prerequisites: MGT 821 and permission of instructor.

MGT 910: Seminar in Operations Management, 1-3 cr. (1-3 and 0)
New methodologies and developments, both analytical and philosophical, in operations management; development of theory of management science; converting management theory into practice while considering behavioral and economic aspects of the problem. Prerequisite: Permission of instructor.

MGT 911: Seminar in Decision Theory, 1-3 cr. (1-3 and 0)
Framework and methodology for management decision making in a statistical setting. Prerequisite: Permission of instructor.

MGT 913: Management Systems Analysis, 3 cr. (3 and 0)
Design, construction and analysis of stochastic simulation models for typical management decisions: design, input, output, variance reduction; applications; validation; implementation; optimum seeking techniques; designed experiments; effect of model results on managerial policy decisions. Prerequisite: CPSC 150 or equivalent.

MGT 915: Seminar in Business-Level Strategy Formulation and Implementation, 3 cr. (3 and 0)
Theoretical and empirical foundations of business-level strategy research focusing on how firms compete in a particular business; strategic typologies, the strategic management process, strategy-environment fit, organization performance, business-unit culture, and functional strategies and structure. Prerequisite: MGT 804.

MGT 916: Directed Readings in Management, 1-3 cr. (1-3 and 0)
Directed reading and research in the student's area of interest. May be repeated for a maximum of three credit hours. Prerequisite: Permission of instructor.

MGT 918: Seminar in Management Support Systems, 3 cr. (3 and 0)
Contemporary topics in decision-oriented information systems research; structure of the field, research methodologies and research opportunities. Prerequisite: MGT 918 or permission of instructor.

MGT 921: Seminar in the Science and Practice of Business and Economic Modeling, 3 cr. (3 and 0)
Current literature used as a resource for studying and analyzing selected topics important in the design and development of simulation models, students lead and participate in group discussions. Prerequisite: MGT 913 or equivalent.

MGT 950: Seminar in Corporate-Level Strategy Formulation and Implementation, 3 cr. (3 and 0)
Theoretical and empirical foundations of corporate-level strategy research emphasizing both formulation and implementation issues; boards of directors, decision making, diversification, strategic fit, mergers and acquisitions, divestitures, joint ventures and corporate structure. Prerequisite: MGT 804.
MGT 952: Seminar in Manufacturing and Operations Strategy, 3 cr. (3 and 0) F
Emerging theoretical and empirical research showing the linkages among competitive business priorities, patterns of operations decisions and firm performance. Topics include development of operations objectives and strategies that reflect competitive priorities, and strategic operations decisions in the areas of process, capacity, facility, and planning and control systems. Prerequisite: MGT 804.

MGT 991: Doctoral Dissertation Research, credit to be arranged

H ADM 608: Hospital and Health Services Administration, 3 cr. (3 and 0)
Survey of the practice of hospital and health-care administration practiced within the United States. Topics include planning; social, legal and political considerations, alternate forms of organization; management practices; control systems; and trends/issues facing the future of health-care administrators. Prerequisite: Senior or graduate-level standing or permission of instructor.

H ADM 610: Hospital Internship, 3 cr. (0 and 9)
Internship in local hospital for nine hours per week on a specified program of observing, practicing and experiencing the duties of hospital administrators. Course will be specifically outlined along with the amount of time the student will spend in each phase or department of the hospital. Student progress will be constantly monitored by University faculty and hospital staff. Prerequisite: H ADM 408.

Management Science

Peter R. Nelson, Program Coordinator, Department of Management Sciences.

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<th>Major</th>
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<tr>
<td>Management Science</td>
<td>Ph.D.</td>
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The departments of Management and Mathematical Sciences (College of Engineering and Science) jointly offer and administer this program. Applicants should have a demonstrated aptitude for quantitative analysis and a primary interest in scientific management research and practice. The program is for persons interested in using and developing the growing array of statistical and quantitative decision-making techniques used by the larger and more sophisticated American, foreign and multinational firms. Such techniques include probability models; statistical analysis; linear, nonlinear and dynamic programming; and decision theory.

The program structure blends courses in statistical theory, operations research and functional areas of management to provide a balanced offering of advanced work in each field contributing to the degree.

Management science students are required to take some of the following courses offered by various departments.

MGT 803: Operations Management, 3 cr. (3 and 0) F
Introduction to a broad range of operations management topics; foundation for understanding the importance, relevance and significance of analytical models and tools to be introduced in subsequent courses in the MSIM program. Topics include operations strategy, process and facility design, planning and control, quality management and continuous improvement. Prerequisite: Graduate standing.

MGT 808: Manufacturing Planning and Control Systems, 3 cr. (3 and 0) F
Important components of a manufacturing planning and control system emphasizing the integration of planning and control functions in a dynamic manufacturing environment; extensive hands-on work with integrated manufacturing software. Prerequisite: MGT 803 or permission of instructor.

MGT 821: Process and Facility Design, 3 cr. (3 and 0) F
Design of operating systems emphasizing the implications of technology and automation. Topics include technologi-
cal core competencies, technological forecasting, process design, capacity planning, facility location and layout, and product and process development processes. Prerequisite: MGT 803 or permission of instructor.

MGT 861 (M BA 861): Management Information Systems Development, 3 cr. (3 and 0) S
Overview of information technologies used by organizations for supporting operations and gaining competitive advantage; concepts and methods for modeling, analysis and design of information systems that support a business. Topics include systems analysis, object-oriented modeling and database design. Prerequisite: Basic computer skills.

MGT 903: Seminar in Manufacturing Planning and Control Systems, 3 cr. (3 and 0)
Current research issues and developments in manufacturing planning and control systems emphasizing current research (philosophical, analytical and empirical) dealing with alternative approaches for planning and control of manufacturing operations. Prerequisite: MGT 803 or permission of instructor.

MGT 907: Seminar in the Design of Operations Systems, 3 cr. (3 and 0)
Current management issues and developments in the evaluation, selection, design and installation of systems for manufacturing and service operations; empirical research dealing with the building blocks of operations such as process technology scanning, selection and installation; operations systems location and layout; and management systems selection and installation. Prerequisites: MGT 821 and permission of instructor.
MTHSC 803: Management Systems Analysis, 3 cr. (3 and 0)
Design, construction and analysis of stochastic simulation models for typical management decisions. Topics include design, input-output, variance reduction, applications, validation, implementation, optimum seeking techniques and designed experiments. Emphasis is on effect of model results on managerial policy decisions. Prerequisite: CP SC 150 or equivalent.

MGT 921: Seminar in the Science and Practice of Business and Economic Modeling, 3 cr. (3 and 0)
Current literature used as a resource for studying and analyzing selected topics important in the design and development of simulation models; students lead and participate in group discussions. Prerequisite: MGT 913 or equivalent.

MTHSC 800: Probability, 3 cr. (3 and 0) F
Basic probability theory with emphasis on results and techniques useful in operations research and statistics. Topics include axiomatic probability, advanced combinatorial probability, conditional probability, geometric probability, conditional expectations, functions of random variables, moment generating functions, distribution theory and limit theorems. Prerequisite: MTHSC 206.

MTHSC 801: General Linear Hypothesis I, 3 cr. (3 and 0) F
Least-square estimates; Gauss-Markov theorem; confidence ellipsoids and confidence intervals for estimable functions; tests of hypotheses; one-, two- and higher-order layouts; analysis of variance for other models. Prerequisites: MTHSC 403/603 and 311.

MTHSC 802: General Linear Hypothesis II, 3 cr. (3 and 0) S
Continuation of MTHSC 801.

MTHSC 803: Stochastic Processes, 3 cr. (3 and 0) S, SS
Theory and analysis of time series, recurrent events, Markov chains, random walks, renewal theory, application to communication theory and operations research. Prerequisite: MTHSC 400/600 or 800.

MTHSC 805: Data Analysis, 3 cr. (3 and 0) F, S
Methodology in analysis of statistical data emphasizing applications to real problems using computer-oriented techniques: computer plots, transformations, criteria for selecting variables, error analysis, multiple and stepwise regression, analysis of residuals, model building in time series and ANOVA problems, jackknife and random subsampling, multidimensional scaling and clustering. Prerequisites: MTHSC 301 and 400/600, or MTHSC 403/603 and 800.

MTHSC 806: Nonparametric Statistics, 3 cr. (3 and 0) F
Order statistics; tolerance limits; rank-order statistics; Kolmogorov-Smirnov one-sample statistics; Chi-square goodness-of-fit test; two-sample problems; linear rank statistics; asymptotic relative efficiency. Prerequisite: MTHSC 600 or 800.

MTHSC 807: Applied Multivariate Analysis, 3 cr. (3 and 0) F
Applied multivariate analysis: computer plots of multivariate observations; multidimensional scaling; multivariate tests of means; covariances and equality of distributions; univariate and multivariate regressions and their comparisons; MANOVA; principle components analysis; factor analysis; analytic rotations; canonical correlations. Prerequisites: MTHSC 403/603 and 805 or permission of instructor.

MTHSC 808: Reliability and Life Testing, 3 cr. (3 and 0) S
Probability models and statistical methods relevant to parametric and nonparametric analysis of reliability and life testing data. Prerequisites: MTHSC 400/600 or 401/601 or equivalent.

MTHSC 809: Time Series Analysis, Forecasting and Control, 3 cr. (3 and 0) F
Modeling and forecasting random processes; autocorrelation functions and spectral densities; model identification, estimation and diagnostic checking; transfer function models; feedback and control feedback control schemes. Prerequisites: MTHSC 600 and 605, or MTHSC 800 and 805, or equivalent.

MTHSC 810: Mathematical Programming, 3 cr. (3 and 0) F, S
Formulation and solution of linear programming models; mathematical development of the simplex method; revised simplex method; duality; sensitivity analysis; parametric programming, implementation and software packages. Prerequisite: MTHSC 311.

MTHSC 811: Nonlinear Programming, 3 cr. (3 and 0) S
Theoretical development of nonlinear optimization with applications, classical optimization, convex and concave functions, separable programming, quadratic programming and gradient methods. Prerequisites: MTHSC 440 and 454.

MTHSC 813: Advanced Linear Programming, 3 cr. (3 and 0) S
Development of linear programming theory using inequality systems, convex cones, polyhedra and duality; solution algorithms and computational considerations for large scale and special structured problems using techniques of upper bounded variables, decomposition, partitioning and column generation; game theory; non-linear representations and other methods such as ellipsoid and Karmarkar. Prerequisite: MTHSC 440/640, 810 or equivalent.

MTHSC 814: Network Flow Programming, 3 cr. (3 and 0) F
Max-flow/min-cut theorem, combinatorial applications, minimum cost flow problems (transportation, shortest path, transshipment), solution algorithms (including the out-of-kilter) and implementation and computational considerations. Prerequisite: MTHSC 440/640, 810 or equivalent.

MTHSC 817: Stochastic Models in Operations Research I, 3 cr. (3 and 0) F
Stochastic control; structure of sequential decision processes; stochastic inventory models; recursive computation of optimal policies; discrete parameter finite Markov decision processes; various optimality criteria; computation by policy improvement and other methods; existence of optimal stationary policies; stopping-rule problems; examples from financial management, maintenance and reliability, search, queueing and shortest path. Prerequisite: MTHSC 803.

MTHSC 818: Stochastic Models in Operations Research II, 3 cr. (3 and 0) S
Introduction to queuing theory: Markovian queues, repairman problems, queues with an embedded Markov structure, the queue GI/G/1, queues with a large number of servers, decision making in queues, introduction to reliability theory; failure distributions; stochastic models for complex systems; maintenance and replacement policies; reliability properties of multicomponent structures. Prerequisite: MTHSC 817.

MTHSC 881: Mathematical Statistics, 3 cr. (3 and 0) S
Fundamental concepts of sufficiency, hypothesis testing and estimation; robust estimation; resampling (jackknife, bootstrap, etc.) methods; asymptotic theory; two-stage and sequential sampling problems; ranking and selection procedures. Prerequisite: MTHSC 403/603 or equivalent.

Marketing
Richard M. Reese, Chair, Department of Marketing

Advanced degrees are not awarded in marketing. Courses are offered to provide electives for students in other areas.

MKT 623: Promotional Strategy, 3 cr. (3 and 0)
Promotion as the communication function of marketing, communication theory and promotion's relation to mass and interpersonal communication; factors affecting the promotional decision-making process; promotion as a competitive tool. Prerequisite: MKT 301 or permission of instructor.
MKT 627: International Marketing, 3 cr. (3 and 0)
Marketing from the international point of view; the necessary modification of marketing thinking and practice for foreign markets due to individual environmental differences. Prerequisite: MKT 301.

MKT 628: Services Marketing, 3 cr. (3 and 0)
The nature of service organizations and the principles which guide the marketing of their products; a marketing mix that is fundamentally different than that found in traditional goods marketing. Prerequisite: MKT 301 or permission of instructor.

MKT 629: Public and Nonprofit Marketing, 3 cr. (3 and 0)
The role and application of marketing in public and nonprofit settings; a conceptual understanding of the marketing discipline and marketing processes; application of basic concepts and principles of marketing to public and nonprofit organizations. Prerequisite: MKT 301 or permission of instructor.

MKT 630: Marketing Product Management, 3 cr. (3 and 0)
Management of the firm's product or service offerings; new product screening, evaluation and development; product line and mix analysis; abandonment decisions, brand manager's role; new product development department. Emphasis is on decision making. Prerequisites: MKT 301 and MA SC 310 or permission of instructor.

MKT 631: Marketing Research, 3 cr. (3 and 0)
Research used in marketing decision making; methods and techniques used in planning, collecting, processing and utilizing information. Topics include research design, sources of information, questionnaire design, sampling, data collection and data analysis. Prerequisites: MKT 301 and MA SC 310, or permission of instructor.

MKT 695: Selected Topics, 3 cr. (3 and 0)
Timely topics in marketing. May be repeated for credit as topics vary. Prerequisite: MKT 301 or permission of instructor.

SCHOOL OF SOCIAL SCIENCE AND APPLIED SOCIOLOGY

Political Science

David Swindell, Director of Public Administration Program

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<th>Major</th>
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<tr>
<td>Public Administration</td>
<td>M.P.A.</td>
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Advanced degrees are not awarded in political science. Courses are offered at the 600 level to provide electives for students in other areas.

The department participates with the Department of Government and International Relations at the University of South Carolina in offering the joint professional degree, Master of Public Administration. Courses for this program are taught only at the University Center of Greenville, S.C.

From 36 to 45 semester hours are required for the M.P.A. degree, depending on the student's background. Students lacking proficiency in statistics or American government are required to take prerequisites in one or both areas. Students who do not have substantial administrative experience are required to complete an internship encompassing at least three months of full-time administrative work. All M.P.A. students must complete seven core courses (PO SC 702, 821, 822, 827, 829, 841 and 862), one level of government course (PO SC 806, 867, 868) of the student's choice and five electives.

PO SC 609: Directed Study in American Politics, 3 cr. (3 and 0)
Supervised reading and/or research in selected areas of American government. Prerequisite: Permission of instructor.

PO SC 616: Interest Groups and Social Movements, 3 cr. (3 and 0)
Empirical and normative examination of the origins, roles and influence of interest groups and social movements in the United States; the relationships among interest groups, social movements and democratic theory. Prerequisite: PO SC 101, junior standing or permission of instructor.

PO SC 621: Public Policy Processes, 3 cr. (3 and 0)
Public policy process, analysis and evaluation; examination and comparison of policy-making models, policy analysis and decision-making techniques, and approaches to program evaluation. Prerequisites: PO SC 101, junior standing or permission of instructor.

PO SC 623: Urban Politics, 3 cr. (3 and 0)
Interaction of political, technical and administrative processes in urban America. Emphasis is on the history and future of urban areas. Prerequisite: PO SC 101, junior standing or permission of instructor.

PO SC 624: Federalism and Intergovernmental Relations, 3 cr. (3 and 0)
Introduction to the historical, theoretical, legal and fiscal aspects of constitutionally divided government. Federal, state and local division of responsibility for public services will be emphasized along with the emerging devolution of those responsibilities from the federal government to states and localities.

PO SC 627: Public Personnel Management, 3 cr. (3 and 0)
Government personnel systems; current trends and problems; essentials of recruitment, classification, compensation, motivation, evaluation, training and discipline. Prerequisite: PO SC 101, junior standing or permission of instructor.

PO SC 628: National Security Policy I, 3 cr. (3 and 0)
Overview and analysis of the principal national security policy issues facing the United States, emphasizing weapons proliferation; arms control; support to military forces and operations; terrorism; intelligence/counterintelligence; narcotics and organized crime; economic issues; and of the national security decision-making process. Prerequisite: PO SC 102 or 104, junior standing; or permission of instructor.

PO SC 629: National Security Policy II, 3 cr. (3 and 0)
Analysis, assessment and management of specific country and regional security threats and challenges to the United States. Principal targets of assessment include rogue nations, regional superpowers, alliances and areas of potential or ongoing threat or conflict. Prerequisites: 102 or 104, junior standing; or permission of instructor.

PO SC 632: American Constitutional Law I, 3 cr. (3 and 0)
Examination and analysis of Supreme Court decisions and other legal materials in the areas of national power; federalism; the separation of powers; and the role of the judiciary.

PO SC 633: American Constitutional Law II, 3 cr. (3 and 0)
Examination and analysis of Supreme Court decisions and other legal materials in the areas of civil rights and civil liberties with an emphasis on freedom of speech, freedom of religion, equal protection of the laws, and privacy rights.

PO SC 642: Political Parties and Elections, 3 cr. (3 and 0)
Distinctive features of the American two-party system with emphasis on presidential elections. Parties are examined as formal organizations, coalitions of voters and interest groups, coordinators of nomination and election processes and managers of policy-making institutions. Prerequisite: PO SC 101, junior standing or permission of instructor.

PO SC 654: Southern Politics, 3 cr. (3 and 0)
Examination of the unique political environment of the American South with emphasis on the events and social forces that have shaped politics in the region since World War II. Course is approached from a variety of perspectives, including history, literature, social themes and political culture.

PO SC 657: Political Terrorism, 3 cr. (3 and 0)
International phenomenon of terrorism in terms of origins, operations, philosophies and objectives. Prerequisite:
PO SC 102: junior standing or permission of instructor.

PO SC 658: Political Leadership, 3 cr. (3 and 0)
Comparative examination of political leaders; types, methods and consequences of leadership; relationship between leaders and followers. Prerequisite: PO SC 101, junior standing or permission of instructor.

PO SC 680: Gender and Politics, 3 cr. (3 and 0)
The role of gender in politics in the United States and in other countries emphasizing the role of women in electoral politics, the impact of nationalist violence and development policies on women's lives, and women's rights as human rights. Prerequisite: PO SC 101, 102, junior standing or permission of instructor.

PO SC 689: Selected Topics, 1-3 cr. (1-3 and 0)
Intensive examination of a selected area of political science. May be repeated for a maximum of six credits, but only if different topics are covered. Prerequisite: Permission of instructor.

PO SC 702: Methods for Public Management, 3 cr. (3 and 0)
Use of social science research methods in addressing issues in public management and policy; research design, measurement, data collection, sampling and polling; use of statistical procedures in policy studies and decision-making theory.

PO SC 821: Perspectives on Public Administration, 3 cr. (3 and 0)
Study and practice of public administration in the United States in the twentieth century; historical development of the field of public administration; current approaches to the study and practice of public administration.

PO SC 822: Public Policy Process, 3 cr. (3 and 0)
Major models of policy making including incrementalism, rationalism, pluralism and elitism; selected areas of public policy including transportation, poverty, energy and the environment.

PO SC 827: Public Personnel Administration, 3 cr. (3 and 0)
Organization, techniques and theories of personnel management; interpersonal relations in organizations; personnel change and development; changing conditions in the public service; educational specialization, unions, collective bargaining; etc.; ethics for the public service.

PO SC 829: Public Financial Management, 3 cr. (3 and 0)
Organization and techniques of governmental financial management; budgetary theories; intergovernmental financial relations.

PO SC 830: Constitutional Law for Public Administration, 3 cr. (3 and 0)
Principles of American constitutional law; legal issues related to public administration including delegation of power, separation of powers, due process, and civil rights and liberties. May not be taken for credit by students who have taken PO SC 632 or 633, or their equivalents.

PO SC 834: Administrative Law, 3 cr. (3 and 0)
Legislative, adjudicatory and general policy-making powers of administrative agencies and regulatory commissions; the scope of judicial review of administrative action; directed primarily toward the analysis of the political nature of bureaucracy.

PO SC 841: Public Data Analysis, 3 cr. (3 and 0)
Various aspects of locating, collecting and processing primary and secondary data utilized by public administrators and policy analysts including design of original surveys, library and archive searches, problems of storage and retrieval, and statistical description. Prerequisites: EX ST 301, MTHSC 301 or equivalent.

PO SC 860: American Government, 3 cr. (3 and 0)
The literature of the American political system, its institutions and processes.

PO SC 862: Administrative Leadership, 3 cr. (3 and 0)
The foundations of leadership in public organizations; personal and organizational values underlying decision processes in the public service.

PO SC 863: Contemporary Administrative Organizations, 3 cr. (3 and 0)
Problems, processes and theories of communication, decision-making, agency planning and control in administrative agencies.

PO SC 867: State Government Administration, 3 cr. (3 and 0)
State government problems and policy issues emphasizing the modernization of government institutions and comparative state politics.

PO SC 868: Local Government Administration, 3 cr. (3 and 0)
Administration of local government from the perspective of the professional administrator; the growth of the manager form of local government; the role of local government administrators with regard to policy making, management and the delivery of services.

PO SC 877: Public Policy Evaluation Seminar, 3 cr. (3 and 0)
Conceptual and analytic issues in policy and program evaluation including problem definition, goal setting and criteria formulation; design of evaluation research; indicator design; treatment of uncertainty; and special problems raised by constraints of the political context.

PO SC 878: Selected Topics in Public Administration, 3 cr. (3 and 0)
In-depth study of an applied problem in public administration as seen through the practitioner's eyes; the methods used to address these problems.

PO SC 879: Internship in Public Administration, 1-3 cr. (1-3 and 0)
Internship with a government agency requiring a written report detailing the experience.

PO SC 880: Capstone Seminar in Public Administration, 3 cr. (3 and 0)
Term project integrating the material from other courses in the analysis of a contemporary public administration problem. Field work and applied project required. Prerequisites: 30 credit hours toward MPA degree and permission of instructor.

PO SC 891: Master's Thesis Research Credit to be arranged.

These courses in Government and International Studies (GINT) are offered at the University Center of Greenville as part of the core courses in the joint program for the professional degree, Master of Public Administration.

GINT 767: State Government, 3 cr. (3 and 0)
State government problems and policy issues emphasizing the modernization of government institutions and comparative state politics.

GINT 771: Public Data Analysis, 3 cr. (3 and 0)
Program of gathering and using public data for public administrators and policy analysts including problems of research design and data gathering, interpretation and use in the analysis of public programs.

GINT 773: Personnel Administration, 3 cr. (3 and 0)
Organization, techniques and theories of personnel management; interpersonal relations in organizations; personnel change and development; changing conditions in the public service; educational specialization, unions, collective bargaining, etc.; ethics for public service.

GINT 774: The Public Policy Process, 3 cr. (3 and 0)
The public policy process including the role of public officials in the process and constraints on its outcomes.
PSYCHOLOGY

James McCubbin, Chair, Department of Psychology

Majors                              Degrees

Applied Psychology       M.S.
Industrial/Organizational  Ph.D.

The Department of Psychology offers a Ph.D. degree in industrial/organizational psychology and an M.S. degree in applied psychology with concentrations in industrial/organizational psychology and human factors psychology. These programs are designed to provide the student with the requisite theoretical foundations, skill in quantitative techniques and research design, and practical problem-solving skills to address human problems related to work. The Department of Psychology is a member of the Council on Applied Master's Programs in Psychology. The human factors conceptualism is fully accredited by the Human Factors and Ergonomics Society.

Applicants to these programs should have an undergraduate degree with a major in psychology or a related field from an accredited college or university. Students with a major other than psychology should have a minimum of 15 semester hours beyond the introductory psychology survey course. A formal thesis and supervised field internship are required for the M.S. degree. M.S. students complete 45 semester hours, including six semester hours of thesis credit and six semester hours of credit for the internship. Typically, the internship is completed in the summer between the first and second years of the program. In some cases, six semester hours of approved electives may be substituted for the field internship.

Students in the doctoral program are expected to satisfy the master's program requirements prior to receiving their doctorate. In addition to the required core content courses, a doctoral program must include at least one course from each of four major areas of psychology (biological, cognitive-affective, social, individual differences). In addition, 18 hours of dissertation research are required. Students are admitted to candidacy for the Ph.D. degree upon successful completion of a qualifying examination.

PSYCH 657: Principles and Processes of Teamwork, 3 cr. (3 and 0) Individual and group processes as they apply to team performance; theories, research and models of team functioning; applications of principles to ad hoc, business, multidisciplinary work and computer-supported teams. Prerequisite: PSYCH 201, one 300-level PSYCH course or permission of instructor.

PSYCH 569: Group Dynamics, 3 cr. (3 and 0) Current theory and research on small-group processes, group formation and development, group structure, the dynamic forces within a group, leadership group problem solving and decision making. Prerequisites: PSYCH 201 and one 300-level psychology course or permission of instructor.

PSYCH 662: Psychology and Culture, 3 cr. (3 and 0) Seminar examining the cultural context in which psychological theories and research are generated, and psychological perspectives on human diversity. Topics include the philosophical positions influencing psychological theory and research; methodological issues in the study of diversity, historical and contemporary perspectives; and cross-cultural psychological research in selected content areas. Prerequisite: PSYCH 310 or permission of instructor.

PSYCH 680: Health Psychology, 3 cr. (3 and 0) The role of health-related behaviors in the prevention, development and/or exacerbation of health problems; the biopsychosocial model and its application in the assessment, treatment and prevention of health problems. Prerequisite: PSYCH 201, one 300-level psychology course or permission of instructor.

PSYCH 683: Abnormal Psychology, 3 cr. (3 and 0) The physiological, psychological and cultural factors involved in such behavioral disorders as transient situational disturbances, personality disorders, psychoneuroses, psychoses and psychosomatic disturbances; the advantages and disadvantages of particular conceptual models in labeling and describing behaviors as either normal or abnormal. Prerequisites: PSYCH 201 and one 300-level psychology course or permission of instructor.

PSYCH 689: Selected Topics, 3 cr. (3 and 0) Seminar in current topics in psychology. Topics vary from semester to semester and will be announced prior to each semester's registration. May be repeated once for credit, but only if a different topic is covered. Prerequisite: Grade of C or better in 201.

PSYCH 810: Research Design and Quantitative Methods I, 3 cr. (3 and 0) Bivariate and multivariate data analysis applied to industrial and other work-related settings; the major data analytic tools needed for research in applied psychology. Prerequisite: Six credits of statistics, research methods or equivalent.

PSYCH 811: Research Design and Quantitative Methods II, 3 cr. (3 and 0) Research methodologies; experimental, quasi-experimental and nonexperimental designs emphasizing applied psychological research; scientific method; basic versus applied research; technical writing; grant writing and ethics. Prerequisite: PSYCH 810.

PSYCH 815: Advanced Studies in Systems and Theories, 3 cr. (3 and 0) The foundations of contemporary psychology, the origins of major theories, the conceptions of scientific knowledge implicit in them, and the reasons for accepting or rejecting them. Prerequisite: PSYCH 415 or permission of instructor.

PSYCH 822: Human Perception and Performance, 3 cr. (3 and 0) Basic research on human perception as applied to task performance; vision and audition in adults; basic knowledge of human sensory and perceptual characteristics as applied to such tasks as machine operation, task performance, etc.

PSYCH 823: Perception, Cognition and Technology, 3 cr. (3 and 0) Fundamentals of sensory and perceptual processes focusing on human vision and audition. Emphasis on perceptual aspects of applications and communication in electronic and traditional media. Topics include perception of speech, time, depth, color and motion in natural and virtual environments, as well as psychophysics, attention, eye movements and reading. Prerequisite: Enrollment in MFAC degree program or permission of instructor.

PSYCH 833: Cognitive Psychology, 3 cr. (3 and 0) Research and theory concerning perception, memory, reasoning, problem solving, knowledge representation, psychology of language, semantics, attention, concept formation and other high-level mental processes; applications of these areas are considered.
PSYCH 835: Advanced Human Factors Psychology, 3 cr. (3 and 0)
Provides a solid foundation from which to study interactions between human beings and systems in order to maximize safety, performance and user satisfaction. Emphasizes the integration and application of basic research and theory in sensation, perception, cognition and motor control. Prerequisite: Graduate student standing and permission of instructor.

PSYCH 837: Ergonomics for Applied Psychology, 3 cr. (3 and 0)
Perception and action capabilities of humans as they relate to the design of machines and environments; biomechanics, anthropometry, human movement and work and the perceptual supports action.

PSYCH 845: Advanced Studies in Adulthood and Aging, 3 cr. (3 and 0)
Human development from young adulthood through late adulthood; biological, cognitive, personality development and social development examined from the perspective of several major theoretical frameworks. Prerequisite: PSYCH 345 or permission of instructor.

PSYCH 852: Advanced Studies in Social Psychology, 3 cr. (3 and 0)
Human social behavior from the perspective of the individual as a participant in social relationships; contemporary theories of human social behavior and human behavior in social settings. Prerequisite: PSYCH 352 or permission of instructor.

PSYCH 860: Psychology of Training and Evaluation, 3 cr. (3 and 0)
Evaluation issues such as criteria development, organizational assessment, process and outcome criteria along with current methods, theory and applications in the measurement of job performance; training in the development and evaluation of performance appraisal systems. Prerequisite: PSYCH 364 or permission of instructor.

PSYCH 865: Job Analysis, 3 cr. (3 and 0)
Applied and theoretical issues in the analysis of work; structured techniques for person and job-oriented analyses; applications of job analysis in the areas of test development, performance appraisal and job evaluation. Prerequisite: PSYCH 364 or equivalent or permission of instructor.

PSYCH 866: Attitude Measurement Theory, 3 cr. (3 and 0)
Classic and contemporary approaches to attitude theory, measurement and scaling techniques; theories of job satisfaction; the measurement of attitudes toward work. Prerequisite: PSYCH 471 or permission of instructor.

PSYCH 871: Psychological Tests and Measurement, 3 cr. (3 and 0)
Advanced survey of psychological test development, evaluation and utilization in organizational and research settings; professional guidelines for the practice of testing in industrial/organizational psychology and legal guidelines for using tests in industry. Prerequisite: Permission of instructor.

PSYCH 883: Advanced Studies in Abnormal Psychology, 3 cr. (3 and 0)
Seminar on the etiology and classification of abnormal behavior; cultural influences on judgment of abnormality; in-depth examination of specific psychological disorders. Prerequisite: PSYCH 483 or permission of instructor.

PSYCH 891: Master's Thesis Research, credit to be arranged
PSYCH 895: Applied Psychology Internship, 3-6 cr. (0 and 3-6)
Supervised field experience in industry, business or government. Site location, on-site supervision and credit hours must be approved in advance by the graduate coordinator.

PSYCH 897: Special Problems in Applied Psychology, 1-3 cr. (1-3 and 0)
Study of a particular topic under the direction of a faculty member. Specific program is organized by the student and faculty member and submitted to the graduate coordinator for approval; project is not used to support M.S. thesis. May be repeated for a maximum of six credits.

PSYCH 898: Industrial/Organizational Psychology, 3 cr. (3 and 0)
Contemporary topics in industrial/organizational psychology. Prerequisite: Permission of instructor.

PSYCH 899: Selected Topics, 3 cr. (3 and 0)
Selected current and classic topics not covered in other courses. May be repeated for credit.

PSYCH 991: Doctoral Dissertation Research, credit to be arranged

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Sociology

John W. Ryan, Chair, Department of Sociology

<table>
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<th>Major</th>
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<tr>
<td>Applied Sociology</td>
<td>M.S.</td>
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The Department of Sociology offers the M.S. degree in applied sociology emphasizing practical and theoretical knowledge in the areas of industrial and organizational sociology and focusing on the acquisition of social research skills, theory application and practical field experience. Students are prepared for employment in federal, state and local government agencies; in industry and related agencies; and to pursue a doctorate.

Applicants must hold a bachelor's degree from an accredited degree program; have completed a minimum of 15 undergraduate semester hours in sociology or another social science discipline that includes at least one course each in statistics, research methods and sociological theory; submit GRE scores on the verbal, quantitative and analytical sections (satisfactory scores normally include a minimum of 500 on each section of the test); submit three letters of recommendation, at least two of which are from faculty members of the applicant's previously attended college or university; and submit a 500-word essay on career aspirations and goals, explaining how completion of this program in applied sociology will assist in achieving these goals.

All students are required to write a thesis and to complete a minimum of 40 hours of course work, including SOC 803, 805, 807, 810, 830, 833, 895 and selected electives. Students must demonstrate competency in basic statistics in the first semester by either passing a departmentally administered competency examination or obtaining a grade of B in EX ST 801. Students also must demonstrate competency in multivariate regression in the second semester by either passing a departmentally administered competency examination or obtaining a grade of B in MTHSC 500.
SOC 601: Human Ecology (R S 601), 3 cr. (3 and 0) S
Interrelationships among the physical world, modifications in natural environments, human settlement patterns and institutions that both encourage and regulate environmental modification. Emphasis is on conditions whereby natural resources become public policy concerns. Prerequisite: Sophomore standing.

SOC 604: Sociological Theory, 3 cr. (3 and 0)
Development of sociological theory. Required of all sociology majors. Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 614: Policy and Social Change, 3 cr. (3 and 0)
Sociological perspective is used to examine policy development, implementation and evaluation in the public and private sectors. Focuses on values and ethics and the effects of social change efforts on the outcomes of policy formation, social planning and implementation. Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 630: Sociology of Organizations, 3 cr. (3 and 0)
Analysis of administrative organizations and voluntary associations; applied analysis of their formal and informal group relations, communications and effectiveness. Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 633: Globalization and Social Change, 3 cr. (3 and 0)
Social and historical causes of development and underdevelopment societies; sociological theories of development. Selected countries are examined in an international context. Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 635: Leadership and Team Building, 3 cr. (2 and 3)
Introduction to leadership and the process of building effective teams. Examines various sociological perspectives on leadership and their role in developing and maintaining various types of groups. Students will participate in experiential learning opportunities. Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 640: Leisure, the Mass Media and Culture, 3 cr. (3 and 0)
Production and consumption of leisure activities in contemporary society; popular culture and the mass media as dominant forces for the social effects of leisure activities, relationship between work and leisure. Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 641: Sociology of Sport, 3 cr. (3 and 0)
Sport as a social phenomenon emphasizing leadership, discrimination, socialization, communication, conflict and cooperation in sports; emerging social issues in contemporary sports. Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 660: Race, Ethnicity and Class, 3 cr. (3 and 0)
Sociological perspectives on race, ethnic relations and social stratification; analysis of the impact of social class on minority movements. (Not open to students who have taken SOC 431.) Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 662: Men, Masculinity and Society, 3 cr. (3 and 0)
Masculinity and social order: norms, roles, relationships and activities; identity and socialization: work, family, sexuality, war and sports; subcultural comparisons. Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 663: Sociology of Parenting, 3 cr. (3 and 0)
Sociology of parenting, child rearing, parenting styles and outcomes; social change and parenting; variations by sex, race and class; cross-cultural comparisons; research-based with applied orientation. Prerequisites: SOC 201 and junior standing.

SOC 671 (R S 671): Demography, 3 cr. (3 and 0) F
Demographic concepts, theory and research methods for vital statistics, migration and population distribution and projections, collection and processing of demographic data and organization of demographic data systems. Prerequisite: ANTH 201 or SOC 201 or R S 301.

SOC 680: Medical Sociology, 3 cr. (3 and 0)
Socio-cultural factors in the etiology and treatment of physical illness; medical occupations and professions; organization of health-care delivery systems. Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 681: Aging and Death, 3 cr. (3 and 0)
Sociological orientation to aging populations focusing on the impact of health care, welfare and retirement systems; dying as a social phenomenon; suicide; euthanasia; funerals. (Not open to students who have taken SOC 383.) Prerequisites: SOC 201 and junior standing or permission of instructor.

SOC 684: Child Abuse and Treatment, 3 cr. (3 and 0)
Child abuse, neglect and exploitation as major social problems; causes, effects and prevalence of physical, sexual and emotional maltreatment; definitional controversies; social policy and legal considerations; therapeutic approaches for children and their caretakers; child maltreatment and the judicial system. Prerequisites: SOC 201 and senior standing or permission of instructor.

SOC 693: Sociology of Corrections, 3 cr. (3 and 0)
Analysis of correctional alternatives. Topics include sentencing strategies and their impact, prison populations (male, female and juvenile), inmate social structures, treatment and custody issues, community based alternatives (probation, parole, electronic monitoring and work release), and correctional management issues. Prerequisites: SOC 201 and 390 or permission of instructor.

SOC 803: Survey Designs for Applied Social Research, 3 cr. (3 and 0) F
Survey research design principles, procedures and techniques used in applied sociology; instrumentation; data collection and management and their interpretation. Prerequisite: SOC 303 or equivalent.

SOC 805: Evaluation Research, 3 cr. (3 and 0) S
Research methods and techniques of computer-assisted data management and analyses used in evaluating policies, operation, organization and effectiveness of social programs in the private and public sectors; microcomputer software packages available for these purposes. Prerequisite: SOC 803.

SOC 807: Advanced Research Methods, 3 cr. (3 and 0) S
Advanced methods in social research; measuring techniques and data analysis strategies; practical experience in various phases of social research. Prerequisite: SOC 803.

SOC 810: Theoretical Models in Applied Social Research, 3 cr. (3 and 0) S
Comparative analysis of theoretical models in sociology and their uses in applied research; uses of these models in research concerned with the processes of industrial and economic growth and development. Prerequisite: SOC 404 or equivalent.

SOC 812: Seminar on Marriage and the Family, 3 cr. (3 and 0) N
Current family research and theory in areas such as problem-solving strategies, developmental processes, family and work life, changes throughout the lifespan including premarital sexuality.
pregnancy, divorce, marriage enrichment and courtship. Topics vary from year to year. May be repeated for credit. **Prerequisite:** SOC 311 or equivalent.

**SOC 830: Human Systems**  
**Development: Organizations and Society, 3 cr. (3 and 0) F**  
Complex organizations such as human systems with primary focus on development and change, interorganizational relations and the influence of these structures on the community life. **Prerequisite:** SOC 430 or equivalent.

**SOC 833: Work and Society, 3 cr.**  
(3 and 0) S  
The history of industrial development and its consequences at the societal, community and individual levels; current issues involved in the relationship between work and society; strategies for developing research and policy related to these issues. **Prerequisite:** SOC 330 or equivalent.

**SOC 836: Environmental Sociology,**  
3 cr. (2 and 3)  
Introduction to environmental sociology; relationship among human behavior, society and the environment; focuses on the natural rather than the built environment; U.S. and global issues. **Prerequisite:** Graduate student status.

**SOC 882: Systems of Marital and Family Therapy,**  
3 cr. (3 and 0)  
Theories and techniques of marital and family therapy. **Prerequisite:** Permission of instructor.

**SOC 891: Master's Thesis Research**  
Credit to be arranged.

**SOC 892: Selected Topics in Sociology,**  
3 cr. (3 and 0) N  
Current topics in applied sociology not covered in other graduate courses. May be repeated once for credit.

**SOC 895: Field Experience,**  
3-6 cr. SS  
Supervised full-time work experience in a public agency or private enterprise to gain planning, research and policy experience. May not be repeated for credit. Graded on a pass/fail basis. **Prerequisite:** 12 hours of 800-level course work in sociology.

**SOC 896: Independent Study,**  
1-3 cr. (1-3 and 0)  
Individual readings or research in a topic area selected according to a student's interests or program needs. May be repeated for up to six hours. Graded on a pass/fail basis. **Prerequisite:** Approval of the director of graduate studies.

**ANTH 601: Cultures and the Environment,**  
3 cr. (3 and 0)  
Global impact of humans on the environment; prehistoric development and historical consequences of population growth, agriculture, political and economic complexity; future implications. **Prerequisites:** ANTH 201 and junior standing or permission of instructor.
### College of Engineering and Science

#### School of Chemical and Materials Engineering • 114
- Bioengineering • 114
- Ceramic and Materials Engineering • 118
- Chemical Engineering • 119
- Materials Science and Engineering • 120

#### School of the Environment • 123
- Environmental Science and Policy • 123
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- Textiles, Fiber and Polymer Science • 132

#### Directed by a Council of Department Chairs • 134
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- Biosystems Engineering • 134
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- Civil Engineering • 136
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- Computer Science • 141
- Electrical Engineering • 143
- Fine Arts in Computing • 147
- Management Science • 147
- Mathematical Sciences • 147
- Physics • 151
The College of Engineering and Science offers advanced degrees in these areas of study:

- Biosystems Engineering*
- Bioengineering
- Ceramic and Materials Engineering
- Chemical Engineering
- Chemistry
- Civil Engineering
- Computer Engineering
- Computer Science
- Electrical Engineering
- Engineering Mechanics
- Environmental Engineering and Science
- Environmental Toxicology**
- Fine Arts in Computing
- Hydrogeology
- Industrial Engineering
- Management Science***
- Materials Science and Engineering
- Mathematical Sciences
- Mechanical Engineering
- Physics
- Textiles, Fiber and Polymer Science

Courses are offered in astronomy, engineering graphics, and environmental science and policy to provide electives for students in other areas.

Degrees offered are the Master of Engineering, Master of Science and Doctor of Philosophy. Precise offerings in each area are found in the individual departmental or program descriptions.

The M.S. and Ph.D. programs serve primarily full-time graduate students. Industrial Residency programs leading to the Master of Science degree are available in certain engineering departments. Financial aid, in the form of full and partial fellowships and teaching and research assistantships, is available. Other financial aid packages are available to outstanding applicants. A broad and vigorous research program provides excellent thesis and dissertation research opportunities. Details on current research projects and special facilities are available from the various departments.

The Master of Engineering program is open to individuals who are interested in professionally-oriented advanced study. Requirements for the program are a baccalaureate degree from an ABET-accredited engineering program or equivalent, academic and professional records which indicate motivation for and the ability to complete additional professional study, and acceptance by the head of the department in which the individual plans to major and by the dean of the College of Engineering and Science.

The college offers cooperative graduate programs in which semesters of on-campus study are alternated with work assignments in industry.

The Clemson University Master of Engineering Program at The Citadel offers high quality graduate engineering education in the South Carolina Low Country. With few exceptions, the students are practicing engineers pursuing graduate education part-time in the evening hours. Currently courses are offered in civil engineering in the subject areas of structural, water resources and construction engineering. Information about courses and registration can be obtained by writing to Clemson University Master of Engineering Program at The Citadel, P.O. Box 12099, Charleston, SC 29422-2099, or by calling (843) 953-2242. The Master of Science degree program in civil engineering, both thesis and nonthesis options, is offered at The Citadel.

* This program is administered jointly by the College of Engineering and Science and the College of Agriculture, Forestry and Life Sciences. The degrees are awarded by the College of Engineering and Science.

** This program is administered jointly by the College of Agriculture, Forestry and Life Sciences and the College of Engineering and Science.

*** This program is administered jointly by the Department of Management (College of Business and Public Affairs) and the Department of Mathematical Sciences. The Ph.D. is awarded by the College of Business and Public Affairs.

SCHOOL OF CHEMICAL AND MATERIALS ENGINEERING
R. Larry Dooley, Director

Bioengineering

R. Larry Dooley, Chair, Department of Bioengineering

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<th>Major</th>
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<tr>
<td>Bioengineering</td>
<td>M.S., Ph.D.</td>
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The bioengineering program is devoted to the application of engineering science, methods and techniques to problems ranging from basic biomedical research to applied health care delivery. The principal area of concentration is biomaterials, engineering and related fields, including biomechanics and research instrumentation. The traditionally strong emphasis in the areas of materials and mechanics is directed toward the development of materials and devices (including artificial organs) for surgical implantation. Artificial intelligence is applied to medical diagnostic problems and to assist in the design, evaluation and fabrication of custom implants. Heavy reliance is placed on considerable direct laboratory experience.

The faculty is augmented by adjunct medical faculty, and most research programs are conducted in collaboration with medical, clinical or research-oriented institutions. All students have some direct experience with an appropriate aspect of this medical involvement. A three-month clinical internship is available to all students through the Bioengineering Alliance of South Carolina.

Students enrolling in this program usually have a strong background in the more traditional engineering disciplines. Some background in general biology and physiology is recommended but is not a prerequisite. Students with degrees in science may be considered for admission if they can demonstrate proficiency in certain prescribed engineering courses.

Candidates are allowed flexibility in planning their programs, but they are encouraged to seek advice and direction from the faculty because of the rapid evolution of this emerging discipline.

The master's degree curriculum offers both a thesis and a nonthesis option. The thesis option requires a minimum of 30 semester hours including six semester hours of research. The nonthesis option requires a minimum of 33 semester hours including six semester hours of nonthesis research, special topics or internship, and a report. Both options require a final examination.

BIO E 680 (C M E 680): Research Principles, 1 cr. (1 and 0)
Principles and practices of scientific research; developing scientific concepts, developing projects, pursuing research, collaborating in multi-disciplinary teams, patenting, publishing technical and scientific information, and reviewing professional and ethical standards of performance. Graded on a pass/fail basis.

BIO E 800: Seminar in Bioengineering Research, 1 cr. (2 and 0)
Original research in bioengineering; weekly one hour seminar associated with weekly recitation covering seminar preparation, presentation, professional writing,
bioengineering ethics and related topics. Graded on a pass/fail basis.

BIO E 801: Biomaterials, 3 cr. (3 and 0)
Structure and properties of the main classes of materials used in the articulation of organs and surgical implants; metals, ceramics, polymers, composites and materials of biological origin; mechanical properties, corrosion and design. Prerequisite: Permission of instructor.

BIO E 802: Compatibility of Biomaterials, 3 cr. (1 and 6)
Determining compatibility of biomaterials with the physiological environment; optical microscopy, microradiography and ultraviolet fluorescence; normal histology of tissues, basic pathological reactions and tissue reactions to materials.

BIO E 803: Polymeric Biomaterials, 3 cr. (3 and 0)
Interplay of physicochemical properties of polymeric materials and the design of biomedical devices and their in vitro and in vivo performance; critical manufacturing aspects of selected augmentation and prosthesis devices for soft and hard tissues; analysis of case studies and reports on recent research findings. Prerequisite: Permission of instructor.

BIO E 804: Metallic and Ceramic Implant Materials, 3 cr. (3 and 0)
Interaction between implant material and host tissue, selection of materials for different applications, influences of material and host tissue performance on implant design and on in vitro testing of implant materials and devices. Prerequisites: CME 310, BIO E 801 and permission of instructor.

BIO E 805: Composite Biomaterials, 3 cr. (3 and 0)
Mechanics of fiber-reinforced composite materials and their use in the design of structural orthopaedic implants; macro- and micro-mechanics, materials considerations, biocompatibility, diffusion, environmental resistance, aging, sterilization and fracture behavior. Prerequisite: BIO E 820 or permission of instructor.

BIO E 812: Orthopaedic Engineering and Pathology, 3 cr. (3 and 0)
Interdisciplinary study of orthopaedic cases (bone growth, bone remodeling, osteoarthritis, implant fixation and joint replacements); biomechanical, biomaterials and clinical diagnosis of failed implants (total joint, fracture fixation and spinal instrumentation); basic concepts of orthopaedic pathology for engineers. Prerequisites: BIO E 801, 802, 820 and 882 or permission of instructor.

BIO E 820: Structural Biomechanics, 3 cr. (3 and 0)
Mechanical functions of the human body treated as an engineering structure and the devices used to assist and supplement these functions; movement of the musculoskeletal system; locomotion; gait;prehension; lifting; function of artificial limbs; orthopedic prostheses and braces; effect of vibration and impact on the body; mathematical and other models of the body. Prerequisite: Permission of instructor.

BIO E 821: Human Dynamics, 3 cr. (3 and 1)
Elements of kinetics and kinematics, anthropometry, body segment parameters, link segment model development and synthesis of human movement, muscle mechanics, sports mechanics, blood flow and other delivery systems, organ motion and other topics of particular interest to students, all with reference to the human body in health and disease. Prerequisites: BIO E 820 or equivalent and permission of instructor.

BIO E 823: Cardiovascular Implants and Devices, 2 cr. (2 and 0)
Medical and bioengineering aspects of cardiovascular implants and devices; physiology and pathological aspects of patients with need for such implants and devices; history of cardiovascular implant and device design aspects of current implants and devices; cardiovascular tissue engineering. Prerequisite: BIO E 846 or equivalent.

BIO E 840: Creative Biomedical Engineering Design, 3 cr. (2 and 2)
Design philosophy; product liability; need analysis and specifications; feasibility studies; patent law; creativity and inventions; modeling and decision making; design of devices and systems; computer-aided design and manufacture (CAD/CAM); optimization; reliability; human factors. Students complete biomedical design project with hands-on CAD/CAM experience. Prerequisite: Permission of instructor.

BIO E 846: Biomedical Basis for Engineered Replacement, 3 cr. (3 and 0)
Form and function of human organs; major systems; examples of engineering repair and replacement methods presented in light of pathological or traumatic organ malfunction. Core course for all graduate students preferably during their first fall semester.

BIO E 847: Elements of Bioengineering, 4 cr. (4 and 0)
Cardiovascular systems and regulation; physiology of blood, heart and organ blood flow; properties of blood as a fluid; fluid flow equations; fluid mechanics; blood pressure; pulse propagation; respiration and control of breathing; gas exchange; heart-lung bypass devices; renal function and control; artificial kidney devices; heat flow and temperature regulation. Prerequisite: BIOSC 459/659.

BIO E 848: Cellular Interactions with Biomaterials, 4 cr. (2 and 2)
Cell biological concepts and issues relevant to cell-biomaterial interactions; methods for studying cell structure and function including basic cell culture techniques and in vitro biocompatibility analysis; biomaterial physicochemical properties which influence cellular interactions; interactions between implant materials and host tissues at the cellular and molecular level; overview of tissue engineering.

BIO E 850: Special Topics in Biomedical Engineering, 1-4 cr. (0-4 and 12-0)
Advanced topics in bioengineering intended to develop in-depth areas of particular student interest. Credit may be earned for more than one semester. Prerequisite: Permission of instructor.

BIO E 870: Bioinstrumentation, 3 cr. (2 and 2)
Concepts and techniques of instrumentation in bioengineering emphasizing effects of instrumentation on the biological system under investigation; transducers and couplers; data conversion; conditioning and transmission; experimental problems in acute and chronic procedures with static and dynamic subjects.

BIO E 882: Biomaterials Implantology, 4 cr. (2 and 6)
All phases of experimental surgery including selection of animal models, preparation of animals for surgery, general and special surgical techniques, and basic and applied instrumentation. Prerequisite: BIOSC 459/659 or equivalent.

BIO E 890: Internship, 1-5 cr. (0 and 8-40)
Observation and assignment in a medical college, dental college, hospital, veterinary clinic, dental clinic, health service or industrial department. Credit to be arranged. Prerequisite: Permission of department head.

BIO E 891: Master's Thesis Research, credit to be arranged

BIO E 892: Nonthesis Independent Study in Bioengineering, 1-6 cr.
Independent study in bioengineering for work necessary to complete requirements for the Master of Science degree in bioengineering, nonthesis option. May be repeated for additional credit. Graded on a pass/fail basis.

BIO E 991: Doctoral Dissertation Research, credit to be arranged

The following courses offered by various departments represent possible electives for the student in bioengineering.

AN PH 660: Systems Physiology, 1 cr. (1 and 0) F
Physiology of digestive and endocrine systems. Corequisite: BIOSC 459 or permission of instructor.
AN PH 801 (BIOSC 801): Electron Microscopy of Biological Specimens, 3 cr. (1 and 6) F, S
Concepts and practice in preparing biological specimens for electron microscopy: fixing, embedding, thin-sectioning, staining, operating microscopes and photographing, developing, printing and interpreting micrographs. Each student must achieve proficiency with a selected specimen including writing a brief research proposal, preparing specimen, studying specimen with electron microscope and interpreting micrographs. Prerequisite: Permission of instructor.

AN PH 802: Selected Topics, 1-3 cr. (1-3 and 0-3) F, S
Current topics in animal physiology not covered in other courses. May be repeated for a maximum of six credits. Prerequisite: Permission of instructor.

AN PH 806: Care and Use of Research Animals, 3 cr. (1 and 6) F
Demonstration and practice of humane care and use of animals in research; study of animal anesthesia and analgesia; regulatory aspects of the use of animals in teaching and research; surgical techniques and sample collection. Prerequisites: BIOSC 659 and AN PH 660 or permission of instructor.

AN PH 807: Special Problems in Animal Physiology, 1-3 cr. (1-3 and 0) Research not related to a thesis. May include a comprehensive review of related literature.

AN PH 808: Current Concepts in Endocrinology, 3 cr. (3 and 0) S
Advanced concepts relevant to interrelationships between the nervous and endocrine systems as they influence growth and development, body metabolism and regulatory mechanisms, reproduction and lactation. Prerequisites: AN PH 660 and BIOSC 680, or BIOCH 817, or permission of coordinator.

AN PH 812: Digestive-Metabolic, Excretory and Respiratory Physiology, 5 cr. (4 and 3) F (even numbered years)
Advanced concepts of mechanisms and functions of gastrointestinal tract (mastication, salivation, digestion, absorption, metabolism, excretion), kidney (anatomy, filtration, secretion, reabsorption) and respiratory systems (transport, exchange and utilization of gases); the action of the nervous system, hormones and pharmacologic agents on these organ systems. Prerequisites: BIOSC 659 and AN PH 660 or permission of course coordinator.

AN PH 814: Membrane, Cardiovascular and Neuromuscular Physiology, 5 cr. (4 and 3) S (even numbered years)
Advanced concepts in membrane physiology (permeability, action potentials, specialized functions), cardiovascular physiology (functions of the heart, blood vascular system in maintaining acid-base balance, clotting mechanisms, hemostasis, circulation), neuromuscular physiology (anatomy and function of the nervous system, special senses, reflexes, control of muscular activity); and the action of several pharmacologic agents on multiple physiological functions. Prerequisites: BIOSC 659 and AN PH 660 or permission of course coordinator.

AN PH 851: Animal Physiology Seminar, 1 cr. (1 and 0) F, S
Current research and development in animal physiology through related literature and student and faculty participation. May be repeated for a maximum of two credit hours.

AN PH 891: Master's Thesis Research, credit to be arranged
AN PH 991: Doctoral Dissertation Research, credit to be arranged

BIOCHEMISTRY

BIOCHEM 606: Physiological Chemistry, 3 cr. (3 and 0)
Chemical basis of the mammalian physiological processes of muscle contraction, nerve function, respiration, kidney function and blood homeostasis; composition of specialized tissue such as muscle, nerve, blood and bone; regulation of water, electrolytes and acid-base balance. Prerequisite: BIOCH 210 or organic chemistry.

BIOCH 623: Principles of Biochemistry, 3 cr. (3 and 0)
Chemistry of amino acids, monosaccharides, fatty acids, purines, pyrimidines and associated compounds; an understanding of their properties and the relationship between structure and function that make them important in biological processes; use of modern techniques. Prerequisite: CH 224 or equivalent.

BIOCHEM 659: Systems Physiology, 3 cr. (3 and 0)
Physiological systems of vertebrates and their homeostatic controls; function of the major physiological systems in terms of anatomical structure and chemical and physical principles. Prerequisite: One year each of biology, chemistry and physics or permission of instructor.

BIOCHEM 661: Cell Biology, 3 cr. (3 and 0)
Analysis of how and where intracellular and extracellular molecules control general and specific cellular functions such as gene expression, secretion, motility, signaling, cell-cycle control and differentiation. Taught and graded at a level where students are expected to infer from and integrate cellular events. Prerequisite: BIOCH 301 or permission of instructor.

CH E 820 (T C 820): Composite Polymeric Materials, 3 cr. (3 and 0) N
Morphology, chemistry, processing and physical characterization of engineered fibers and matrix materials; influence of fiber and matrix properties on composite characteristics; application of surface chemistry to analyze fiber/matrix wetting and adhesion. Prerequisite: CH 224 or permission of instructor.

E M 630: Mechanics of Composite Materials, 3 cr. (3 and 0)
Fundamental relationships for predicting the mechanical and thermal response of multi-layered materials and structures; microstructural and macromechanical relationships for laminated materials with emphasis on continuous filament composites; unique nature of composites and advantages of designing with composites. Prerequisite: E M 304.

E M 831: Theory of Elasticity I, 3 cr. (3 and 0)
Theory of stress and deformation for continuous media; linear stress-strain relationships for elastic material; two-dimensional problems including Airy stress function, polynomial solutions, plane stress and plane strain in rectangular and polar coordinates, torsion and bending of prismatic bars and thermal stresses. Prerequisites: E M 304 and MTHSC 208.

EX ST 801: Statistical Methods, 4 cr. (3 and 3) F, S
Role and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components, design of experiments, prediction, linear regression and correlation, and non-parametric procedures. Prerequisite: Permission of instructor.

The following courses offered by various departments represent possible electives for the student in animal physiology.

AVS 653: Animal Reproduction, 3 cr. (2 and 2) F
Reproductive physiology and endocrinology of mammals with emphasis on farm animals and reference to reproduction in laboratory animals and humans. Prerequisites: AVS 202 and AN PH 301.

AVS 655: Animal Reproductive Management, 1 cr. (0 and 3) S
Physiology and endocrinology of pregnant and non-pregnant cows, methods of artificial insemination, pregnancy detection and computer recordkeeping for achieving a high level of reproductive efficiency in cattle. Prerequisites: AVS 202, AN PH 301, and to be taken concurrently or to follow AVS 453.

AVS 661: Physiology of Lactation, 2 cr. (2 and 0) S
Anatomy and development of the mammary gland; physiological and biochemical regulation of mammary growth and milk secretion with emphasis on farm animals and reference to other mammals. Prerequisites: AVS 202 and BIOCH 210.
AVS 805: Immunobiology, 3 cr. 
(3 and 0) S
Conceptual approach to immunobiology emphasizing the molecular and cellular aspects. Classical and current literature is the major source for the discussion/lecture format. Prerequisite: Permission of instructor.

AVS 825: Immunobiology, 3 cr. 
(3 and 0) S
Conceptual approach to immunobiology emphasizing the molecular and cellular aspects. Classical and current literature is the major source for the discussion/lecture format. Prerequisite: Permission of instructor.

BIOCHEMISTRY 606: Physiological Chemistry, 3 cr. 
(3 and 0) S
Chemical basis of the mammalian physiological processes of muscle contraction, nerve function, respiration, kidney function and blood homeostasis; composition of specialized tissue such as muscle, nerve, blood and bone; regulation of water, electrolytes and acid-base balance. Prerequisites: BIOCHEM 210 or organic chemistry.

BIOCHEMISTRY 623: Principles of Biochemistry, 3 cr. 
(3 and 0) S
Chemistry of amino acids, monosaccharides, fatty acids, purines, pyrimidines and associated compounds; understanding of their properties and the relationship between structure and function that make them important in biological processes; use of modern techniques. Prerequisites: CH 224 or equivalent.

BIOCHEMISTRY 632: Animal Histology, 3 cr. 
(3 and 0) S
Structural and functional study of the basic tissues of animals and tissue makeup of organs. Emphasis is on light microscopy level with selected tissue studied at the electron microscope level. Prerequisite: BIOCHEM 303 or permission of instructor. Corequisite: BIOCHEM 433.

BIOCHEMISTRY 633: Animal Histology Laboratory, 2 cr. 
(1 and 2) S
Microscopic examination of basic animal tissue types and the tissue makeup of organs which comprise systems. Corequisite: BIOCHEM 432.

BIOCHEMISTRY 659: Systems Physiology, 3 cr. 
(3 and 0) S
Physiological systems of vertebrates and their homeostatic controls; function of the major physiological systems in terms of anatomical structure and chemical and physical principles. Prerequisites: One year each of biology, chemistry and physics or permission of instructor.

BIOCHEMISTRY 660: Systems Physiology Laboratory, 2 cr. 
(1 and 2) S
Modern classical experimental methods will be used to demonstrate fundamental physiological principles discussed in BIOCHEM 459. Students will be introduced to computer-aided data acquisition and computer simulations of physiological function. Prerequisite or Corequisite: BIOCHEM 459.

BIOCHEMISTRY 661: Cell Biology, 3 cr. 
(3 and 0) S
Analysis of how and where intracellular and extracellular molecules control general and specific cellular functions such as gene expression, secretion, motility, signaling, cell-cycle control and differentiation. Taught and graded at a level where students are expected to infer from and integrate cellular events. Prerequisite: BIOCHEM 301 or permission of instructor.

BIOCHEMISTRY 666: Herpetology, 3 cr. 
(2 and 3) S
Systematics, life history, distribution, ecology and current literature of amphibians and reptiles; laboratory study of morphology and identification of world families, U.S. genera, and all Southeastern species. Field trips will be required. Prerequisite: BIOCHEM 303 or permission of instructor.

BIOCHEMISTRY 670: Animal Behavior, 3 cr. 
(3 and 0) S
Historical and modern developments in animal behavior emphasizing the evolutionary and ecological determinants of behavior; synthesis of ethology and comparative psychology. Prerequisite: BIOCHEM 302 or 303 or permission of instructor.

BIOCHEMISTRY 671: Animal Behavior Laboratory, 1 cr. 
(0 and 3) S
Laboratory exercises that explore the behavior of animals. Emphasis is on behavioral observation and analysis and presentation of findings in a report for-
EX ST 805: Design and Analysis of Experiments, 3 cr. (3 and 0) F, S
Basic designs and analysis; data transformations; single degree of freedom, orthogonality and responses in ANOVA; covariance; response surfaces; incomplete blocks; introduction to least squares analysis of experiments; uses of standard computer programs for selected analyses. Prerequisite: EX ST 801.

Ceramic and Materials Engineering
Henry J. Rack, Chair, Department of Ceramic and Materials Engineering

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<tr>
<th>Major</th>
<th>Degrees</th>
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<tbody>
<tr>
<td>Ceramic and Materials</td>
<td>M.S., M.Engr., Ph.D.</td>
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<tr>
<td>Engineering</td>
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Enrollment is open to students with baccalaureate degrees in any branch of engineering or the sciences.

Students may direct their programs toward traditional ceramic and metal materials, or they may focus on such advanced materials as photonics, electronic ceramics, optical fibers, ceramic/metal matrix composites or advanced structural materials. Courses in chemistry, physics, mathematics, textiles and engineering provide background for learning the behavior of materials. Study includes research into selected material topics in ceramics, metals or polymers with the preparation of a thesis as a major part of the program.

The M.S. degree program requires a minimum of 30 hours of graduate credit, including six hours of thesis research. The M.Engr. program requires 36 hours of graduate credit and passage of the Fundamentals of Engineering examination. The Ph.D. degree program requires 18 hours of dissertation research.

Ceramic and materials engineers with graduate degrees perform all functions expected of ceramic engineers with baccalaureate degrees. The studies and research projects lead the M.S., M.Engr. and Ph.D. degrees allow students to specialize in chosen fields and to focus their studies as discussed above. Ph.D. studies go even further, allowing candidates to develop their research skills by performing independent research. Such focused graduate studies in ceramic and materials engineering provide enhanced opportunities for students to practice and perform requisite ceramic and materials engineering functions, which prepares them for leadership roles in industry, government and academia.

As a result of advanced studies in their chosen field, Master's and Ph.D. graduates in ceramic and materials engineering will be able to:

- function easily and well in ceramic and materials laboratories and plants and will be prepared to assume leadership roles in these environments;
- demonstrate understanding of the application of scientific, mathematic and engineering principles to practical ceramic and materials engineering problems and will be prepared to provide leadership in these areas;
- design and conduct ceramic and materials experiments utilizing appropriate experimental design methodologies and will be prepared to provide leadership in such efforts; and
- function easily and well within local, national and international ceramics and materials communities.

Additionally, Ph.D. graduates in ceramic and materials engineering will be able to function well in design, modification, and performance of independent ceramic and materials engineering research.

C M E 602: Solid State Ceramics, 3 cr. (3 and 0)
Effects of the composition, form and source of raw materials on the manufacturing processes and final properties of ceramics; fundamental studies of phenomena such as diffusion, sintering, phase transformation, stability and microstructural development; property measurement and analytical methods for characterization. Prerequisites: C M E 302, 311 and MTHSC 206.

C M E 603: Glasses, 3 cr. (3 and 0)
Glass structure and composition and their relation to the properties of glasses; processing variables which control the properties of glasses including glass products, enamels, glasses and vitreous bonds. Prerequisite: C M E 302.

C M E 604: Ceramic Coatings, 3 cr. (3 and 0)
Raw materials, methods of manufacture and properties of ceramic coating. Prerequisite: C M E 302.

C M E 610: Analytical Processes, 3 cr. (2 and 3)
Theory and use of X-ray diffraction and spectroscopic methods. Prerequisite: Junior standing.

C M E 614: Processing of Ceramics, 3 cr. (3 and 0)
Ceramic processing after the raw material preparation with emphasis on modern processing theories and practices; nature of particles, forming methods, characterization techniques, consolidation by heat, surface chemistry of solids and chemical processing of specialized ceramics and composites. Prerequisite: CH 102 or equivalent.

C M E 616: Electronic Ceramics, 3 cr. (3 and 0)
Theory and measurement of the electronic properties of ceramic products.

C M E 618: Process Control, 3 cr. (3 and 0)
Process control techniques and apparatus with emphasis on temperature measurement and control systems; application of laboratory techniques to the control of product quality and process efficiency. Prerequisite: Junior standing.

C M E 630: Fine Particle Processing in Ceramic Systems, 3 cr. (3 and 0)
Cause-and-effect relationship in particular suspensions controlling rheological behavior, porosity, packing densities, shrinkage and other properties of ceramic ware; particle size analysis techniques and measurements, particle packing, rheological properties and measurements, surface area analysis, and interfacial chemicals including both flocculants and deflocculants. Prerequisites: C M E 202, 204, 304 or permission of instructor.

C M E 660: Metals and Their Composites, 3 cr. (3 and 0)
The course will examine the control of microstructure-property relationships in metallic materials and their composites through development and selection of appropriate thermal processing procedures. Prerequisite: C M E 210 or M E 301.

C M E 661: Processing of Metals and Their Composites, 3 cr. (3 and 0)
This course will examine the control of microstructure-property relationships in metallic materials and their composites through development and selection of innovative manufacturing methods. Prerequisite: C M E 210 or M E 301.

C M E 680: Research Principles, 1 cr. (1 and 0)
Principles and practices of scientific research. Topics include developing scientific concepts, developing projects, pursuing research, collaborating in multidisciplinary teams, patenting and publishing technical and scientific information, and reviewing professional and ethical standards of performance. Taken on a pass/fail basis only.

C M E 690: Special Topics in Ceramic Engineering, 1-3 cr. (1-3 and 0)
Topics not ordinarily covered by other courses. Title of course varies, with permission of the instructor. May be repeated for a maximum of six credits, but only if different topics are covered. Prerequisite: Permission of instructor.

C M E 701: Special Problems, 1-3 cr. (1-3 and 0)
Practical problems in ceramic engineering analysis or design. Students are assigned individual problems with topics varying from year to year in keeping with developments, interests and experience of students and instructor. May be repeated for additional credit.

C M E 800: Ceramic Engineering Seminar, 1 cr. (1 and 0)
Discussions and presentations of current topics of ceramic science and engineering by students, faculty members and guest speakers. Required of all graduate students. Graded on a pass/fail basis.
CME 807: Specialized Ceramics, 3 cr. (3 and 0)
Advanced study of one of the following: structural products, refractories, whites, abrasives, enamels, glass, cements or raw materials processing.

CME 809: High-Temperature Materials, 3 cr. (3 and 0)
Properties of oxides, carbides, nitrides, borides and silicides; obtaining and measurement of high temperatures; measurement of properties at high temperatures.

CME 814: Ceramic Physical Processing, 3 cr. (3 and 0)
Role of physical processing in determining structure and composition of products.

CME 815: Colloidal and Surface Science, 3 cr. (3 and 0)
Theory and application of colloidal and surface chemistry to ceramic materials and processes.

CME 816: Constitution and Structure of Glasses, 3 cr. (3 and 0)
Modern concepts of glass structure and properties.

CME 821: X-ray Diffractometry, 3 cr. (2 and 3)
Theory and application of powder X-ray diffractometry to ceramic and materials problems.

CME 822: Scanning Electron Microscopy, 3 cr. (2 and 3)
Theory and application of scanning electron microscopy to ceramic and materials problems.

CME 823: Transmission Electron Microscopy, 3 cr. (2 and 3)
Advanced course in electron microscopy for materials science incorporating all aspects of transmission techniques: basics, diffraction, imaging and spectrometry. Prerequisites: CME 821 and 822 or permission of instructor.

CME 824: Mechanical Properties of Ceramic Materials, 3 cr. (3 and 0)
Stress-strain-time relations in elasticity, plasticity and rupture showing effects of high and low temperature and structures.

CME 825: Magnetic and Electrical Ceramic Materials, 3 cr. (3 and 0)
Application of magnetic and electrical theory to ceramic insulators, semiconductors, and ferroelectric and ferromagnetic products.

CME 828: Solid State Ceramic Science, 3 cr. (3 and 0)
Bonding and structure of crystalline materials as related to mechanical, thermal and chemical properties of solids.

CME 891: Master's Thesis Research, credit to be arranged

CME 991: Doctoral Dissertation Research, credit to be arranged

### Chemical Engineering

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<tr>
<th>Major</th>
<th>Degrees</th>
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<tr>
<td>Chemical Engineering</td>
<td>M.Eng., M.S., Ph.D.</td>
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</table>

Students may be accepted with backgrounds in chemistry, physics or branches of engineering other than chemical engineering. Special programs will be planned for non-chemical engineering graduates. Candidates for the M.S. degree must complete a thesis. The M.Eng. degree is granted upon completion of an approved program of study which consists of 30 credit hours of course work including the core courses listed for the M.S. degree.

The M.S. degree program consists of 30 credit hours of work including six credit hours of research. The course work includes CH E 803, 804, 805 and 823. In addition, six hours of approved chemical engineering electives and six hours of approved technical electives are required. At least six of the 12 elective hours must be selected from courses numbered 800 or above.

The Ph.D. program consists of 36 credit hours of approved graduate courses beyond the B.S. degree including 12 credit hours of approved graduate courses at Clemson University. Doctoral students must satisfy the M.S. course requirements through courses taken either at Clemson University or elsewhere. Each doctoral student must complete six credit hours of approved graduate courses offered by departments other than chemical engineering. In addition, each student is required to complete 30 credit hours of graduate research including 18 doctoral dissertation research credit hours (CH E 991) taken at Clemson University. These requirements establish minimum course work and research credit requirements and usually are exceeded at the advice of the individual student's advisory committee.

Minors for doctoral students may be taken in chemistry, physics, mathematics, life sciences or other branches of engineering.

CH E 601: Transport Phenomena, 3 cr. (3 and 0)
Mathematical analysis of single and multidimensional steady-state and transient problems in momentum, energy and mass transfer; similarities and differences in these mechanisms. Prerequisites: CH E 312 and MTHSC 208.

CH E 612: Polymer Engineering, 3 cr. (3 and 0)
Design-oriented course in synthetic polymers; reactor design used in polymer production, effect of step versus addition kinetics on reactor design, epoxy curing reactions, polymer solubility, influence of polymerization and processing conditions on polymer crystallinity. Prerequisites: CH E 224 and 332 or permission of instructor.

CH E 628 (B E 628): Biochemical Engineering, 3 cr. (3 and 0)
Use of microorganisms and enzymes for the production of chemical feedstocks, single-cell protein, antibodies and other fermentation products; kinetics and energetics of microbial metabolism; design and analysis of reactors for microbial growth and enzyme-catalyzed reactions; considerations of scale-up, mass transfer and sterilization during reactor design. Prerequisites: BIOS 340, MICRO 305 and BIOCH 301. Chemical Engineering majors take CH E 628 as prerequisite and CH E 450 as corequisite.

CH E 650: Chemical Reaction Engineering, 3 cr. (3 and 0)
Kinetics of chemical reactions; analysis and design of chemical reactors; homogeneous and heterogeneous reactions; batch and continuous flow reaction systems; catalysis, design of industrial reactors. Prerequisites: CH E 312, 321 and CH 332.

CH E 654: Computer Process Control, 3 cr. (3 and 0)
Digital computer control as applied in chemical process industries; dynamics of process systems, control computer hardware and software, sampled data mathematics, digital control algorithms, process identification and advanced control techniques. Prerequisites: CH E 353 or equivalent and CH E 307, MTHSC 208.

CH E 802: Process Dynamics and Control, 3 cr. (3 and 0)
Utilization of engineering principles in dynamic analysis and design of chemical processes, processing equipment and plants; systems dynamics; closed loop control and optimization. Prerequisites: CH E 353 and MTHSC 208 or permission of instructor.

CH E 803: Advanced Transport Phenomena, 3 cr. (3 and 0)
Analysis of heat, mass and momentum transfer; derivation and application of the governing equations; solution of steady and unsteady-state multidimensional problems in fluid flow, heat transfer and mass transfer.

CH E 804: Chemical Engineering Thermodynamics, 3 cr. (3 and 0)
Equilibrium of physical and chemical systems; generalized properties of hydrocarbons; application of thermodynamic methods in equipment design.

CH E 805: Chemical Engineering Kinetics, 3 cr. (3 and 0)
Kinetics of chemical reactions, particularly in design and operation of chemical reactors.

CH E 814 (EES 814): Applied Numerical Methods in Process Simulation, 3 cr. (3 and 0)
Numerical solution techniques as applied to chemical process systems; finite difference techniques for partial differential equations; numerical methods rather than theoretical numerical analysis; standard methods for ordinary differential equations reviewed. Prerequisite: Permission of instructor.
CH E 818: Polymer Processing, 3 cr. (3 and 0)
Processing of polymeric materials; polymerization; characterization; extrusion; blending; injection molding; fiber and film formation; physical science principles such as fluid flow, heat transfer, crystallization and rheology applied to polymer processing operations.

CH E 820 (T C 820): Composite Polymer Materials, 3 cr. (3 and 0)
Morphology, chemistry, processing and physical characterization of engineered fibers and matrix materials; influence of fiber and matrix properties on composite characteristics; application of surface chemistry to analyze fiber/matrix wetting and adhesion. Prerequisite: CH E 224 or permission of instructor.

CH E 823: Mass Transfer and Stagewise Contact Operations, 3 cr. (3 and 0)
Stagewise contact operations emphasizing distillation; vapor-liquid equilibria; integral and differential distillation; binary and multicomponent rectification; analytical methods; batch rectification; azeotropic and extractive distillation.

CH E 829: Membrane Separation Processes, 3 cr. (3 and 0)
Fundamental principles, mathematical modeling and applications of microfiltration, ultrafiltration, reverse osmosis, gas permeation and pervaporation; introduction to other membrane processes, including dialysis, Donnan dialysis, electrodialysis, liquid membranes, facilitated transport, membrane reactor and controlled release technology. Prerequisite: CH E 401 or equivalent or permission of instructor.

CH E 834: Advanced Chemical Engineering Thermodynamics, 3 cr. (3 and 0)
Classical and statistical thermodynamics applied to problems in chemical engineering with emphasis on modern methods of predicting thermophysical properties of gases and liquids; students' and instructor's interests influence course content, but usually include fundamentals of applied statistical mechanics; molecular theory of dense fluids; description of intermolecular forces, gas-liquid and liquid-liquid critical phenomena; theory of interfacial phenomena and adsorption, statistical mechanics of polymeric systems, statistical mechanics of polydispersed systems, computer simulation of fluids by Monte Carlo, molecular dynamics and stochastic dynamics methods. Prerequisite: CH E 804 or equivalent.

CH E 845: Selected Topics in Chemical Engineering, 3 cr. (3 and 0)
Topics not covered in other courses emphasizing current literature and results of current research. Topics vary from year to year to keep pace with developments. May be repeated for credit.

CH E 890: Special Projects, 1-6 cr.
Comprehensive analytical and/or experimental treatment of phenomena of current interest in chemical engineering emphasizing modern technological problems. May be repeated for a maximum of six credits. Graded on a pass/fail basis. Prerequisites: Permission of instructor and department chair.

CH E 891: Master's Thesis Research, credit to be arranged

CH E 895: Chemical Engineering Graduate Seminar, 1 cr. (1 and 0)
Series of weekly, one-hour seminars given by students, faculty and guests on topics of current interest. Graded on a pass/fail basis. Credits earned in this course do not apply to nor alter the required minimum of three research hours for the M.S. degree or the required 30 research credit hours for the Ph.D. degree.

CH E 945: Selected Topics in Chemical Engineering, 3 cr. (3 and 0)
A more comprehensive study of topics first covered in CH E 845.

CH E 991: Doctoral Dissertation Research, credit to be arranged

Materials Science and Engineering

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<tr>
<th>Materials Science and Engineering</th>
<th>Major</th>
<th>Degrees</th>
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<tr>
<td>Rajendra Singh, Director, Department of</td>
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<td>M.S., Ph.D.</td>
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<tr>
<td>Materials Science and Engineering</td>
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The Materials Science and Engineering program prepares graduate students to apply science and engineering principles to solve problems related to the scientific understanding, characterization and development of new technology necessary for the processing and manufacturing of different materials and related products.

Students with a baccalaureate degree in any branch of engineering, as well as chemistry, physics and biology majors with a strong mathematical background, may be admitted to the program. The curriculum provides for specialization in metallurgy, glasses and ceramics, electronic materials, semiconductor or manufacturing, biomaterials, polymer and fiber science, and composite materials. The program is designed to produce engineers and scientists whose degrees represent specialization coupled with a broad foundation in all materials.

Master's degree candidates must complete 24 credits of course work and six credits of research. Out of the 24 credits of course work, a maximum of 12 credit hours can be taken from 600 level courses. Each master's degree student must take MAT E 826 and MAT E 827.

The Doctor of Philosophy degree is aimed at providing the student with a comprehensive foundation in the science and engineering. The major field of study is generally interdisciplinary in nature, consisting of course work in several areas of engineering and science. A minimum of 45 credits of course work is required. Qualifying, comprehensive and final examinations are required. No foreign language is required, but proficiency in one is recommended.

Both master's and Doctor of Philosophy students must take at least one of the following courses (students should consult with their advisor when making the decision): MTH SC 805, MTH SC 806, MTH SC 808, EX ST 71 and EX ST 805. All students in their first semester at Clemson University must enroll in the Materials Research Seminar Course MAT E 800.

Candidates for the master's and doctoral degrees are affiliated with the department in which their research professor holds faculty position.

MAT E 800: Seminar in Materials Research, 1 cr. (1 and 0)
Special topics and original research in materials engineering. Credit may be earned for more than one semester.

MAT E 811: Materials Science and Engineering I: Structure, Bonding and Synthesis, 4 cr. (4 and 0)
Fundamentals of materials science and engineering, crystal structures, chemical and atomic bonding, mechanical properties, periodicity in relation to material engineering, methods of materials synthesis. Prerequisites: B.S. degree in materials science and engineering, physics, chemistry or appropriate engineering discipline, or permission of instructor.

MAT E 812: Materials Science and Engineering II: Electronic, Magnetic, Thermal and Optical Properties of Materials, 4 cr. (4 and 0)
Continuation of MAT E 811: electronic, magnetic, thermal and optical properties of materials; structure/properties and application of metals, semiconductors, ceramics and polymers and their importance in materials science and engineering. Prerequisites: MAT E 811 or permission of instructor.

MAT E 820: Deformation Mechanisms in Solids, 3 cr. (3 and 0)
Dislocation theory of solids; mechanisms of plastic deformation in single crystals and polycrystalline aggregates of metals and nonmetals; ductile and brittle fractures; fatigue, creep and stress corrosion cracking of metals. Prerequisite: Permission of instructor.
MAT E 826: Phase Equilibria in Materials Systems, 3 cr. (3 and 0)
Advanced treatment of phase equilibria in materials systems, phase diagrams, thermodynamics of defects, surfaces, interfaces and solutions. Prerequisites: C M E 310 and permission of instructor. Corequisite: M E 810.

MAT E 827: Kinetics of Phase Transformation, 3 cr. (3 and 0)
Advanced treatment of the kinetics of phase transformation in materials systems including nucleation, growth and spinodal decomposition. Prerequisites: MAT E 826 or equivalent, graduate standing and permission of instructor.

MAT E 991: Doctoral Dissertation Research, credit to be arranged
The following courses offered by various departments complete the curriculum for the program.

BIO E 801: Biomaterials, 3 cr. (3 and 0)
Structure and properties of the main classes of materials used in artificial organs and surgical implants; metals, ceramics, polymers, composites and materials of biological origin; mechanical properties, corrosion and design. Prerequisite: M E 204, C M E 310 or equivalent, or permission of instructor.

BIO E 803: Polymeric Biomaterials, 3 cr. (3 and 0)
Interplay of physicochemical properties of polymeric materials and the design of biomedical devices and their in vitro and in vivo performance; critical manufacturing aspects of selected augmentation and prosthetic devices for soft and hard tissues; analysis of case studies and reports on recent research findings. Prerequisite: Permission of instructor.

BIO E 805: Composite Biomaterials, 3 cr. (3 and 0)
Mechanics of fiber-reinforced composite materials and their use in the design of structural orthopaedic implants; macro- and micro-mechanics, materials considerations, biocompatibility, diffusion, environmental resistance, aging, sterilization and fracture behavior. Prerequisite: BIO E 820 or permission of instructor.

BIO E 850: Special Topics in Biomedical Engineering, 1-4 cr.
(0-4 and 12-0)
Advanced topics in bioengineering intended to develop in-depth areas of particular student interest. Credit may be earned for more than one semester. Prerequisite: Permission of instructor.

C M E 616: Electronic Ceramics, 3 cr. (3 and 0)
Theory and measurement of the electronic properties of ceramic products.

C M E 607: Specialized Ceramics, 3 cr. (3 and 0)
Advanced study of one of the following: structural products, refractories, white-wares, abrasives, enamels, glass, cements or raw materials processing.

C M E 809: High-Temperature Materials, 3 cr. (3 and 0)
Properties of oxides, carbides, nitrides, borides, and silicides; structure, chemical bonding, and thermal and chemical properties of solids.

C M E 814: Ceramic Physical Processing, 3 cr. (3 and 0)
Role of physical processing in determining structure and composition of products.

C M E 815: Colloidal and Surface Science, 3 cr. (3 and 0)
Theory and application of colloidal science. Theory and application of colloidal and surface chemistry to ceramic materials and processes.

C M E 816: Constitution and Structure of Glasses, 3 cr. (3 and 0)
Modern concepts of glass structure and properties.

C M E 821: Analytical Procedures and Equipment I, 3 cr. (2 and 3)
Theory and application of powder X-ray diffractometry, electron microscopy and optical microscopy to ceramic problems.

C M E 822: Analytical Procedures and Equipment II, 3 cr. (2 and 3)
Continuation of C M E 821.

C M E 824: Mechanical Properties of Ceramic Materials, 3 cr. (3 and 0)
Stress-strain-time relations in elasticity, plasticity and rupture showing effects of high and low temperature and structures.

C M E 825: Magnetic and Electrical Ceramic Materials, 3 cr. (3 and 0)
Application of magnetic and electrical theories to ceramic insulators, semiconductors, and ferroelectric and ferromagnetic products.

C M E 828: Solid State Ceramic Science, 3 cr. (3 and 0)
Bonding and structure of crystalline materials as related to mechanical, thermal and chemical properties of solids.

CH E 601: Transport Phenomena, 3 cr. (3 and 0)
Mathematical analysis of single and multidimensional steady-state and transient problems in momentum, energy and mass transfer; similarities and differences in these mechanisms. Prerequisites: CH E 302 and MTHSC 208.

CH E 612: Polymer Engineering, 3 cr. (3 and 0)
Design-oriented course in synthetic polymers; reactor design used in polymer production, effect of step versus addition kinetics on reactor design, epoxy curing reactions, polymer solubility, influence of polymerization and processing conditions on polymer crystallinity. Prerequisites: CH 224 and 332 or permission of instructor.

CH E 803: Advanced Transport Phenomena, 3 cr. (3 and 0)
Analysis of heat, mass and momentum transfer; derivation and application of the governing equations; solution of steady and unsteady-state multidimensional problems in fluid flow, heat transfer and mass transfer.

CH E 818: Polymer Processing, 3 cr. (3 and 0)
Processing of polymeric materials; polymer flow characterization; extrusion; mixing; filtration; injection molding; fiber and film formation; physical science principles such as fluid flow, heat transfer, crystallization and rheology applied to polymer processing operations.

CH E 819: Viscoelastic Properties of Polymers and Polymeric Composites, 3 cr. (3 and 0)
Time- and frequency-dependent behavior of structural polymers and their composites; interrelationship between various viscoelastic properties; influence of aging; prediction of composite viscoelastic response by application of the Viscoelastic Correspondence Principle. Prerequisite: Permission of instructor.

CH E 820 (T C 820): Composite Polymeric Materials, 3 cr. (3 and 0) N
Morphology, chemistry, processing and physical characterization of engineered fibers and matrix materials; influence of fiber and matrix properties on composite characteristics; application of surface chemistry to analyze fiber/matrix wetting and adhesion. Prerequisite: CH 224 or permission of instructor.

CH 602: Inorganic Chemistry, 3 cr. (3 and 0) F
Basic principles of inorganic chemistry with emphasis on atomic structure, chemical bonding, solid state, coordination chemistry, organometallic chemistry and acid-base theories; chemistry of certain selected elements. Prerequisites: CH 331, 332.

CH 804: Fundamental Principles of Inorganic Chemistry, 3 cr. (3 and 0) F
Fundamental principles of modern inorganic chemistry showing their relationship to other areas of chemistry.

CH 808: Chemistry of the Nonmetallic Elements, 3 cr. (3 and 0) S
(odd numbered years)
Development and application of a bonding model for descriptive inorganic chemistry of boron, carbon, silicon, nitrogen, phosphorus, oxygen and sulfur. Prerequisite: CH 804 or permission of instructor.
CH 809: Chemical Applications of X-Ray Crystallography, 3 cr. (2 and 2) S (odd numbered years)
Physical description of the crystalline state, symmetry in crystals, X-ray diffraction, modern methods of structure determination and chemical interpretation of structural results. Prerequisite: CH 331, 332 or permission of instructor.

CH 811: Analytical Chemistry, 3 cr. (3 and 0) F
Graduate-level review of modern analytical chemistry; literature, sampling, quality control/assurance, chemometrics and the use of modern analytical methods; team taught by the analytical faculty.

CH 812: Chemical Spectroscopic Methods, 3 cr. (2 and 3) S
Emission and absorption spectroscopy, chemical microscopy, X-ray diffraction and fluorescence techniques in analytical chemistry; theory and operation of instruments.

CH 834: Statistical Thermodynamics, 3 cr. (3 and 0) S (odd numbered years)
Statistical thermodynamics: ensemble method, ideal gases, internal degrees of freedom, solid state, imperfect gases, distribution function method in fluids and time-dependent fluctuations. Prerequisite: CH 831.

CH 837: Quantum Chemistry, 3 cr. (3 and 0) F (odd numbered years)
Mathematical and conceptual formulation of quantum theory of electronic structure of atoms and molecules; eigenvalue solution of one-dimensional Schrödinger equation and application of this method to chemical problems.

CH 910: Selected Topics in Analytical Chemistry, 1-4 cr. (1-4 and 0) N
New techniques and their applications in analytical chemistry, laser methods; data acquisition processing; electronics, instrument/computer interfacing; field methods of sampling and analysis. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.

E C E 606: Introduction to Microelectronics Processing, 3 cr. (3 and 0) S
Microelectronic processing, MOS and bipolar monolithic circuit fabrication, thick and thin film hybrid fabrication, applications to linear and digital circuits, fundamentals of device design. Prerequisite: E C E 320. Corequisite: MTHSC 311 or 434.

E C E 823: Integrated Circuit Technology, 3 cr. (3 and 0)
Physical and chemical principles underlying the major processing operations used in the fabrication of integrated circuit semiconductor devices, process simulation, diagnostic testing and factors affecting device yield and reliability. Prerequisite: Permission of instructor.

E C E 825: Solid-State Electronics, 3 cr. (3 and 0)
Modern physics approach to electrons and solids; elementary quantum mechanics; statistics; plasmas; band theory; application of these principles to modern amplifiers; e.g., the traveling-wave, tunnel diode, masers and parametric amplifiers. Prerequisite: C E 808 or equivalent, or permission of instructor.

E C E 840: Physics of Semiconductor Devices, 3 cr. (3 and 0)
Semiconductor device physics emphasized rather than circuits; detailed analysis of the p-n junction, traps, surface states and conduction processes and devices; association and method of Schottky diode, MIS diode, MOSFET, charge couples devices and solar cells; charge control concepts, transit time effects, surface-type devices and practical aspects of device process. Prerequisites: E C E 404 and 406/606.

E M 630: Mechanics of Composite Material, 3 cr. (3 and 0)
Fundamental relationships for predicting the mechanical and thermal response of multi-layered materials and structures; micromechanical and macromechanical relationships for laminated materials with emphasis on continuous filament composites; unique nature of composites and the advantages of designing with composites. Prerequisite: E M 304.

E M 831: Theory of Elasticity I, 3 cr. (3 and 0)
Theory of stress and deformation for continuous media; linear strain-stress relations for elastic material; two-dimensional problems including Airy stress function, polynomial solutions, plane stress and plane strain in rectangular and polar coordinates, torsion and bending of prismatic bars and thermal stresses. Prerequisites: E M 304 and MTHSC 208.

E M 832: Theory of Elasticity II, 3 cr. (3 and 0)
Continuation of E M 831 including topics from either three-dimensional problems associated with an infinite elastic medium, elastic half-space, contact stresses, symmetrically loaded sphere and circular cylinder, or complex variable methods in plane elasticity, stress concentration problems, singular stresses and fracture, and composite materials. Prerequisites: E M 831 and PHYS 812.

E M 836: Fracture Mechanics, 3 cr. (3 and 0)
Fundamental elasticity-based course in the development of the basic concepts of engineering fracture mechanics; the Griffith criterion, Barrenblatt and Dugdale models, linear elastic fracture mechanics (L.E.F.M.), plane strain fracture toughness, the crack-tip stress and strain field, and plasticity and the J-integral. Prerequisite: E M 831.

E M 852 (C E 852): Advanced Finite Element Analysis, 3 cr. (3 and 0)
Application of variational and weighted residual methods; nonlinear analysis, steady-state and time-dependent problems; application of commercial finite element codes; advanced computational procedures. Prerequisite: C E 808 or equivalent, or permission of instructor.

EX ST 801: Statistical Methods I, 3 cr. (3 and 3) F, S
Role and application of statistics in research: estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components analysis, simple and multiple linear regression and correlation, and non-parametric procedures. Prerequisite: Permission of instructor.

EX ST 805: Design and Analysis of Experiments, 3 cr. (3 and 3) F, S
Basic designs and analysis; data transformations; single degree of freedom, orthogonality and responses in ANOVA; covariation; response surfaces; incomplete blocks; introduction to least squares analysis of experiments; uses of standard computer programs for selected analyses. Prerequisite: EX ST 801.

M E 801: Foundations of Fluid Mechanics, 3 cr. (3 and 0)
Derivations of basic equations for multi-dimensional flow fields; analytical techniques for solving problems in laminar viscous flow and laminar inviscid flow; theories of similitude. Prerequisites: Graduate standing and permission of instructor.

M E 810: Macroscopic Thermodynamics, 3 cr. (3 and 0)
First, second and third laws of thermodynamics with engineering applications; thermodynamic property relations; chemical equilibrium. Prerequisite: M E 312 or equivalent.

M E 815 (PHYS 815): Statistical Thermodynamics I, 3 cr. (3 and 0)
Fundamental principles of kinetic theory and quantum statistical mechanics; Boltzmann statistics, Fermi-Dirac statistics and Bose-Einstein statistics. Prerequisite: A course in thermodynamics or permission of instructor.

M E 818: Introduction to Finite Element Analysis, 3 cr. (3 and 0)
Introduction to the finite element method; applications to heat transfer, fluid flow and solids; introduction to transient analysis; analysis strategies using finite elements; introduction to solid modeling, finite element modeling and analysis using commercial codes. Prerequisite: A numerical methods course or permission of instructor.

M E 932: Advanced Topics in Thermodynamics, 3 cr. (3 and 0)
Topics not covered in other courses. May be repeated for a maximum of six credits.
MTHSC 805: Data Analysis, 3 cr. (3 and 0) F, S
Methodology in analysis of statistical data emphasizing applications to real problems using computer-oriented techniques: computer plots, transformations, criteria for selecting variables, error analysis, multiple and stepwise regression, analysis of residuals, model building in time series and ANOVA problems, jackknife and random subsampling, multidimensional scaling. Prerequisites: MTHSC 301 and 400/600, or MTHSC 401/601 and 800.

MTHSC 806: Nonparametric Statistics, 3 cr. (3 and 0) F, S
Order statistics; tolerance limits; rank-order statistics; Kolmogorov-Smirnov one-sample statistics; Chi-square goodness-of-fit test; two-sample problem; linear rank statistics; asymptotic relative efficiency. Prerequisite: MTHSC 600 or 800.

MTHSC 808: Reliability and Life Testing, 3 cr. (3 and 0) S
Probability models and statistical methods relevant to parametric and nonparametric analysis of reliability and life testing data. Prerequisites: MTHSC 400/600 and 401/601 or equivalent.

PHYS 646: Solid State Physics, 3 cr. (3 and 0) F
Introductory treatment of the crystal structure of solids and the properties of solids which depend on crystal structure, free electron model of metals, band theory of solids, Brillouin zones, crystalline defects and diffusion. Prerequisite: PHYS 222 or permission of instructor.

PHYS 655: Quantum Physics I, 3 cr. (3 and 0) F
Solution of the Schroedinger equation for free particles, the hydrogen atom and the harmonic oscillator. Prerequisites: PHYS 322 and 441, or permission of instructor.

PHYS 656: Quantum Physics II, 3 cr. (3 and 0) F
Continuation of PHYS 455; application of principles of quantum mechanics as developed in PHYS 455 to atomic, molecular, solid state and nuclear systems. Prerequisite: PHYS 455.

PHYS 811: Methods of Theoretical Physics I, 3 cr. (3 and 0) F
Analytical methods and techniques used in theoretical physics: vector and tensor analysis as applied to physical problems, use of matrices and groups in classical and quantum mechanics, complex variables and partial differential equations of physics.

PHYS 812: Methods of Theoretical Physics II, 3 cr. (3 and 0) F
Continuation of PHYS 811: use of integral transforms, integral equations, special functions, calculus of variations and numerical approximations in solutions of physical problems.

PHYS 816: Statistical Thermodynamics II, 3 cr. (3 and 0) F
Generalized ensemble theory and fluctuations; applications to solids, liquids, gases and blackbody radiation. Prerequisite: PHYS 815.

PHYS 845: Solid State Physics I, 3 cr. (3 and 0) F
Physical properties of crystalline solids; crystalline state determination by diffraction methods; theories of specific heat; properties of metallic lattices and alloys; lattice energy and ferroelectrics.

PHYS 846: Solid State Physics II, 3 cr. (3 and 0) F
Continuation of PHYS 845; electronic properties of solids, band theory of solids, physics of semiconductors, theories of magnetism and magnetic resonance phenomena.

T C 615: Introduction to Polymer Science and Engineering, 3 cr. (3 and 0) F
Chemistry of monomers and polymers; chemical and physical properties of polymers emphasizing fiber-forming, synthetic polymers; includes molecular characterization, structure, morphology and mechanical properties as they relate to the design of polymer systems for end uses in textiles, geotextiles, plastics and fiber-reinforced composite materials. Prerequisites: CH 201, 330 (or 224) and T C 304 or permission of instructor.

T C 811: Polymer Science I, 3 cr. (3 and 0) F
Fundamentals of polymer chemistry; chemistry and synthesis of monomers and polymers discussed in relation to the thermodynamics, kinetics and mechanisms of polymerization reactions emphasizing fiber-forming polymers, plastics and composite matrix materials.

T C 812: Polymer Science II, 3 cr. (3 and 0) F
Chemical structure and properties of polymers; polymer solution properties, the viscoelastic state and the crystalline morphology of polymeric materials; the current theories for describing polymer thermal transitions, molecular weight, molecular weight distributions and transport phenomena in polymeric systems, as well as interfacial phenomena.

TEXT 821: Fiber Physics I, 3 cr. (3 and 0) F
Fiber physical properties and their relationship to fiber structure; methods of investigating fiber structure and physical properties; theories of viscoelastic behavior and thermal properties; models of fiber structure.

TEXT 822: Fiber Physics II, 3 cr. (3 and 0) F
Extension of TEXT 821 providing a more in-depth study of the mathematics of polymer fiber viscoelasticity and the solid state thermodynamics of polymeric systems; properties of copolymers; polymer optical and electrical properties; radiation physics of polymers. Prerequisites: TEXT 821 and MTHSC 208 or permission of instructor.

TEXT 830: Textile Physics, 3 cr. (3 and 0) F
Physical principles underlying manufacturing environments in which fibers, yarns and fabrics are produced. Physical and mathematical techniques are developed for the study and analysis of the textile plant environment, controls and energy requirements. Prerequisite: Graduate standing.

TEXT 835: Textile Structures I, 3 cr. (3 and 0) F
Pioneering works relating fiber properties to yarn properties; yarn geometry, fiber arrangements in twisted yarns, extension and breakage of continuous filament yarns, and deformation of staple fiber yarns.

TEXT 846: Textile Structures II, 3 cr. (3 and 0) S
Recent advances in the theoretical and experimental studies on fabric structures; structural mechanics of woven, knitted and nonwoven fabrics; relationship between yarn geometry and fabric structure; design of industrial fabrics and laminated structures. Prerequisite: Permission of instructor.

TEXT 856: Textile Mechanics, 3 cr. (3 and 0) S
The response of fibers to deformation and the mechanics of behavior of fibers when they are combined in a fabric. Prerequisite: TEXT 830 or permission of instructor.

SCHOOL OF THE ENVIRONMENT
Alan W. Elzerman, Director

Environmental Science and Policy
Alan W. Elzerman, Program Director, Department of Environmental Engineering and Science

Advanced degrees are not awarded in environmental science and policy, but courses are offered to provide a minor, a concentration or electives for students in other areas. Course selection for a minor or concentration should be approved in advance. Scientific and engineering courses are offered as well as relevant courses in economics, history, ethics, public health, political science and other related areas.

EN SP 631: Public Health Administration, 3 cr. (3 and 0) N
Career topics in the environmental sciences including public health organizations and regulations, public relations, psychology of public health administration, and the use of the communications media in educating the public on health problems.
EN SP 671: Man and His Environment, 2 cr. (2 and 0) N
The interaction of man with his environment; urbanization, population growth, pathogens, disease vectors, ionizing radiation, sewage disposal and noise control; effects of environmental contacts with air, water, food, and solid and liquid wastes. Prerequisite: Permission of instructor.

EN SP 672: Environmental Planning and Control, 2 cr. (2 and 0) N
Application of planning and control to effective environmental quality improvement; water supply and treatment, wastewater treatment and disposal, solid waste disposal, air pollution abatement, and land use and zoning. Not intended for graduate students in engineering. Prerequisite: Permission of instructor.

### Environmental Engineering and Science

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<tr>
<th>Major</th>
<th>Degree</th>
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<tr>
<td>Environmental</td>
<td>M.Eng., M.S.</td>
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<tr>
<td>Engineering and Science</td>
<td>Ph.D.</td>
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Environmental Engineering and Science is concerned with the characterization and control of environmental pollution. Emphasis is placed on applying the fundamental principles of the basic and engineering sciences through research and design to the solution of environmental problems in natural and engineered systems.

The M.Eng. program is designed to build on an ABET-accredited engineering baccalaureate background, while the M.S. degree builds on a student's previous engineering or science background. Students with a baccalaureate degree in any branch of engineering, as well as chemistry, physics, geology, biology or related majors with a strong mathematical background, may be admitted to the program. Students may specialize in one of five areas: (1) environmental process engineering; (2) nuclear environmental/risk assessment; (3) environmental and waste management; (4) environmental fate and transport; and (5) environmental chemistry. Research master's degree candidates must complete 24 hours of course work and six hours of research culminating in the presentation of a satisfactory thesis for M.Eng. candidates or a special problem report for M.Eng. candidates. An M.S. nonthesis option which requires 30 hours of course work and three hours of independent study is available. The course work must include EE&S 802, 843 and 851. A final examination is required of all master's candidates.

The Ph.D. program is directed toward providing the student with a comprehensive background in the fundamental aspects of environmental engineering and science. The major field of study is generally interdisciplinary in nature, consisting of course work in several areas of engineering and the basic sciences. Each student's curriculum and research program is tailored to suit his or her personal and professional goals. Qualifying comprehensive and final examinations are required. No foreign language is required.

EE&S 601: Environmental Engineering, 3 cr. (3 and 0) F, S
Introduction to the field of environmental engineering including environmental phenomena, impact of pollutants in the aquatic environment, solid-waste management, air pollution control, radiological health, and simple water and wastewatter treatment systems. Prerequisite: Junior standing in engineering or consent of instructor. Corequisite: E M 320 or permission of instructor.

EE&S 602: Water and Waste Water Treatment Systems, 3 cr. (3 and 0) S
Fundamental principles, rational design considerations and operational procedures of the unit operations and processes employed in water and waste water treatment; physicochemical and biological treatment techniques; introduction to the integration of unit operations and processes into water and waste treatment systems. Prerequisite: E M 320 or permission of instructor.

EE&S 608 (B E 608) (AGRON 608): Land Treatment of Wastewater and Sludges, 3 cr. (3 and 0) F
Principles for designing environmentally acceptable land application systems using municipal and industrial wastewaters and sludges; land-lmiting constituent analysis soil-plant interactions; system equipment and design; system operation and management; public acceptance, social and regulatory issues. Case studies and field trip(s) are planned. Prerequisite: Senior standing in agriculture or engineering or permission of instructor.

EE&S 610: Environmental Radiation Protection, 3 cr. (3 and 0) F
Fundamental principles of radiological health and radiation safety; radiation fundamentals, basic concepts of environmental radiation protection, internal and external dosimetry, environmental dose calculations and radiation protection standards. Prerequisite: Permission of instructor.

EE&S 611: Ionizing Radiation Detection and Measurement, 3 cr. (2 and 3) S
Laboratory exercises in ionizing radiation detection and measurements; nuclear electronics; counting statistics; radiation interactions; basic gas, scintillation and semiconductor detectors; gamma-ray spectroscopy; health physics survey instrumentation; and thermoluminescent dosimetry. Prerequisite: EE&S 410/610 or permission of instructor.

EE&S 630: Air Pollution Engineering, 3 cr. (3 and 0) S
Air pollution and its control; air pollutants and effects, sources, dispersion models, engineering controls and air-quality legislation. Prerequisite: Senior standing in engineering or physical sciences.

EE&S 651 (B E 651) (FOR 651):
Newman Seminar and Lecture Series in Natural Resources Engineering, 1 cr. (0 and 2) S, F
Development and protection of land, air, water and related resources will be covered by seminar with instructor and by invited lecturers. Current environmental and/or resource conservation issues will be addressed. Prerequisites: Senior or graduate standing, permission of instructor.

EE&S 680: Environmental Risk Assessment, 3 cr. (3 and 0) S
The quantitative estimation of the human health risk posed by the release of a contaminant to the environment; methods for analyzing emission rate, environmental transport, exposure and health effects of uncertainty analysis; role of risk assessment in environmental regulation and environmental decision making. Prerequisite: EE&S 401 or permission of instructor.

EE&S 684 (B E 684) (I E 684): Municipal Solid Waste Management, 3 cr. (3 and 0) S
Problems, regulations, collection, handling, recycling and disposal of municipal solid wastes in the urban and rural sectors; integrated waste-management systems with resource recovery, composting, incineration, landfill disposals and their costs. Prerequisite: Senior standing in engineering or science or permission of instructor.

EE&S 685: Hazardous Waste Management, 3 cr. (3 and 0) S
Problems, regulations, treatment and ultimate disposal of hazardous and toxic materials; spill cleanup, groundwater transport, land disposal, incineration and treatment technologies. Prerequisites: EN SP 200 or EE&S 401 or permission of instructor and two semesters of general chemistry.

EE&S 701: Special Problems, 1-6 cr.
(1-6 and 0) F, S
Environmental engineering problems selected to meet the interests and experience of student and/or instructor; formal report required. Restricted to Master of Engineering students. Graded on a pass/fail basis.

EE&S 802: Environmental Engineering Principles, 3 cr. (3 and 0) F
Fundamental principles required for simulation and modeling of environmental phenomena; mass transfer, reactor kinetics, simulation techniques and applications to various natural and engineered systems.

EE&S 803: Physicochemical Operations in Water and Wastewater Treatment Systems, 3 cr. (3 and 0) S
Principles of physicochemical operations used in water and wastewater treatment including sedimentation, filtration, mixing, gas transfer, adsorption, ion exchange, coagulation, precipitation, disinfection and...
oxidation. Prerequisites: EE&S 803 and 843.

EE&S 804: Biochemical Operations in Wastewater Treatment Systems, 3 cr. (3 and 0) F
Principles of biochemical operations used in wastewater treatment, modeling of ideal biochemical reactors and design criteria for aeration basins, activated sludge, trickling filters, rotating biological contacts, nitrification, denitrification and digestion. Prerequisites: EE&S 802 and EE&S 851.

EE&S 805: Laboratory in Water and Wastewater Treatment Operations, 1-2 cr. (0 and 6) S
Laboratory exercises in selected water and wastewater treatment operations including sedimentation, filtration, adsorption, coagulation, softening, aeration, activated sludge, aerobic digestion and anaerobic digestion. Corequisites: EE&S 803 or 804.

EE&S 806: Process and Facility Design for Environmental Control Systems, 2-4 cr. (4 and 0) F
Integration of unit operations into complex systems for treatment of industrial/domestic water and wastewater, contaminated groundwater or air, landfill leachate and toxic liquid wastes. The team approach is employed in the design of one integrated system for either water/waste-water or a hazardous/toxic waste. Prerequisites: EE&S 803 and 804.

EE&S 807: Physicochemical Operations in Hazardous Waste Treatment Systems, 3 cr. (3 and 0) F
Principles of physicochemical processes used for hazardous waste treatment and air pollution control systems. Prerequisites: EE&S 807 and 804.

EE&S 808 (GEO 808): Groundwater Modeling, 3 cr. (3 and 0) F
Mathematical and computer modeling of groundwater flow and nonreactive solute transport through geological formations; conceptual flow-models for geological systems; formulation of governing mass and energy conservation equations; application of analytical, numerical and stochastic models to real-world problems. Prerequisite: Permission of instructor.

EE&S 809 (GEO 809): Subsurface Remediation Modeling, 3 cr. (3 and 0) N
Lectures and computer exercises involving subsurface remediation methods including groundwater extraction, soil vapor extraction, steamflooding and a variety of other techniques; modeling flow of multiphase and multicomponent mixtures in porous media. Prerequisites: GEO/ EE&S 806 or permission of instructor.

EE&S 810 (GEO 810): Analytical Methods for Hydrogeology, 3 cr. (3 and 0) F
Analytical mathematical methods for modeling subsurface fluid flow and transport processes including saturated water flow, unsaturated zone gas flow, chemical transport and heat transfer, emphasizing the derivation and solution of governing equations for modeling subsurface flow and transport. Prerequisite: GEO 808 or a graduate level groundwater course or permission of instructor.

EE&S 812: Environmental Nuclear Engineering, 3 cr. (3 and 0) S
Environmental aspects of nuclear technology emphasizing nuclear reactors and the nuclear fuel cycle; environmental transport of radioactive materials; radioactive effluents from nuclear power plants; nuclear power plant safety; environmental aspects of fuel cycle activities; waste management. Prerequisites: EE&S 610 and permission of instructor.

EE&S 813: Environmental Radiation Protection Laboratory, 1 cr. (0 and 3) F
Continuation of EE&S 611: advanced experiments in radiation detection, radiation protection, health physics, and environmental monitoring. Prerequisites: EE&S 611 and permission of instructor.

EE&S 814 (CH E 814): Applied Numerical Methods in Process Simulation, 3 cr. (3 and 0) F
Numerical solution techniques as applied to chemical process systems; finite difference techniques for partial differential equations stressing applied numerical methods rather than theoretical numerical analysis; standard methods for ordinary differential equations reviewed. Prerequisite: Permission of instructor.

EE&S 832: Air Pollution Meteorology, 3 cr. (3 and 0) F
Applications of meteorology to air pollution; micrometeorology, plume rise modeling, atmospheric deposition, washout of pollutants; air chemistry; applications of diffusion modeling to air quality planning. Prerequisite: Permission of instructor.

EE&S 833: Air Pollution Control Systems, 3 cr. (3 and 0) F
Principles and design of air pollution control equipment including mechanical collectors, electrostatic precipitators, baghouse filters, wet scrubbers, adsorbers and incinerators. Prerequisite: EE&S 430/630 or permission of instructor.

EE&S 837: Biodegradation and Bioremediation, 3 cr. (3 and 0) F
Basic principles of biodegradation for major classes of organic contaminants including halogenated aliphatics and aromatics, fuel hydrocarbons, pesticides and nitrate nitrogen compounds; biotransformations of metals; biodegradation principles applied to the development of bioremediation technologies including intrinsic, in situ and on-site engineered approaches. Prerequisite: EE&S 851.

EE&S 843: Environmental Engineering Chemistry I, 3 cr. (3 and 0) F
Principles of chemical kinetics and thermodynamics applied to fundamental understanding of aqueous environmental samples including natural waters, wastewaters and treated waters; factors controlling chemical concentrations, acid-base equilibria, solubility equilibria, complex formation, electrochemistry, adsorption phenomena. Prerequisites: CH 101 and 102 or equivalent.

EE&S 844: Environmental Engineering Chemistry Laboratory I, 3 cr. (2 and 3) F
Laboratory experience in basic analytical methods used in water quality studies; experimental design, sampling, wet-chemical analytical techniques, data collection and analysis, data interpretation and data quality techniques. Prerequisites: Two semesters of general chemistry.

EE&S 845: Environmental Engineering Chemistry II, 3 cr. (3 and 0) S
Application of parameters that describe the equilibrium distribution and exchange rates for environmentally significant organic compounds to the modeling of processes in engineered and natural systems, including environmental parameter estimation techniques, structure-activity relationships, and integration of environmental processes to model contaminant distribution and residence time in environmental systems. Prerequisites: Two semesters of general chemistry and EE&S 843 or equivalent.

EE&S 847: Advanced Environmental Chemistry, 3 cr. (3 and 0) S
Advanced principles and methods in environmental engineering chemistry with applications to both natural and treatment systems; current investigational and study techniques; nature, fluxes and controlling states of chemical species, and radionuclides in environmental systems. Prerequisite: EE&S 843 or equivalent.

EE&S 849: Environmental Engineering Chemistry Laboratory II, 2 cr. (0 and 6) N
Theory and applications of instrumental methods of analysis as applied to measurements for environmental control; spectroscopy and spectrophotometric techniques, electrochemical analyses, chromatographic methods of analysis; light scattering and electrophoretic measurements.

EE&S 850: Stream and Estuarine Analysis, 3 cr. (3 and 0) F
Physical, chemical and biological processes and relationships which exist in streams and estuaries; estuarine environment; free-flowing streams; mechanisms describing transport of conservative and nonconservative materials through estuarine systems; the estuary as a resource and techniques for its management.
EE&S 851: Biological Principles of Environmental Engineering, 3 cr. (3 and 0) F
Basic principles of biology and biochemistry as applied to problems of environmental control and wastewater treatment; kinetic and energetic aspects.

EE&S 852: Subsurface Hydraulics, 3 cr. (3 and 0) F
The hydraulics of soil water and ground water including applications of Darcy's law to unsaturated flow, steady state flow in aquifers and aquitards, transient flow to wells, and well test analysis including slug tests, pumping tests and flowmeter tests. Mathematics will be at the level of elementary ordinary differential equations. Prerequisites: Differential equations; fluid mechanics or EE&S 802; or permission of instructor.

EE&S 855: Surface and Subsurface Transport, 3 cr. (3 and 0)
Quantitative analysis of reactive transport and biodegradation in ground water and surface water; applications of the advection-dispersion equation with reaction terms, including classical chemical reactions, radioactive decay and reactions mediated by microbes. Prerequisites: C E 340 and MTHSC 208 or equivalent.

EE&S 856: Pollution of the Aquatic Environment, 3 cr. (3 and 0) F
Effects of domestic and industrial water pollution on the physical, chemical and biological characteristics of natural waters; associated environmental determinants of human disease, toxicology and epidemiology of chronic disease.

EE&S 857: Pollution of the Aquatic Environment Laboratory, 1 cr. (0 and 3) N
Field and laboratory investigations into physical, chemical and biological effects resulting from pollution of the aquatic environment.

EE&S 861: Environmental Systems Engineering Seminar, 1 cr. (1 and 0) F, S
Current advances and research developments in various areas of environmental engineering; off-campus speakers, students and faculty participate. Graded on a pass/fail basis.

EE&S 880: Environmental Risk Assessment, 3 cr. (3 and 0) S
Methodology of quantitative risk assessment including identification and quantification of the source term, calculation of environmental transport and estimation of health effects; applications involve various classes of contaminants in atmospheric and aquatic environmental pathways. Prerequisites: MTHSC 208 and graduate-level standing in engineering or science.

EE&S 881: Special Problems, 1-4 cr. F, S
Problems selected to meet interests and experiences of student and instructor.

EE&S 883: Selected Topics in Environmental Engineering, 1-4 cr. F, S
A topic in environmental engineering not covered in another course. Topic varies to keep pace with current developments. May be taken concurrently with EE&S 884, which (if offered) would be a different topic.

EE&S 884: Selected Topics in Environmental Engineering, 1-4 cr. F, S
A topic in environmental engineering not covered in another course. Topic varies to keep pace with current developments. May be taken concurrently with EE&S 883, which (if offered) would be a different topic.

EE&S 891: Master's Thesis Research, credit to be arranged, F, S

EE&S 899: Doctoral Dissertation Research, credit to be arranged, F, S

Environmental Toxicology
Stephen J. Klaire, Chair, Department of Environmental Toxicology

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<th>Major</th>
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<tr>
<td>Environmental Toxicology</td>
<td>M.S., Ph.D.</td>
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See the College of Agriculture, Forestry and Life Sciences for information on this program.

Hydrogeology
Richard D. Warner, Chair, Department of Geological Sciences

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<th>Major</th>
<th>Degree</th>
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<tr>
<td>Hydrogeology</td>
<td>M.S.</td>
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The Master of Science in Hydrogeology is an interdisciplinary program focusing on groundwater geology and subsurface remediation and drawing on the expertise of faculty in the Department of Geological Sciences and the School of the Environment. The curriculum is structured to impart a strong background in field experimentation complemented by laboratory studies and computer modeling.

Candidates for the Master of Science degree in hydrogeology should have a baccalaureate degree in the geosciences. However, students having a strong undergraduate background in other fields of science or related engineering disciplines may be admitted, but they will be required to correct deficiencies in their geological education during the first year. Specifically, GEOL 101/103 (Physical Geology), GEOL 302 (Structural Geology), GEOL 306 (Mineralogy), plus a course in petrology (GEOL 314 or GEOL 316 or an equivalent) or GEOL 415 (Stratigraphy) are required. Students entering this program should also have a strong mathematics background; normally, three semesters of calculus are required, and differential equations is recommended.

The degree requires 24 semester hours of course work and six hours of thesis research. Candidates must write a thesis based on original research and defend it in an oral examination. Students may pursue a variety of research projects ranging from aquifer performance tests at an experimental well-field site in Atlantic Coastal Plain sediments near Aiken, S.C., to field scale and/or theoretical modeling studies of subsurface NAPL contamination and remediation. For students on leave from industry, a thesis option is available which requires 30 semester hours of course work and a comprehensive written examination.

All candidates must take at least six courses from an approved list of core courses maintained by the department. Three of these must be 800-level geology and environmental engineering GEOL 875 (Hydrogeology Summer Field Camp) and at least one of the following courses: GEOL 808 (Groundwater Modeling) or GEOL 809 (Subsurface Remediation Modeling).

GEOL 601: Applied Geophysics, 3 cr. (2 and 2)
Methods of geophysical exploration and their application to the investigation of subsurface groundwater and mineral resources; principles, techniques, interpretations and limitations of magnetic, gravimetric, electrical, electromagnetic, well-logging and geophysical surveys. Prerequisite: GEOL 101 or permission of instructor; PHYS 208 or 221 recommended.

GEOL 603: Invertebrate Paleontology, 3 cr. (2 and 3)
Life of past geologic ages, as shown by fossilized remains of ancient animals, with emphasis on the invertebrates. Prerequisite: GEOL 101 or permission of instructor.

GEOL 605: Geomorphology, 3 cr. (2 and 3)
Surface features of the earth — their form, nature, origin, development, and the rates and patterns of changes they are undergoing. Laboratory studies emphasize a process approach to terrain analysis stressing complex interactions of geologic, climatic and tectonic forces. Prerequisites: GEOL 101, 102; permission of instructor.

GEOL 608: Geohydrology, 3 cr. (3 and 0)
Hydrologic cycle, aquifer characteristics, theory of groundwater movement, mechanics of well flow, experimental methods and subsurface mapping. Prerequisites: GEOL 101,102.

GEOL 613: Stratigraphy, 3 cr. (2 and 2)
Analysis of stratified rocks as the repository of earth history and the conceptual framework used to synthesize the world geologic record as a coherent whole; traditional litho-stratigraphy, modern seismic stratigraphy, biostratigraphy, magnetostratigraphy and current stratigraphic issues. Prerequisite: GEOL 314 or permission of instructor.

GEOL 615: Analysis of Geological Processes, 3 cr. (3 and 0)
Introduction to methods for analyzing geological processes. Mathematical
methods will be introduced to solve problems related to stream flow, reaction kinetics, radioactive decay, heat flow, diffusion, fluid flow through geologic media and related processes. **Prerequisite:** MTHSC corequisite or permission of instructor.

**GEOL 651: Selected Topics in Hydrogeology, 1-4 cr. (1-3 and 0-3)**
Selected topics in hydrogeology with emphasis on new developments in the field. May be repeated for a maximum of six credits, but only if different topics are covered. **Prerequisite:** GEOL 300 or 408, or permission of instructor.

**GEOL 790: Selected Topics in Earth Sciences, 1-6 cr. (0-6 and 0-18)**
One or more earth science topics; lecture and laboratory emphasize the incorporation of new or updated subject matter into classroom instruction. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered.

**GEOL 800: Groundwater Geochemistry, 3 cr. (2 and 3)**
Lectures and project-oriented field work focusing on processes controlling natural impurities in groundwater and the occurrence of inorganic, organic and radioactive contaminants; solution equilibria, chemical weathering, oxidation-reduction, utilization of radioactive isotopes as tracers and studies of contamination plumes. **Prerequisites:** CH 101 and 102 or equivalent.

**GEOL 801: Groundwater Geophysical Techniques, 3 cr. (1 and 4)**
Lectures and project-oriented field work focusing on the utilization of geophysical instruments to detect groundwater-bearing fracture zones, to determine the depth to the water table, and to map contamination plumes. **Prerequisite:** PHYS 221 or permission of instructor.

**GEOL 803: Geostatistics, 3 cr. (3 and 0)**
Numerical and statistical treatment of geodetic data emphasizing the analysis of spatially and temporally distributed variables and unique aspects of geologic variables; methods of sampling geodetic data, quantitative procedures for reducing the dimensionality of geologic data sets, and techniques for presentation and interpretation of results. **Prerequisite:** MTHSC 301 or EX ST 301.

**GEOL 805: Advanced Stratigraphy, 3 cr. (3 and 0)**
Classification, distribution, chronologic succession and correlation of sedimentary rocks; interpretation of features of strata in terms of their origin, depositional environment, paleogeography and relation to organic evolution; Atlantic Coastal Plain stratigraphy. **Prerequisite:** GEOL 413/613 or permission of instructor.

**GEOL 806: Aquifer Characterization, 3 cr. (3 and 0)**
Characterization of aquifers from the microscopic scale to the regional scale; geological origin of aquifers and modification by diagenetic and deformational processes; application of subsurface geologic techniques to data acquisition and interpretation; prediction of fluid occurrence and flow by integrating results of subsurface analysis.

**GEOL 808: Groundwater Modeling (EE&S 808), 3 cr. (3 and 0)**
Mathematical and computer modeling of groundwater flow and nonreactive solute transport through geological formations; conceptual flow-models for geologic systems; formulation of governing mass and energy conservation equations; application of analytical, numerical and stochastic models to real-world problems. **Prerequisite:** Permission of instructor.

**GEOL 809 (EE&S 809): Subsurface Remediation Modeling, 3 cr. (3 and 0)**
Lectures and computer exercises involving subsurface remediation methods including groundwater extraction, soil vapor extraction, stream flooding and a variety of other techniques; modeling flow of multiphase and multicomponent mixtures in porous medium. **Prerequisite:** GEOL 808 or permission of instructor.

**GEOL 810 (EE&S 810): Analytical Methods for Hydrogeology, 3 cr. (3 and 0)**
Analytical mathematical methods for modeling subsurface fluid flow and transport processes including saturated water flow, unsaturated zone gas flow, chemical transport and heat transfer, emphasizing the derivation and solution of governing equations for modeling subsurface flow and transport. **Prerequisite:** GEOL 808 or a graduate level groundwater course or permission of instructor.

**GEOL 813: Environmental Geochemistry, 3 cr. (3 and 0)**
Inorganic geochemistry, specifically the distribution of trace elements in rocks, regolith and water. Topics include micronutrients and concepts of essentiality; health problems related to natural occurrence of toxic elements; environmental pollution arising from non-ferrous metal mining, coal mining and coal use, and gasoline additives; urban and regional geochemistry. **Prerequisite:** GEOL 318 or permission of instructor.

**GEOL 816: Aquifer Systems, 3 cr. (3 and 0)**
Hydrogeologic characteristics of selected major aquifer systems in the U.S. and elsewhere; conceptual models for the controls of recharge, discharge and flow through aquifers in different geologic settings; development of numeric models to simulate natural and stressed aquifers. **Prerequisites:** GEOL 408/608 and 808 or permission of instructor.

**GEOL 818: Hydrogeology of Fractured Aquifers, 3 cr. (3 and 0)**
Processes and characteristics of fluid flow through naturally and artificially fractured subsurface formations; principles of flow in dual porosity materials, characterizing fractures and fractured aquifers, mechanisms of fracture formation, methods of inducing fractures from wells; case studies and applications. **Prerequisites:** GEOL 408/608 and 808 or permission of instructor.

**GEOL 850: Selected Topics in Environmental Geology, 1-4 cr. (1-3 and 0-3)**
Selected topics in environmental geology emphasizing the subsurface contamination. May be repeated for a maximum of six credit hours, but only if different topics are covered. **Prerequisite:** Permission of instructor.

**GEOL 851: Geology Seminar, 1 cr. (1 and 0)**
Students review current topics in geology and make oral presentations. May be taken twice for credit.

**GEOL 875: Hydrogeology Summer Field Camp, 6 cr. (4 and 6)**
Groundwater geology field techniques including examination of surface exposures, analysis of cores and geophysical well logs, subsurface mapping, aquifer performance tests and groundwater remediation. **Prerequisite:** Permission of instructor.

**GEOL 876: Applied Hydrogeology, 3 cr. (3 and 0)**
Well installation methods and techniques; describing core and constructing lithologic logs; applying lithologic and geophysical logs to delineate aquifers and aquitards by subsurface mapping; using well testing methods to determine aquifer characteristics by conducting aquifer performance tests and analyzing test data. Taught at the Savannah River Site.

**GEOL 891: Master's Thesis Research, credit to be arranged.**
SCHOOL OF MECHANICAL AND INDUSTRIAL ENGINEERING
William F. Beckwith, Director

Engineering Graphics
William F. Beckwith, Program Director, General Engineering and Engineering Graphics

Advanced degrees are not awarded in engineering graphics. Courses are offered as electives for students in engineering and other areas.

E G 612: Interactive Computer Graphics, 3 cr. (3 and 0)
Graphics hardware and display technology; reduction and presentation of engineering data; techniques of geometrical transformations, perspective and model manipulation; methodology of computer-aided design; application of higher-level software to engineering problems. Prerequisites: E G 208 and MTHSC 208 or permission of instructor.

E G 690: Special Topics in Engineering and Computer Graphics, 1-3 cr. (1-3 and 0)
Computer-aided topic in engineering graphics not covered in other courses. May be repeated for a maximum of six credits. Prerequisite: Permission of instructor.

E G 823: Computer-Aided Geometric Modeling, 3 cr. (3 and 0)
Shape modeling and design by computer; curve and surface representation, methods of solid modeling by computer; data base representation and integral properties of solid models. Prerequisite: Graduate standing.

Engineering Mechanics
Richard S. Figliola, Chair, Department of Mechanical Engineering

Major Degrees
Engineering Mechanics M.S., Ph.D.

Enrollment is open to students with baccalaureate or master's degrees in any branch of engineering and to those with degrees in physics or applied mathematics who have credit for certain prescribed courses in engineering.

General areas of concentration are solid mechanics, composite materials, numerical methods and dynamics. Some limitations are imposed on the selection of courses to reflect the particular concentration. The usual minor is mathematics. Suitable minor programs also may be arranged in physics, civil engineering or mechanical engineering.

Candidates for the M.S. degree are required to write a thesis and complete 36 hours of course work including six hours of thesis research. Candidates for the Ph.D. degree are required to complete 18 hours of dissertation research.

E M 625: Advanced Strength of Materials, 3 cr. (3 and 0)
Topics in strength of materials not covered in E M 304. Three-dimensional stress and strain transformations, theories of failure, shear center, unsymmetrical bending, curved beams and energy methods. Other topics such as stress concentrations and fatigue concepts are treated as time permits. Prerequisite: E M 304.

E M 630: Mechanics of Composite Materials, 3 cr. (3 and 0)
Fundamental relationships for predicting the mechanical and thermal response of multi-layered materials and structures; micromechanical and macromechanical relationships for laminated materials with emphasis on continuous filament composites; unique nature of composites and advantages of designing with composites. Prerequisite: E M 304.

E M 650: Mechanical Vibrations, 3 cr. (3 and 0)
Mathematical analysis of physical problems in the vibration of mechanical systems. Topics include linear-free vibrations, forced vibrations, and damping in single degree of freedom systems, transient vibrations, critical speeds and whirling of rotating shafts, dynamical balancing, and multi-degree of freedom systems with lumped parameters. Prerequisites: E M 202, 304, MTHSC 208.

E M 629: Energy Methods and Variational Principles, 3 cr. (3 and 0)
Application of variational principles in solid mechanics problems; virtual work; Castigliano's theorems on deflection and rotation; stationary potential energy; energy stability criterion; Hamilton's principle. Prerequisite: E M 831 or permission of instructor.

E M 831: Theory of Elasticity I, 3 cr. (3 and 0)
Theory of stress and deformation for continuous media; linear stress-strain relations for elastic material; two-dimensional problems including Airy stress function, polynomial solutions, plane stress and plane strain in rectangular and polar coordinates, torsion and bending of prismatic bars and thermal stresses. Prerequisites: E M 304 and MTHSC 208.

E M 832: Theory of Elasticity II, 3 cr. (3 and 0)
Continuation of E M 831 including topics from either three-dimensional problems associated with an infinite elastic medium, elastic half-space, contact stresses, symmetrically loaded sphere and circular cylinder, or complex variable methods in plane elasticity, stress concentrations problems, singular stresses and fracture, and composite materials. Prerequisites: E M 831 and PHYS 812.

E M 834: Principles of Structural Stability, 3 cr. (3 and 0)
Practical criteria for analysis of conservative and nonconservative systems' stability; methods of adjacent equilibrium, initial imperfections, total potential energy and vibration as applied to practical problems. Prerequisite: E M 831.

E M 836: Fracture Mechanics, 3 cr. (3 and 0)
Fundamental elasticity-based course in the development of the basic concepts of engineering fracture mechanics; the Griffith criterion, Barrenblatt and Dugdale models, linear elastic fracture mechanics (L.E.F.M.), plane strain fracture toughness, the crack-tip stress and strain field, and plasticity and the J-integral. Prerequisite: E M 831.

E M 845: Intermediate Dynamics, 3 cr. (3 and 0)
Kinematics and dynamics of particles and rigid bodies, Lagrange and Hamilton's formulation of mechanics; two-body central force problem; rendezvous of two bodies in a central force field; rotation of rigid bodies about a fixed point in space; vector analysis and matrix methods as aids in mathematical analysis. Prerequisite: E M 202 or permission of instructor.

E M 852 (C E 852): Advanced Finite Element Analysis, 3 cr. (3 and 0)
Application of variational and weighted residuals methods; nonlinear analysis; steady-state and time-dependent problems; application of commercial finite element codes; advanced computational procedures. Prerequisite: C E 808 or equivalent, or permission of instructor.

E M 891: Master's Thesis Research, credit to be arranged

E M 893: Selected Topics in Engineering Mechanics, 1-6 cr. (1-6 and 0)
Topics not covered in other courses. May be repeated for credit.

E M 991: Doctoral Dissertation Research, credit to be arranged

Industrial Engineering
Delbert L. Kimbier, Chair, Department of Industrial Engineering

Major Degrees
Industrial Engineering M.S., Ph.D.

Industrial engineering is concerned with the design, improvement and installation of integrated systems of people, materials, equipment and information. It draws upon specialized knowledge and skill in the mathematical, physical and social sciences, together with the principles and methods of engineering analysis and design, to specify, predict and evaluate the results obtained from such systems.

The focus of the graduate program is on quality engineering. In general, students concentrate their studies in one of four areas: human factors engineering, manufacturing systems, operations research and quality engineering. They choose supporting course
work from within the department and from other departments. Areas of research interest among the faculty include applied optimization, computer-integrated manufacturing, design methodologies, engineering economic analysis, facility planning and material handling, health care and information systems design, human-computer interaction, human-machine systems engineering, industrial ergonomics, maintenance systems design, manufacturing systems engineering, production planning and control, quality engineering, solid and hazardous waste management, and systems modeling and simulation. Laboratory facilities are available within the department to support research in these areas.

Students with a bachelor's degree in engineering or the physical sciences may be accepted. Those with other backgrounds may be accepted or may be required to complete successfully certain prerequisite courses before acceptance into the program. Entering graduate students are assumed to have competency in the following areas: mathematics, including calculus, linear algebra, differential equations, probability and statistics; calculus-based physics; computer programming. A student with deficiencies in these areas is required to take additional undergraduate course work as a condition of admission to the graduate program. No graduate credit is given for such courses.

Students may pursue an M.S. degree with a thesis requiring a minimum of 24 graduate credit hours of course work, six credit hours of master's thesis research and one credit hour of seminar. Alternatively, students may pursue an M.S. degree without a thesis requiring a minimum of 30 graduate credit hours of course work, three credit hours of project work, and two credit hours of seminar. The prescribed credit hours of course work are agreed upon by the student and his or her advisory committee and are in addition to any needed to compensate for undergraduate deficiencies.

Work leading to the Ph.D. degree is planned to give the student a comprehensive knowledge of the field of industrial engineering and a mastery or the methods of research. The advisory committee aids the student in developing a doctoral degree curriculum. A minimum requirement of 48 semester credit hours of graduate course work exists for the doctoral degree. A dissertation is mandatory for all Ph.D. candidates and requires 18 credit hours of doctoral research.

I E 660: Quality Management, 3 cr. (3 and 0)

Modern quality improvement techniques presented in an integrated, comprehensive context. Prerequisite: Senior standing.

I E 651: Quality Engineering, 3 cr. (3 and 0)

Design aspects of quality and the engineer's role in problems of quality in production systems. Prerequisite: I E 361.

I E 655: Facilities Planning and Design, 3 cr. (3 and 0)

Principles and techniques of plant layout; economic selection of materials handling equipment and integration of this equipment into the layout plan to provide effective product flow; quantitative techniques for evaluation of facilities plans. A design project is required. Prerequisites: I E 210 and 380 or permission of instructor.

I E 682: Systems Modeling, 3 cr. (3 and 0)

Modeling of discrete industrial systems using a digital computer; purpose, theory and techniques of system modeling. Prerequisites: I E 381 and MTHSC 302 or permission of instructor.

I E 684 (E 684) (EE&S 684): Municipal Solid Waste Management, 3 cr. (3 and 0)

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I E 685: Industrial Systems Engineering, 3 cr. (3 and 0)

Modeling and analysis of multistage decision processes, recursive optimization, process and system design, and control problems. Prerequisites: I E 380 and 381 or permission of instructor.

I E 686: Production Planning and Control, 3 cr. (3 and 0)

Fundamentals of forecasting demand, scheduling production, and controlling the movement and storage of material associated with production; state-of-the-art manufacturing techniques. A design project is required. Prerequisites: I E 380 and 384.

I E 687: Industrial Safety, 3 cr. (3 and 0)

Recognition and prevention of hazards; recognition and control of hazardous materials; developing and managing a safety program; designing inherently safe equipment and workplaces. Prerequisite: Junior standing.

I E 688: Human Factors Engineering, 3 cr. (3 and 0)

Introduction to design for human use. Information about human performance; abilities and limitations will be surveyed and applied to the design of tools, machines, facilities, tasks and environments for efficient, safe and comfortable human use. Prerequisite: I E 210 or permission of instructor.

I E 691: Selected Topics in Industrial Engineering, 1-3 cr. (0-3 and 0-9)

Timely or special topic in industrial engineering not included in other courses. May be repeated for a total of six credits. Prerequisite: Permission of instructor.

I E 692: Design Topics in Industrial Engineering, 1-3 cr. (1-3 and 0)

Timely or special design topic in industrial engineering. May be repeated for a total of six credits. Prerequisite: Permission of instructor.

I E 801: Design and Analysis of Human-Machine Systems, 3 cr. (3 and 0)

Methodologies used in the design and evaluation of human-machine systems including function and task analysis; questionnaires and interviews; scenarios, mockups and prototypes; participative design, empirical testing and iterative design; models of human-system interaction; analysis and classification of human error; and design of job performance and training aids. Prerequisites: Graduate standing and permission of instructor.

I E 802: Design of Human-Computer Systems, 3 cr. (3 and 0)

Issues in designing, implementing, maintaining and refining the user interface of interactive computer systems including interface design theories, models, principles and guidelines; interaction styles; input and output devices; system messages; screen design, manuals, on-line help and tutorials; and iterative design, testing and evaluation. Prerequisite: I E 801 or permission of instructor.

I E 803: Engineering Optimization and Applications, 3 cr. (3 and 0)

Introduction to optimization through the study of problems related to the planning, design and control of production/ manufacturing systems using both linear and non-linear optimization and algorithmic procedures, primal and dual problems with postoptimality analysis, Markov chains. Prerequisites: Graduate standing and permission of instructor.

I E 804: Manufacturing Systems Planning and Design, 3 cr. (3 and 0)

Concepts and principles associated with the design of manufacturing systems with a focus on modeling and integration methodologies; group technology, process planning, manufacturing modeling and design for manufacturing. Prerequisites: Graduate standing and permission of instructor.

I E 805: Foundations in Quality Engineering, 3 cr. (3 and 0)

Fundamental tools of quality engineering and their application to real situations; advanced statistical process control, design of experiments, Taguchi techniques and Shainin methodologies. Prerequisites: Graduate standing and permission of instructor.
I E 807: Discrete Systems Simulation, 3 cr. (3 and 0)
Discrete and Monte Carlo simulation used to model and study stochastic operational systems; simulation languages GPSS V, SLAM and/or SIMAN. Prerequisite: Introductory statistics or permission of instructor.

I E 811: Human Factors in Quality Control, 3 cr. (3 and 0)
Aspects of use of the human as a detector of product quality, serving as the basis for a taxonomy of human tasks in inspection; incorporates models of visual search and human decision making within the quality control framework. Prerequisites: Graduate standing and permission of instructor.

I E 860: Dynamic Programming, 3 cr. (3 and 0)
Theory and methodology of dynamic programming; Bellman's principle of optimality; Mitter's sufficiency conditions; recursive optimization of serial and nonserial multistage systems; optimization of discrete and continuous systems through decomposition; special aspects of problem formulation. Prerequisite: I E 803.

I E 865: Facility Planning and Design, 3 cr. (3 and 0)
Planning and design of industrial facilities emphasizing automated production facilities; quantitative approaches to equipment design and evaluation of performance. Prerequisite: I E 803.

I E 871: Industrial Testing and Quality, 3 cr. (3 and 0)
Design and use of component and product tests; automated inspection; test and inspection in integrated systems; cost-based models. Prerequisite: I E 661.

I E 872: Design for Quality, 3 cr. (3 and 0)
Advanced quality engineering techniques with application to design of products and processes; advanced statistical techniques as well as contemporary modifications such as Taguchi and Shainin methodologies. Prerequisites: I E 805 and EX ST 805.

I E 880: Advanced Methods of Operations Research, 3 cr. (3 and 0)
Methods and applications of advanced operations research techniques; discrete optimization, integer and mixed integer programming, Boolean minimization, network optimization, permutation methods on implicit enumeration. Prerequisite: I E 803 or permission of instructor.

I E 884: Advanced Engineering Economic Analysis, 3 cr. (3 and 0)
Engineering economic analysis for engineering research, development and construction projects emphasizing detailed treatment of tax effects, methods for determining discount rates, proper use of economic criteria in various decision environments (certainty vs. uncertainty, single vs. multiple project selections, etc.). Prerequisite: Permission of instructor.

I E 886: Operations Research in Production Control, 3 cr. (3 and 0)
Latest techniques in scientific inventory management, scheduling and forecasting; operations research; statistics; computer methods; case studies. Prerequisite: I E 803.

I E 888: Applied Queuing Theory and Markov Processes, 3 cr. (3 and 0)
Advanced treatment of stochastic optimization, potentially including single and multiple channel queues, Markov programming and stochastic optimal control. Prerequisite: I E 860 or permission of instructor.

I E 890: Special Problems in Industrial Engineering, 1-3 cr. (1-3 and 0)
Principles and methods of industrial engineering applied to analysis of a current interest problem. May be repeated for additional credit. Graded on a pass/fail basis. Prerequisite: Permission of instructor.

I E 891: Master's Thesis Research, credit to be arranged

I E 892: Master's Design Project, 3 cr. (1 and 0)
Design project in industrial systems; integration of IE principles and methodologies; resolution of contemporary systems design problems; project requires research, development, implementation planning, reporting and project assessment. Prerequisite: Permission of instructor.

I E 893: Selected Topics in Industrial Engineering, 1-3 cr. (1-3 and 0)
Selected topics in industrial engineering emphasizing new developments in systems science, systems analysis and operations research. May be repeated for additional credit. Prerequisite: Permission of instructor.

I E 895: Industrial Engineering Research Techniques, 1 cr. (1 and 0)
Series of weekly, one-hour lectures given by students, faculty and guests on methods and issues involved in industrial engineering research. Graded on a pass/fail basis.

I E 971: Advanced Quality Engineering Seminar, 3 cr. (3 and 0)
Current topics in the research and development of quality engineering methodologies. Prerequisite: I E 871 or permission of instructor.

I E 991: Doctoral Dissertation Research, credit to be arranged

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**Mechanical Engineering**

Richard S. Filigola, Chair, Department of Mechanical Engineering

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<tr>
<th>Major</th>
<th>Degrees</th>
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<td>Mechanical Engineering</td>
<td>M.Eng., M.S., Ph.D.</td>
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Students are accepted for the Master of Engineering degree program with undergraduate degrees in mechanical engineering (or equivalent) from ABET-accredited programs. Enrollment in the M.S. and Ph.D. programs is open to students with degrees in physics, applied mathematics or any branch of engineering.

Students in the M.S. degree program may choose the thesis or nonthesis option. Students in the thesis program must complete 30 hours of course work including six hours of thesis research. Students in the nonthesis program and in the M.Eng. program must complete 33 hours of course work including six hours of project-related credits. Students in the Ph.D. program must complete 18 hours of dissertation research.

Programs may be selected with concentrations in mechanical and manufacturing systems design (CAD/CAM, kinematics and dynamics, materials, robotics and vibrations) or thermal/thermal sciences (fluid mechanics; heat transfer, thermodynamics and energy systems).

M E 607: Applied Heat Transfer, 3 cr. (3 and 0)
Application-oriented extension of M E 304 considering topics in transient conduction, flow of fluids, energy exchange by radiation and mass transfer, applications in heat-exchanger design with emphasis on economics and variation of operating conditions from the design point. Prerequisites: M E 304 and permission of instructor.

M E 617: Control Systems Design, 3 cr. (2 and 1)
Application of analytical, simulation and experimental methods to control system design; fundamentals of linear state variable and computer-control systems. Laboratory emphasis is placed on control systems performance measurement and control-system implementation including sensors and actuators. Prerequisite: M E 416 or permission of instructor.

M E 620: Energy Sources and Their Utilization, 3 cr. (3 and 0)
Availability and use of energy sources such as fossil fuels, solar (direct and indirect) and nuclear; energy density and constraints to use (technical and economic) for each source. Prerequisites: M E 312 or both M E 303 and 304.

M E 621: Introduction to Compressible Flow, 3 cr. (3 and 0)
Introductory concepts to compressible flow; methods of treating one-dimensional gas dynamics including flow in nozzles and diffusers, normal shocks, moving and oblique shocks, Prandtl-Meyer Flow, Fanno Flow, Rayleigh Flow and reaction propulsion systems. Prerequisites: M E 320, M E 311.
M E 622: Design of Gas Turbines, 3 cr. (3 and 0)
Guiding principles in gas turbine cycles; turbine and compressor design procedures and performance prediction for both axial and radial flow machines; methods of design of rotary heat-exchangers and retrofitting gas turbine for regenerative operation. Design projects are used to illustrate the procedures. 
Prerequisite: M E 320.

M E 623: Introduction to Aerodynamics, 3 cr. (3 and 0)
Basic theories of aerodynamics for accurately predicting the aerodynamic forces and moments which act on a vehicle in flight. 
Prerequisite: E M 320.

M E 625: Kinematics and Dynamics of Machinery II, 3 cr. (3 and 0)
Graphical, analytical and numerical techniques in the dynamic analysis and synthesis of machines; application of the analysis techniques to cams, gears and other mechanisms. 
Prerequisite: E M 405.

M E 629: Thermal Environmental Control, 3 cr. (3 and 0)
Mechanical vapor compression refrigeration cycles, refrigerants, thermoelectrical cooling systems, cryogenics, thermodynamic properties of air, psychometric charts, heating and cooling coils, solar radiation, heating and cooling loads, insulation systems. 
Prerequisites: E M 320 and E M 303.

M E 653: Dynamic Performance of Vehicles, 3 cr. (3 and 0)
Techniques for analyzing the dynamic behavior of vehicles such as aircraft, surface ships, automobiles and trucks, railway vehicles and magnetically levitated vehicles. 
Prerequisites: M E 205, 305 or permission of instructor.

M E 654: Design of Machine Elements, 3 cr. (3 and 0)
Design of common machine elements including clutches, brakes, bearings, springs and gears. Optimization techniques and numerical methods are employed as appropriate. 
Prerequisite: M E 306 or permission of instructor.

M E 655: Design for Computer-Automated Manufacturing, 3 cr. (3 and 0)
Concepts of product and process design for automated manufacturing; product design for automated manufacturing, inspection and assembly using automation, industrial robots, knowledge-based systems and concepts of flexible product manufacture. 
Prerequisites: M E 301, 306 and 404 (or concurrent enrollment) or permission of instructor.

M E 656 (E C E 656): Fundamentals of Robotics, 3 cr. (3 and 0)
Fundamental mechanics and control of robots including their application to advanced automation; robot geometry, kinematics, dynamics and control; planar machine structures including methods using computer analysis; design and operation of robot systems for manufacturing and telerobotics. 
Prerequisites: M E 305, 416 (or concurrent enrollment) or permission of instructor.

M E 671: Computer Aided Engineering Analysis and Design, 3 cr. (3 and 0)
Geometric and solid modeling, finite elements, optimization and rapid prototyping. Students will design an artifact, represent it on the computer, analyze it using FEA then optimize before prototyping it. Emphasis on the use of computer-based tools for engineering design. The Web is used for reporting. 
Prerequisites: Numerical methods and programming experience or permission of instructor.

M E 693: Selected Topics in Mechanical Engineering, 1-6 cr. (3 and 0)
Topics not found in other courses. May be repeated for a maximum of six credits, but only if different topics are covered. 
Prerequisite: Permission of instructor.

M E 801: Foundations of Fluid Mechanics, 3 cr. (3 and 0)
Derivations of basic equations for multidimensional flow fields; analytical techniques for solving problems in laminar viscous flow and laminar inviscid flow; theories of similitude. 
Prerequisites: Graduate standing and permission of instructor.

M E 810: Macroscopic Thermodynamics, 3 cr. (3 and 0)
First, second and third laws of thermodynamics with engineering applications; thermodynamic property relations; chemical equilibrium. 
Prerequisite: M E 312 or equivalent.

M E 811: Gas Dynamics, 3 cr. (3 and 0)
Concepts from thermodynamics, one-dimensional gas dynamics, one-dimensional wave motion, normal and oblique shocks; flow in ducts and wind tunnels; two-dimensional equation of motion; small perturbation theory. 
Prerequisite: Undergraduate course in fluid mechanics.

M E 812: Experimental Methods in Thermal Science, 3 cr. (2 and 2)
Theories of measurements, instrumentation and techniques for measuring temperature, pressure and velocity on a practical graduate engineering level; mathematical presentation of data, uncertainty analysis, data acquisition techniques, and theory and state-of-the-art measuring systems.

M E 814: Concepts of Turbulent Flow, 3 cr. (3 and 0)
Concepts of fluid turbulence; turbulent transport mechanisms, dynamics of turbulence and experimental techniques pertinent to existing theories; classification of shear flows and their prediction methods. 
Prerequisite: M E 801.

M E 815 (PHYS 815): Statistical Thermodynamics I, 3 cr. (3 and 0)
Fundamental principles of kinetic theory and quantum statistical mechanics; Boltzmann statistics, Fermi-Dirac statistics and Bose-Einstein statistics. 
Prerequisite: A course in thermodynamics or permission of instructor.

M E 818: Introduction to Finite Element Analysis, 3 cr. (3 and 0)
Introduction to the finite element method; applications to heat transfer, fluid flow and solids; introduction to transient analysis; analysis strategies using finite elements; introduction to solid modeling, finite element modeling and analysis using commercial codes. 
Prerequisite: A numerical methods course or permission of instructor.

M E 819: Computational Methods in Thermal Sciences, 3 cr. (3 and 0)
Numerical techniques as applied to the solution of fluid flow and heat transfer problems; use of finite difference methods. 
Prerequisite: Graduate standing.

M E 820: Modern Control Engineering, 3 cr. (3 and 0)
Mathematical modeling of engineering systems using differential and difference equations; state variable time solutions using analytic and computer-aided analysis techniques; state control principles of controllability, observability, stability and performance specification; trade-offs between state variable and transfer function techniques. 
Prerequisite: An undergraduate controls course or permission of instructor.

M E 821: Advanced Control Engineering, 3 cr. (3 and 0)
Concepts in multivariable, nonlinear, stochastic and optimal control engineering; design and analysis considerations related to physical machines and processes; mathematical methods as needed. 
Prerequisite: An undergraduate controls course or permission of instructor.

M E 822: Computer Control of Automated Machines, 3 cr. (3 and 0)
Concepts for control of automated manufacturing machines, cells and processes; logic and switching control; programmable controllers; supervisory hierarchical and expert control systems concepts for manufacturing; closed-loop direct digital control design including sampling, stability and response of discrete system models; design and application of computer control algorithms; computer requirements; sensors and signal conversion. 
Prerequisite: M E 820 or permission of instructor.

M E 830: Conduction Heat Transfer, 3 cr. (3 and 0)
Analytical and numerical solutions of conduction heat transfer problems; steady one- and two-dimensional systems; extended surfaces; transient solutions; numerical solutions; transform methods. 
Prerequisites: M E 304 or equivalent and Graduate School enrollment.
M E 831: Convective Heat Transfer, 3 cr. (3 and 0)
Derivation of continuity, momentum and energy equations for boundary layer flow; solutions for confined and external flow regimes in laminar and turbulent flow.
Prerequisites: M E 304 or equivalent and MTHSC 208.

M E 832: Radiative Heat Transfer, 3 cr. (3 and 0)
Radiation properties; enclosure theory; radiation exchange between solid bodies; radiation exchange in the presence of absorbing, transmitting and emitting media; combined radiation, conduction and convection exchange. Prerequisites: M E 304 or equivalent and permission of instructor.

M E 833: Heat Transfer with Change of Phase, 3 cr. (3 and 0)
Nucleate boiling in a pool; film boiling in a pool; forced nucleate boiling; forced film boiling; effect of impurities on boiling phenomena; dropwise condensation; filmwise condensation; effect of noncondensable gases on condensation; boiling and condensing processes in systems. Prerequisites: M E 304 or equivalent and permission of instructor.

M E 841: Advanced Mechanical Engineering Design I, 3 cr. (3 and 0)
Design projects selected from industry or government addressed by a graduate student/faculty design team. Students are required to create and structure a problem solution, the solution being a preliminary design study encompassing analysis, synthesis, evaluation, economic cost/benefit considerations and engineering project organization. Prerequisite: Graduate standing or permission of instructor.

M E 842: Advanced Mechanical Engineering Design II, 3 cr. (3 and 0)
Case study method of individual design problems and projects; cases used as basis for problem formulation, problem analysis, design theory exemplification, and class discussion and evaluation; principles of mechanical and engineering sciences introduced and applied as required for case considerations. Prerequisite: M E 306 or equivalent or permission of instructor.

M E 843: Nonlinear Dynamics of Mechanical Systems, 3 cr. (3 and 0)
Behavior of nonlinear mechanical systems analyzed with numerical, graphical and analytical methods; understanding nonlinear effects and methods of analysis. Prerequisite: Graduate standing and/or permission of instructor.

M E 844: Random Vibration: Theory and Measurement, 3 cr. (3 and 0)
Analysis and measurement of random phenomena; description of random phenomena (probability theory, response of systems to random phenomena and digital signal processing theory); use of spectrum analyzer and other digital signal recording instruments. Prerequisites: M E 302 or MTHSC 208 and permission of instructor.

M E 845: Vibration of Continuous Media, 3 cr. (3 and 0)
Fundamental principles of generation, propagation, absorption, reflection and scattering of vibrational wave in solids and fluids; free and forced oscillation of flexible strings, bars, membranes and plates; theory of wave motion in liquids and gases. Prerequisite: Permission of instructor.

M E 854 (E C E 854): Analysis of Robotic Systems, 3 cr. (3 and 0)
Methods of designing and operating robotics systems for advanced automation; on-line identification and description of 3D objects by digitized images; off-line collision-free path planning and on-line collision avoidance traveling using artificial intelligence. Prerequisite: E C E M E 456 or permission of instructor.

M E 859 (E C E 859): Intelligent Robotic Systems, 3 cr. (3 and 0)
Integration and fusion of data from multiple sensors on multiple robots; intelligent decision making on motion planning and execution based on sensed data, involving mutual compliance; simultaneous force and position controls using computers. Prerequisite: E C E M E 854 or permission of instructor.

M E 890: Engineering Project, 1-3 cr. (0 and 3-9)
Comprehensive analytical and/or experimental treatment of phenomena of current interest in mechanical engineering emphasizing modern technological problems. May be repeated for a maximum of nine credits.

M E 891: Master's Thesis Research, credit to be arranged

M E 893: Selected Topics in Mechanical Engineering, 1-6 cr. (1-6 and 0)
Topics not covered in other courses. May be repeated for credit.

M E 930: Advanced Topics in Heat Transfer, 1-6 cr. (1-6 and 0)
Topics not covered in other courses. May be repeated for a maximum of six credits.

M E 931: Advanced Topics in Fluid Mechanics, 3 cr. (3 and 0)
Topics not covered in other courses. May be repeated for a maximum of six credits.

M E 932: Advanced Topics in Thermodynamics, 3 cr. (3 and 0)
Topics not covered in other courses. May be repeated for a maximum of six credits.

M E 991: Doctoral Dissertation Research, credit to be arranged

SCHOOL OF TEXTILES, FIBER AND POLYMER SCIENCE
Richard V. Gregory, Director

Textiles, Fiber and Polymer Science

Major Degree
Textiles, Fiber and Polymer Science M.S., Ph.D.

Applicants must have a bachelor's degree in textile chemistry, textile science, the physical or life sciences, engineering or a related discipline, and must have training in chemistry, physics and mathematics.

The M.S. degree requires a minimum of 24 credit hours of course work and six credit hours of research.

The major area of study is normally, fiber and polymer chemistry or physics, dye chemistry, textile science, textile materials formation science, computer modeling of materials, experimental statistics or other areas of textile, fiber and composite technologies. The minor area of study is usually in chemistry, physics, engineering, computer science, life sciences or mathematics. Each candidate must complete an independent scientific or technical investigation and formally report and defend the methodology, results and conclusions in a thesis.

Qualification to pursue the degree is accomplished by obtaining a grade of A or B in at least five courses representative of the major areas of textile and polymer science or standing special examinations in these courses. Courses currently considered representative are TEXT 821, Fiber Physics I; TEXT 835, Textile Structures I; TEXT 866, Fiber Formation; T C 811, Polymer Science I; and T C 812, Polymer Science II.

Other courses, tailored to the individual's objectives, are selected by the student and his or her advisory committee. The student normally takes a minor in a selected field of science or engineering and satisfies the requirements established by the minor department. This usually involves 12-24 credit hours in the minor field. A reading knowledge of one foreign language selected by the advisory committee is also required.

Admission to candidacy for the Ph.D. degree requires completion of written and oral comprehensive examinations. Each candidate must carry out an independent, original scientific investigation and formally report and defend the methodology, results and conclusions.

T C 615: Introduction to Polymer Science and Engineering, 3 cr. (3 and 0) F
Chemistry of monomers and polymers; chemical and physical properties of polymers emphasizing fiber-forming, synthetic polymers; includes molecular characterization, structure, morphology and mechanical properties as they relate to the design of polymer systems for end uses in textiles, geotextiles, plastics and fiber-reinforced composite materials. Pre-
requisites: CH 201, 330 (or 224), and T C 304 or permission of instructor.

T C 616: Chemical Preparation of Textiles, 3 cr. (2 and 3) S
Chemicals used in the preparation of fabric for dyeing and finishing; oxidizing and reducing agents and their control and effect on various fibers; colloidal and surface active properties of various compounds and the fundamental factors influencing these properties.

T C 657: Dyeing and Finishing I, 3 cr. (3 and 0) F
Physical, chemical and mechanical principles behind the application of colors and finishes to textiles; fiber chemistry and morphology, dye and finish structures and reactivity; mechanical principles behind the equipment used to effect transfer of these chemicals onto the textile substrate.

T C 658: Dyeing and Finishing II, 3 cr. (3 and 0) S
Kinetics and equilibria of dyeing processes; use of conductivity, diffusion and other methods for measuring absorption of isotherms and dyeing rates and the general thermodynamic relationships applicable to dyeing operations; fiber properties such as zeta potential, dye sites, relative amorphous area available.

T C 811: Polymer Science I, 3 cr. (3 and 0) F
Fundamentals of polymer chemistry; chemistry and synthesis of monomers and polymers in relation to the thermodynamics, kinetics and mechanisms of polymerization reactions emphasizing fiber-forming polymers, plastics and composite matrix materials.

T C 812: Polymer Science II, 3 cr. (3 and 0) S
Chemical structure and properties of polymers; polymer solution properties, the viscoelastic state and the crystalline morphology of polymeric materials; the current theories for describing polymer thermal transitions, molecular weight, molecular weight distributions, and transport phenomena in polymeric systems, as well as interfacial phenomena.

T C 820 (CH E 820): Composite Polymeric Materials, 3 cr. (3 and 0) N
Morphology, chemistry, processing and physical characterization of engineered fibers and matrix materials; influence of fiber and matrix properties on composite characteristics; application of surface chemistry to analyze fiber/matrix wetting and adhesion. Prerequisite: CH 224 or permission of instructor.

T C 840: Analytical Methods in Textile and Polymer Science, 4 cr. (3 and 3) S
Use of chemical and physical instrumental methods to characterize polymeric materials in textile and polymer science; basic principles and unique problems encountered when techniques such as IR, NMR, GC, LC, MS, GC/MS and thermal analysis, microscopy and tensile testing are applied to polymeric materials. Prerequisite: Permission of instructor.

T C 891: Master's Thesis Research, credit to be arranged

TEXT 616: Nonwoven Structures, 3 cr. (2 and 2) S (even numbered years)
Nonwoven fabric structures, their manufacture, properties and applications; methods of nonwoven fabric formation, resultant material characteristics and end-use applications. Prerequisite: TEXT 201 or 301.

TEXT 622: Properties of Textile Structures, 3 cr. (2 and 2) S
Yarn and fabric properties, their scientific significance and analysis. Dimensional, structural and mechanical interrelationships are established and evaluated.

TEXT 626: Instrumentation, 3 cr. (3 and 0) S
Principles of industrial and process instrumentation and control as applied in the textile industry; static and dynamic characteristics of measurement devices; transducer principles and techniques of their application for measurement of physical properties such as pressure, temperature, flow, weight, etc.; principles of process controllers; applications of computers in textile process control.

TEXT 660: Textile Processes, 3 cr. (3 and 0) F, S
Survey of machinery and processes of textile manufacturing from fiber formation through fabric finishing. For students with a nontextile background.

TEXT 672: Textile International Trade, 3 cr. (3 and 0) N
Current structure of the international textile trade including imports, exports, tariffs and trade requirements. Field experience with local firms enhance the student's understanding. Prerequisite: Senior standing or permission of instructor.

TEXT 675: Textile Marketing, 3 cr. (3 and 0) S
Activities involved in the distribution of textile products in today's market; role of consumer research and the analysis of fashion in the design and promotion of textile products.

TEXT 676: Carpet Manufacturing, 3 cr. (3 and 0) S (odd numbered years)
Materials, manufacturing technologies, products and practices associated with the carpet manufacturing sector of the textile industry; raw materials, product design, formation and finishing systems, evaluation methods, distribution and end-use applications. Prerequisite: TEXT 201, 202 or permission of instructor.

TEXT 821: Fiber Physics I, 3 cr. (3 and 0) F
Fiber physical properties and their relationship to fiber structure; methods of investigating fiber structure and physical properties; theories of viscoelastic behavior and thermal properties; models of fiber structure.

TEXT 822: Fiber Physics II, 3 cr. (3 and 0) S
Extension of TEXT 821 providing a more in-depth study of the mathematics of polymer fiber viscoelasticity and the solid state thermodynamics of polymeric systems; properties of copolymers, polymer optical and electrical properties; radiation physics of polymers. Prerequisites: TEXT 821 and MTHSC 208 or permission of instructor.

TEXT 830: Textile Physics, 3 cr. (3 and 0) F
Physical principles underlying manufacturing environments in which fibers, yarns and fabrics are produced; physical and mathematical techniques for the study and analysis of the textile environment, controls and energy requirements. Prerequisite: Graduate standing.

TEXT 835: Textile Structures I, 3 cr. (3 and 0) F
Pioneering works relating fiber properties to yarn properties; yarn geometry, fiber arrangements in twisted yarns, extension and breakage of continuous filament yarns, and deformation of staple fibers.

TEXT 845: Geotextiles and Geomembranes in Engineering Structures, 3 cr. (3 and 0) N
Application of textile materials used in civil engineering constructions, design methods and technological advances; fundamentals of soil mechanics and the manufacture of the textile material; testing and evaluation of the materials. Prerequisite: Permission of instructor.

TEXT 846: Textile Structures II, 3 cr. (3 and 0) S
Recent advances in the theoretical and experimental studies on fabric structures, structural mechanics of woven, knitted and nonwoven fabrics; relationship between yarn geometry and fabric structure; design of industrial fabrics and laminate structures. Prerequisite: Permission of instructor.

TEXT 866: Fiber Formation, 3 cr. (3 and 0) S
Formation of fibers by wet, dry and melt spinning, emphasizing rheology of solutions and melts, fiber structure, stretching and drawing processes; interrelationships of polymer properties and processes that determine fiber properties.

TEXT 880: Selected Topics, 3 cr. (3 and 0) N
Topics not covered in other textile chemistry or textile science courses.
TEXT 888: Seminar, 1 cr. (1 and 0)
Current topics in textiles, fiber and polymer science. May be repeated for a maximum of five credits. Graded on a pass/fail basis. Prerequisite: Graduate standing or permission of undergraduate advisor.

TEXT 891: Master's Thesis Research
credit to be arranged

TEXT 991: Doctoral Dissertation Research
credit to be arranged

These programs are directed by a council of the department chairs.

Astronomy

Students may specialize but not major or minor in astronomy or astrophysics, although their M.S. or Ph.D. degree is awarded in physics.

ASTR 802: Stellar Structure and Evolution, 3 cr. (3 and 0)
Physical principles governing the structure, power, luminosity and evolution of stars; equation of state, equations for pressure and thermal balance, heat transport, thermonuclear power and numerical techniques of structure calculation. Prerequisite: PHYS 455 or equivalent or permission of instructor.

ASTR 803: Galactic Structure, 3 cr. (3 and 0)
Kinematics, dynamics and content of the Milky Way galaxy; galactic rotation, galactic distance scale, stellar populations, spiral structure, the galactic center, and the evolution of the Milky Way and other galaxies. Prerequisite: Permission of instructor.

ASTR 805: Nuclear Astrophysics, 3 cr. (3 and 0)
Nuclear science applied to problems in astronomy, nuclear structure, fusion reactions, weak and electromagnetic reactions, nuclear burning in stars and resulting abundances of nuclides. Prerequisite: PHYS 455 or equivalent or permission of instructor.

STR 875: Selected Topics, 1-3 cr. (1-3 and 0)
Study of one or more advanced topics in contemporary astrophysics. May be repeated for credit, but only if different topics are covered. Prerequisite: Permission of instructor.

Bioengineering

John C. Hayes, Chair, Department of Agricultural and Bioengineering

Major Degrees
Bioengineering M.Engr., M.S., Ph.D.

Graduate programs in bioengineering are designed to prepare the individual for leadership, creative accomplishment and continued professional learning, and to qualify the student to conduct independent scientific research.

Students may be accepted with backgrounds in quantitative-based scientific fields related to chemistry, mathematics, physics, biology or any branch of engineering. A number of undergraduate prerequisite or corequisite courses may be required for applicants with undergraduate degrees in nonengineering disciplines.

Each degree program is planned individually to augment the student's previous engineering and science background with adequate breadth in engineering and specialization in an area of bioengineering. Course work, in addition to bioengineering engineering, consists of mathematics, physics, chemistry, statistics, and biological and engineering sciences.

Candiates for the M.Engr. degree must complete a minimum of 30 hours of course work as outlined by the advisory committees. A thesis is not required for this degree. Candidates for the M.S. degree are required to complete a minimum of 24 hours of course work plus an additional six hours of thesis research.

Candidates for the Ph.D. degree are required to complete an additional 36 semester hours of course work beyond the M.S. degree. Also required is the completion of 18 hours of dissertation research and the submission of an acceptable dissertation.

B E 608 (EE& S 608) (AGRON 608):
Land Treatment of Wastewater and Sludges, 3 cr. (3 and 0) F
Principles for designing environmentally acceptable land application systems using municipal and industrial wastewater and sludges; land-limiting constituent analysis; soil-plant interactions; system equipment and design; system operation and management; public acceptance, social and regulatory issues. Case studies and field trip(s) are planned. Prerequisite: Senior standing in agriculture or engineering or permission of instructor.

B E 616: Mechanical Design for Agricultural and Biological Systems, 3 cr. (2 and 3) F
Fundamentals of mechanical design with applications to machinery, functions relating to soil, plants and biological products. A design project is performed. Prerequisite: E M 304.

B E 628 (CH E 628): Biochemical Engineering, 3 cr. (3 and 0)
Use of microorganisms and enzymes for the production of chemical feedstocks, single-cell protein, antibiotics and other fermentation products; kinetics and energetics of microbial growth and enzymecatalyzed reactions; considerations of scale-up, mass transfer and sterilization during reactor design. Prerequisite: Agricultural engineering majors take AG E (BIO SC) 430 and MICRO 305, BIO CH 301; chemical engineering majors take CH E 312 as prerequisite and CH E 450 as corequisite.

B E 630 (BIO SC 630): Engineering Modeling of Biological Systems, 3 cr. (3 and 0)
Principal mechanisms of energy capture and transformation in living organisms; quantitative models of energetic reactions and associated transport processes are developed according to the principles of equilibrium and nonequilibrium thermodynamics; basic cell biology, photosynthesis, respiration, chemosomatic theory, electron transport, mass and energy transport phenomena. Prerequisite: BIO CH 301, MTH SC 208 or consent of instructor. Corequisite: M E 310 or instruction in thermodynamics.

B E 631: Structural Design for Biosystems, 2 cr. (2 and 0) F
Analysis and design of structures and statically determinant components with emphasis on wood. Prerequisite: E M 304 or C E 200.

B E 642: Properties and Processing of Biological Products, 3 cr. (2 and 3) S
Engineering properties of biological materials and their uniqueness as design restraints on systems for handling, processing and preserving biological products. Prerequisites: B E 333, E M 304, M E 310 and C E 341.

B E 650: Instrumentation for Biosystems Engineers, 3 cr. (2 and 3)
Modern instrumentation techniques for biosystems emphasizing laboratory use of equipment; properties and characteristics of instruments, analog signal conditioning, transducer theory, and applications and digital systems for data acquisition and control. Prerequisites: B E 350, familiarity with computer programming or permission of instructor.

B E 651 (EE& S 651) (FOR 651):
Newman Seminar and Lecture Series in Natural Resources Engineering, 1 cr. (0 and 2) S, F
Topics dealing with the development and protection of land, air, water and related resources will be occasioned by seminars with instructor and by invited lecturers; current environmental and/or resource conservation issues. Prerequisites: Senior or graduate standing, permission of instructor.

B E 658 (BIO SC 658): Cell Physiology, 3 cr. (3 and 0)
Chemical and physical principles of cell function emphasizing bioenergetics and membrane phenomena. Prerequisite: BIO CH 210 or 301 or permission of instructor.

B E 684 (EE& S 684) (L E 684):
Municipal Solid Waste Management, 3 cr. (3 and 0) S
Problems, regulations, collection, handling, recycling and disposal of municipal solid wastes in the urban and rural sectors; integrated waste-management system with resource recovery, composting, incineration, landfill disposals
and their costs. Prerequisite: Senior standing in engineering or science or permission of instructor.

B E 781: Special Problems, 1-3 cr.
(1-3 and 0)
Student selects subject and conducts library, laboratory and/or field research; technical report documenting study required. May be repeated for maximum of six credits. For Master of Engineering degree candidates only.

B E 865: Heat and Moisture Transfer in Biological Materials, 3 cr.
(3 and 0)
Heat and moisture diffusion in biological materials; criteria for selecting proper operational mathematics to solve certain boundary value problems; integral transforms of Laplace, Fourier and Hankel applied to various geometric configurations; influence of respiration heat and transpiration moisture production. Prerequisite: MTHSC 453/653 or 434/634 or permission of instructor.

B E 871: Selected Topics in Agricultural Engineering, 1-3 cr.
(1-3 and 0)
Supervised, in-depth study of an area not covered in other courses; performance measured by oral and written reports and/or by examination. May be repeated for a maximum of six credits.

B E 882: Systems Engineering, 3 cr.
(3 and 0)
Systems analysis methods applied to engineering of biological and agricultural operations; development of equations of motion, system analogs, and computer models and simulations; linear control analysis and stability. Prerequisite: Permission of instructor.

B E 891: Master's Thesis Research, credit to be arranged

B E 901: Special Problems in Agricultural Engineering, 3 cr.
(3 and 0)
Library and/or laboratory research on one of the following subjects, depending on student's field of study or interests: power and machinery, soil and water resources, farm structures, electric power and processing, food engineering, forest engineering or waste management; technical report required.

B E 991: Doctoral Dissertation Research, credit to be arranged

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Chemistry
Chemistry
Adolph L. Beyerlein, Chair, Department of Chemistry

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<tr>
<th>Major</th>
<th>Degrees</th>
<th>M.S., Ph.D.</th>
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Degree concentrations are offered in analytical, inorganic, organic and physical chemistry. Research areas also include bioorganic chemistry, polymer chemistry and chemical physics. A Ph.D. degree in chemistry with a concentration in textile chemistry is offered jointly with the School of Textiles, Fiber and Polymer Science.

Master of Science degree candidates must complete 24 hours of course work and six hours of research culminating in a satisfactory thesis.

The primary requirement for the Ph.D. degree is the performance of original research leading to a dissertation. Doctor of Philosophy degree candidates must qualify to pursue the Ph.D. degree by completing a core of four courses with at least a B average during the first two years of study. The core courses are taken in four areas: one in organic, one in physical, one in analytical and one in inorganic chemistry. Qualification requirements may also be satisfied by examination. Admission to candidacy for the Ph.D. degree requires completion of either a cumulative or a comprehensive examination in the area of concentration. The examination, the type of which depends upon the area selected by the student, may be followed by an oral presentation before a faculty committee.

CH 602: Inorganic Chemistry, 3 cr.
(3 and 0) F
Principles of inorganic chemistry with emphasis on atomic structure, chemical bonding, solid state, coordination chemistry, organometallic chemistry and acid-base theories; chemistry of certain selected elements. Prerequisites: CH 331, 332.

CH 611: Instrumental Analysis, 3 cr.
(3 and 0) S
Principles of operation and application of modern chemical instrumentation in the field of analytical chemistry: basic electronics, statistics, optical, mass, magnetic resonance, electron and X-ray spectroscopies, radiochemistry and separation science. Prerequisites: CH 331 and 332.

CH 621: Advanced Organic Chemistry, 3 cr.
(3 and 0) M
Modern organic chemistry with an emphasis on synthesis and mechanisms. Prerequisites: CH 224, 332 or equivalent.

CH 625: Medicinal Chemistry, 3 cr.
(3 and 0) M
Survey of the pharmaceutical drug discovery process. Covers discovery of candidate compounds, bioassay methods and associated regulatory and commercial issues. Case studies will be selected from the current literature. Prerequisite: CH 224 or equivalent or permission of instructor.

CH 627: Organic Spectroscopy, 3 cr.
(2 and 3) S (odd numbered years)
Modern spectroscopic techniques used in the determination of molecular structure with emphasis on the interpretation of spectra: nuclear magnetic resonance, ultraviolet, infrared, mass spectroscopy, optical rotatory dispersion and circular dichroism. Prerequisites: One year each of organic chemistry and physical chemistry.

CH 635: Atomic and Molecular Structure, 3 cr.
(3 and 0) S
Quantum theory and its application to atomic and molecular systems; harmonic oscillator, hydrogen atom, atomic and molecular orbital methods, vector model of the atom, atomic spectroscopy and molecular spectroscopy. Prerequisite: CH 332 or permission of instructor.

CH 805: Theoretical Inorganic Chemistry, 3 cr.
(3 and 0) S
Odd numbered years
Application of group theory to structure and properties of inorganic molecules. Prerequisites: CH 435/635 and 804 or permission of instructor.

CH 806: Physical Methods in Inorganic Chemistry, 3 cr.
(3 and 0) S
Odd numbered years
Theory and application of infrared, Raman, visible, ultraviolet, NMR, ESR, NQR, Mössbauer and mass spectrometry to inorganic chemistry. Prerequisite: CH 804 or permission of instructor.

CH 807: Chemistry of the Transition Elements, 3 cr.
(3 and 0) F
Structure, spectroscopy and reactivity of transition metals and their compounds. Prerequisite: CH 804 or permission of instructor.

CH 808: Chemistry of the Nonmetallic Elements, 3 cr.
(3 and 0) S
Odd numbered years
Development and application of a bonding model for descriptive inorganic chemistry of boron, carbon, silicon, nitrogen, phosphorus, oxygen and sulfur. Prerequisite: CH 804 or permission of instructor.

CH 809: Chemical Applications of X-Ray Crystallography, 3 cr.
(2 and 2) S (odd numbered years)
Physical description of the crystalline state, symmetry in crystals, X-ray diffraction, modern methods of structure determination and chemical interpretation of structural results. Prerequisite: CH 331, 332 or permission of instructor.

CH 811: Analytical Chemistry, 3 cr.
(3 and 0) F
Graduate-level review of modern analytical chemistry; literature, sampling, quality control/assurance, chemometrics and the use of modern analytical methods; team taught by the analytical faculty.

CH 812: Chemical Spectroscopic Methods, 3 cr.
(2 and 3) S
Emission and absorption spectroscopy, chemical microscopy, X-ray diffraction and fluorescence techniques in analytical chemistry; theory and operation of instruments.
CH 813: Electrochemical Science, 3 cr. (3 and 0)
Theory and experimental study of electrochemical thermodynamics, electrified interfaces, interfacial charge transfer, electrolyte solutions, electrode processes and membrane electrochemistry; amperometric, voltammetric, electrolytic and potentiometric methods; practical applications of electrochemistry in analysis, materials synthesis and energy technology. Prerequisite: Graduate standing in chemistry or chemical engineering, or permission of instructor.

CH 816: Separation Science, 3 cr. (3 and 0) S (odd numbered years)
Fundamental thermodynamic and kinetic concepts of separation and practical aspects of current separation techniques used in analytical chemistry.

CH 818: Surface and Thin Film Analysis, 3 cr. (2 and 2)
Fundamental principles underlying the most commonly employed techniques for surface and thin films analysis. Representative techniques include atomic force microscopy, scanning electron microscopy, secondary ion mass spectrometry, Auger electron spectroscopy and Rutherford backscattering. Laboratory exercises give insights into analytical methods.

CH 820: Fundamentals of Organic Synthesis, 3 cr. (3 and 0) F
Modern aspects of organic chemistry emphasizing the mechanisms of reactions and synthesis of molecules of current interest. Prerequisites: CH 224 or equivalent plus satisfactory performance in the organic placement examination or permission of instructor.

CH 821: Organic Chemistry I, 3 cr. (3 and 0) F
Theoretical concepts of organic chemistry, stereochemistry and mechanisms of organic reactions. Prerequisite: CH 421 or satisfactory performance on the organic chemistry placement examination.

CH 822: Organic Chemistry II, 3 cr. (3 and 0) S
Continuation of CH 821; mechanisms of organic reactions including photochemistry and Woodward-Hoffman rules; modern synthetic organic chemistry. Prerequisite: CH 821 or permission of instructor.

CH 825: Chemistry of Heterocyclic Compounds, 3 cr. (3 and 0) S (odd numbered years)
Chemistry of heterocyclic compounds of nitrogen, oxygen, sulfur and other elements. Prerequisites: CH 821 and/or CH 822 or permission of instructor.

CH 830: Fundamentals of Physical Chemistry, 3 cr. (3 and 0) F
Principles of classical thermodynamics, chemical kinetics and quantum chemistry. Prerequisite: CH 331/631 or equivalent.

CH 831: Chemical Thermodynamics, 3 cr. (3 and 0) F (odd numbered years)
Classical thermodynamics emphasizing theory and significance of energetics and systems of variable composition. Prerequisite: CH 331/631 or equivalent.

CH 834: Statistical Thermodynamics, 3 cr. (3 and 0) S (odd numbered years)
Statistical thermodynamics: ensemble method, ideal gases, internal degrees of freedom, solid state, imperfect gases; distribution function method in fluids and time-dependent fluctuations. Prerequisite: CH 831.

CH 835: Chemical Kinetics, 3 cr. (3 and 0) S (odd numbered years)
Rate processes and reaction mechanisms; order of reaction; theory of rate processes; relation of reaction rates to mechanism; homogeneous and heterogeneous catalysis; experimental methods; chain reactions; diffusion; effects of solvent, temperature and pressure on reaction rates and mechanisms. Lectures supplemented by assigned problems, paper and oral examination of topic of special interest to student.

CH 837: Quantum Chemistry, 3 cr. (3 and 0) F (odd numbered years)
Mathematical and conceptual formulation of quantum theory of electronic structure of atoms and molecules; eigenvalue solution of one-dimensional Schroedinger equation and application of this method to chemical problems.

CH 840: Techniques of Experimental Chemistry, 3 cr. (1 and 6) F, S
Theory and practice in major experimental techniques used in chemical research; chromatography; NMR, IR, visible, UV and ORD/CD spectrophotometry; glass-blowing and high vacuum techniques; mass spectrometry; ESR; Mossbauer spectroscopy and tracer analysis.

CH 841: Chemical Applications of NMR Spectroscopy, 3 cr. (2 and 2)
Basic concepts of NMR spectroscopy with application to organic, inorganic, physical and analytical chemistry; design of spectroscopic experiments and interpretation of spectra; modern techniques including multipulse, multinuclear and multidimensional methods. Prerequisites: CH 331 and 332 or permission of instructor.

CH 851: Seminar, 1-2 cr. F, S
Students and faculty review current topics in chemistry. May be taken more than one semester.

CH 891: Master's Thesis Research, credit to be arranged, F, S, SS

CH 900: Selected Topics in Inorganic Chemistry, 1-4 cr. (1-4 and 0) N
Metal-metal bonding; homogeneous catalysis; photochemistry; bioinorganic chemistry; solid state chemistry. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.

CH 910: Selected Topics in Analytical Chemistry, 1-4 cr. (1-4 and 0) N
New techniques and their applications in analytical chemistry; laser methods; data acquisition processing; electronics, instrument/computer interfacing; field methods of sampling and analysis. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.

CH 920: Selected Topics in Organic Chemistry, 1-4 cr. (1-4 and 0) N
Heterocyclic compounds; stereochemistry; natural products; organometallic chemistry; photochemistry. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.

CH 930: Selected Topics in Physical Chemistry, 1-4 cr. (1-4 and 0) N
Special problems in molecular spectroscopy, molecular orbital treatments, applications of group theory to chemical structure, irreversible thermodynamics and special topics in statistical mechanics. Topics vary with interests of students. May be repeated for credit, but only if different topics are covered.

CH 991: Doctoral Dissertation Research, credit to be arranged, F, S, SS

Civil Engineering

James K. Nelson Jr., Chair, Department of Civil Engineering

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<th>Major</th>
<th>Degrees</th>
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<tr>
<td>Civil Engineering</td>
<td>M.Engr., M.S., Ph.D.</td>
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Within the graduate degree programs offered by the department, there are five primary emphasis areas: Structural and Geotechnical Engineering, Project Management, Construction Materials, Applied Fluid Mechanics and Transportation. A program of study may also encompass course work in several related interdisciplinary fields such as environmental engineering and science. The department offers graduate degree programs leading to the Master of Science, Master of Engineering and Doctor of Philosophy degrees.

Two options are offered for the M.S. degree. The nonthesis option requires 30 hours of course work and a written examination. The thesis option requires 30 hours of course work, six of which are thesis research. All graduate students are required to complete C E 895 and an oral examination as a requirement for any graduate degree.

Excellent facilities for graduate work are available, and each student's educational and research program can be arranged to suit his or her personal and professional goals.
C E 604: Wood and Masonry Structural Design, 3 cr. (3 and 0)
Wood design and engineering; properties of wood and wood-based materials; design of beams, columns, walls, roofs, panel systems and connections; fundamentals of masonry materials, construction and structural systems; lateral load-resisting shear walls, load-bearing walls, columns and pilasters, and connections. Prerequisite: C E 402 or permission of instructor.

C E 610: Traffic Engineering Operations, 3 cr. (3 and 0)
Basic characteristics of motor-vehicle traffic, highway capacity, applications of traffic control devices, traffic design of parking facilities, engineering studies, traffic safety, traffic laws and ordinances, public relations. Prerequisite: C E 311.

C E 611: Roadway Geometric Design, 3 cr. (2 and 3)
Geometric design of roadways, at-grade intersections and interchanges in accordance with conditions imposed by driver ability, vehicle performance, safety and economics. Prerequisite: C E 610.

C E 612: Urban Transportation Planning, 3 cr. (3 and 0)
Urban travel characteristics, characteristics of transportation systems, transportation and land-use studies, trip distribution and trip assignment models; city planning and subdivision layout. Prerequisite: C E 311.

C E 621: Geotechnical Engineering Design, 3 cr. (3 and 0)
Relationship of local geology to soil formations, groundwater, planning of site investigation, sampling procedures, determination of design parameters, foundation design and settlement analysis. Prerequisite: C E 321.

C E 633: Construction Planning and Scheduling, 3 cr. (3 and 0)
Principles and applications of the Critical Path Method (CPM) and Project Evaluation and Review Techniques (PERT); project breakdown and network graphics; identification of the critical path and resulting floats; definition and allocation of materials, equipment and manpower resources; resource leveling, compression and other network adjustments; computer applications using packaged routines. Prerequisite: C E 331.

C E 634: Construction Estimating and Project Control, 3 cr. (3 and 0)
Specifications, contracts and bidding strategies; purchasing and subcontracting policies; accounting for materials, supplies, subcontracts and labor; procedural details for estimating earthwork, reinforced concrete, steel and masonry; overhead and profit items. Prerequisite: C E 324 or equivalent.

C E 638: Construction Support Operations, 3 cr. (3 and 0)
Description of activities necessary for the completion of a construction job although not specifically recognized as direct construction activities; general conditions, safety, security, quality assurance, value engineering; organizational support features and typical implementation procedures. Prerequisite: C E 331 or equivalent and EX ST 301 or MTHSC 302.

C E 639: Construction Equipment Selection and Maintenance, 3 cr. (3 and 0)
Methodology of selecting the right equipment of the right size for each task of the construction job on the basis of powertrain characteristics, crew size, terrain conditions and job requirements; cycle time, cost, specifications, maintenance, replacement policy, monitoring. Prerequisite: C E 331 or equivalent.

C E 646: Flood Hazards and Protective Design, 3 cr. (3 and 0)
Flood hazards and methods of protective design of the built environment; floodplain mapping and delineation; methods for determining base flood elevations; flood-resistant construction, flood proofing and governmental regulations; case studies and design projects. Corequisite: C E 342.

C E 662: Coastal Engineering I, 3 cr. (3 and 0)
Coastal and oceanographic engineering principles including wave mechanics, wave-structure interaction, coastal water-level fluctuations, coastal-zone processes, and design considerations for coastal structures and beach nourishment projects. Prerequisite: C E 341 or E M 320.

C E 662: Groundwater and Contaminant Transport, 3 cr. (3 and 0)
Basic principles of groundwater hydrology and transport of contaminants in groundwater systems; groundwater system characteristics; steady and transient flow; well hydraulics, design and testing; contaminant sources, movement and transformation. Prerequisite: E M 320. Corequisite: EE&S 401.

C E 691: Selected Topics in Civil Engineering, 1-6 cr. (1-6 and 0)
Structured study of civil engineering topics not found in other courses. May be repeated for a maximum of six credits, but only if different topics are covered. Prerequisite: Permission of instructor.

C E 801: Matrix and Finite Element Analysis, 3 cr. (3 and 0)
Matrix and finite element methods in solution of engineering problems: stiffness matrices for triangular, rectangular and quadrilateral elements in planer systems; plate bending, shell and 3-D elements; applications to solutions of structural and soil mechanics problems using special and general purpose programs. Prerequisite: C E 401 or permission of instructor.

C E 802: Advanced Reinforced Concrete Design, 3 cr. (3 and 0)
Second course in design of reinforced concrete structures; soil mechanics concepts in analysis and design of beams, columns and slabs; introduction to prestressed concrete. Prerequisite: C E 402 or permission of instructor.

C E 803: Advanced Steel Design, 3 cr. (3 and 0)
Advanced design of structural steel buildings emphasizing the relationship between design and response of the structural system; theoretical basis of building code provisions; limit state and plastic design; beam-columns; plate girders and composite sections and connections. Prerequisite: C E 406 or permission of instructor.

C E 805: Advanced Structural Mechanics, 3 cr. (3 and 0)
Development and utilization of mechanics principles in solution of structural problems; unsymmetrical bending and curved beams; beams on elastic foundations; plastic structure analysis of beams and frames; eigenvalue problems; plastic stress-strain relations; strain energy; series and finite element solutions to plate and shell structures. Prerequisite: C E 401 or permission of instructor.

C E 806: Dynamic Analysis of Structures, 3 cr. (3 and 0)
Analysis and design of structures subjected to dynamic loading; response of lumped and distributed parameter systems of one or many degrees of freedom; approximate design methods; introduction to earthquake analysis and design. Prerequisite: C E 801 or permission of instructor.

C E 807: Wind Engineering, 3 cr. (2 and 2)
Effects of wind on buildings, bridges and other structures; meteorological aspects of wind generation; types and characteristics of various wind events; aerodynamics of flow around structures; wind-induced loads; structural responses; design basis safety and serviceability criteria.

C E 808: Earthquake Engineering, 3 cr. (3 and 0)
Effects of earthquake-induced forces on buildings, bridges and other structures; development of design codes and their application to the design of structures to resist seismic forces; fundamental structural dynamics and analysis techniques used to compute the response of structures or obtain design forces. Prerequisite: C E 806 or permission of instructor.
C E 809: Forensic Engineering, 3 cr. (3 and 0)
Civil engineering failures including an analysis of conditions just prior to the failure, load or event causing failure; methods of investigation and design of remedial measures; case histories of failures illustrating common errors and failures. Student projects involve design of remedial measures and alternatives.

C E 813: Highway and Airport Pavement Design, 3 cr. (3 and 0)
Structural design of rigid and flexible pavements; design of bases and sub-bases; theory of stresses and application of plate bearing, triaxial and California Bearing Ratio design methods to flexible pavements; Westergaard analysis for rigid pavements; pavement evaluation methods. Prerequisite: C E 311 and 321 and permission of instructor.

C E 815: Transportation Safety Engineering, 3 cr. (3 and 0)
Methodology for conducting transportation accident studies; accident characteristics as related to operator, facility and mode; statistical applications to accident data; current trends and problems in transportation safety. Prerequisite: C E 311.

C E 819: Transportation Research, 2-4 cr.
Independent investigation of problems in transportation engineering.

C E 821: Advanced Soil Mechanics, 3 cr. (3 and 0)
Stresses in soils; plastic equilibrium of soil masses; failure conditions; earth pressures; analysis of flexible retaining wall bulkheads; solution of problem by elastic theory. Prerequisite: C E 321 or permission of instructor.

C E 822: Foundation Engineering, 3 cr. (3 and 0)
Requirements for satisfactory foundations; theory and design of shallow foundations; pressure distribution beneath rigid and flexible shallow foundations; bearing capacity and settlement of deep foundations; foundation failures. Prerequisite: C E 321 or permission of instructor.

C E 823: Asphalt Concrete Properties, 3 cr. (3 and 0)
Identification and suitability of aggregates for construction; characteristics and properties of bituminous materials; materials behavior, construction and design problems; use of microcomputers and the mainframe. Prerequisite: C E 351 or equivalent or permission of instructor.

C E 825: Soil Dynamics and Geotechnical Earthquake Engineering, 3 cr. (3 and 0)
Fundamentals of soil dynamics, plate tectonics and earthquakes; application of the concepts to seismic ground response, design ground motions, soil liquefaction, seismic slope stability, dynamic lateral earth pressures and soil improvement. Prerequisite: C E 321 or equivalent and C E 821 or C E 805 or permission of instructor.

C E 835: Construction Project Modeling, 3 cr. (3 and 0)
Mathematical and computer models to simulate construction operations; linear models and optimization applications to construction materials, scheduling and equipment allocation; typical computer models used in construction; simple modeling examples. Prerequisite: C E 331 or permission of instructor.

C E 836: Civil Engineering Quality Management, 3 cr. (3 and 0)
Principles of total quality management (TQM) and their applications in the engineering and construction industry; TQM implementation techniques with particular emphasis on the construction environment; concepts of quality assurance (QA) and quality control (QC) in construction. Prerequisite: Permission of instructor.

C E 837: Construction Specifications and Contracts, 3 cr. (3 and 0)
Elements of specifications delineating responsibilities of all involved parties and identifying courses of action during abnormal circumstances; necessary parts of a contract dealing with governmental regulations and institutional preferences, licenses, bonds, insurance and taxes. Prerequisite: C E 331 or equivalent.

C E 838: Materials Management, 3 cr. (3 and 0)
Functions of construction materials management including design interface, purchasing, expediting, transportation, field control and warehousing; design and application of integrated materials management computer systems; new technology that impacts materials management including bar coding, electronic data interchange and voice recognition. Prerequisite: Permission of instructor.

C E 839: Expert Systems Applications in Civil Engineering, 3 cr. (3 and 0)
Applications of expert systems in civil engineering design, construction and facility management; use of expert systems shells for expert systems development; linking expert systems to external programs; knowledge acquisition and system validation.

C E 840: Project Management Applications, 3 cr. (3 and 0)
Quantitative tools for effective management and control of engineered projects from design through construction; cost coding and control, advanced schedule management techniques and quality management principles; extensive hands-on use of the microcomputer. Prerequisites: C E 433/633 or 434/634 or equivalent.

C E 846: Flow in Open Channels, 3 cr. (3 and 0)
Free surface flow problems; applications of digital computer; concepts of boundary layer theory; uniform and varied flow; hydraulic jump; design criteria for prismatic channels and transitions; applications of unsteady flow. Prerequisites: Graduate standing and permission of instructor.

C E 850: Advanced Analysis Techniques in Civil Engineering, 3 cr. (3 and 0)
Analytical and numerical methods in the solution of engineering problems; analysis tools developed and demonstrated through the study and solution of various civil engineering problems; analysis tools include closed form solutions, numerical integration and differentiation, eigenvalues and eigenvectors, finite difference solutions and series solutions.

C E 851: Reliability, 3 cr. (3 and 0)
Elements of probabilistic methods; classical theory of structural reliability and reliability-based design methods. Term project required on reliability design in a relevant field of civil engineering. Prerequisite: Permission of instructor.

C E 860: Advanced Fluid Mechanics, 3 cr. (3 and 0)
Laminar and turbulent flows: boundary layer and free shear flows (jets, wakes, etc.); descriptions of velocity, shear stress and pressure measurements, and aerodynamic drag.

C E 861: Mechanics of Sediment Transport, 3 cr. (3 and 0)
Characterization of sediments, physical principles governing fluvial, estuarial and coastal transport of cohesionless and cohesive sediments, including incipient motion, stable channel design, bedforms and bedload and suspended transport. Prerequisite: C E 342 or equivalent.

C E 863: Coastal Engineering II, 3 cr. (3 and 0)
Littoral processes; coastal structures; port engineering; estuarial hydromechanics, littoral transport; port and harbor design; functional design of coastal structures; tidal dynamics in estuaries. Prerequisite: C E 462/662.

C E 865: Hydrologic Systems Analysis, 3 cr. (3 and 0)
Hydrologic cycle as a hydrologic system; deterministic hydrology; aspects of physical hydrology; emphasizing balanced approach to groundwater hydrology and surface water hydrology; infiltration, soil moisture and evapotranspiration; probability analysis and system synthesis by convolution. Prerequisite: Permission of instructor.

C E 875: Physical and Numerical Models in Applied Fluid Mechanics, 3 cr. (3 and 0)
Tools used in solving complex fluid mechanics problems including use of physical models, dimensional analysis and numerical models. Students design, build and operate a physical hydraulic model and develop and apply a numerical model to simulate test conditions in physical
model. Prerequisite: C E 342 or permission of instructor.

C E 868: Special Problems I, 1-3 cr.
Research design problems from field of structures, construction, soil mechanics, transportation, ocean and coastal engineering, or materials engineering. Subject matter varies with interest and experience of student and instructor.

C E 890: Special Problems II, 1-3 cr.
Research design problems from field of structures, construction, soil mechanics, transportation, ocean and coastal engineering, or materials engineering. Subject matter varies with interest and experience of student and instructor.

C E 891: Master’s Thesis Research, credit to be arranged

C E 893: Selected Topics in Civil Engineering, 1-6 cr. (1-6 and 1-6)
Topics not covered in other courses. May be repeated for credit.

C E 895: Civil Engineering Seminar, 1 cr. (0 and 2)
Current and historic topics in various areas of civil engineering. Speakers may include off-campus experts, faculty and graduate students. Presentation of at least one seminar is required.

C E 991: Doctoral Dissertation Research, credit to be arranged

Computer Engineering

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<td>Computer Engineering</td>
<td>M.S., Ph.D.</td>
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The computer engineering program is a combination of computer software, hardware, systems and applications. Focus areas include computer systems architecture, computer communications and artificial intelligence. Enrollment is open to graduates in any branch of engineering, computer science or applied mathematics who have an appropriate engineering and/or science background.

For the M.S. program, students may write a thesis or follow a nonthesis option. The thesis option requires a total of 30 credit hours including six hours of thesis research. For the nonthesis option, 33 credit hours of course work must be completed.

Specially qualified candidates with a B.S. degree may apply for direct entry to the Ph.D. program in any of the above areas. The program is of study and credit required beyond the baccalaureate degree are specified by the focus area, but must be at least 66 including course work and research credit.

C E 606: Introduction to Microelectronics Processing, 3 cr. (3 and 0) S
Microelectronic processing, MOS and bipolar monolithic circuit fabrication, thick and thin film hybrid fabrication, applications to linear and digital circuits, fundamentals of device design. Prerequisite: C E 320. Corequisite: MTHSC 311 or 434.

C E 617: Elements of Software Engineering, 3 cr. (3 and 0) F, S
Foundations of software design, reasoning about software, the calculus of programs, survey of formal specification techniques and design languages. Prerequisite: C E 329, MTHSC 419.

C E 618: Power System Analysis, 3 cr. (3 and 0) F
Power system planning and operational problems; load flow, economic dispatch, fault studies, transient stability and control of problems. System modeling and computer solutions are emphasized through class projects. Prerequisite: C E 360, 380.

C E 619: Electric Machines and Drives, 3 cr. (3 and 0) S
Performance, characteristics and modeling of AC and DC machines during steady-state and transient conditions; introduction to power electronics devices and their use in adjustable speed motor drives. Prerequisites: C E 321, 360 and 380. Corequisite: MTHSC 434 or permission of instructor.

C E 622: Electronic System Design I, 3 cr. (2 and 2) S
Application of theory and skills to the design, building and testing of an electronic system with both analog and digital components. Application varies each semester. Extensive use is made of computer software tools in the design process. Prerequisite: C E 321, 330, 360, 371, 381.

C E 626: Digital Computer Design, 3 cr. (3 and 0) F
Design of high-speed ALUs, control and timing circuits, memory systems and I/O circuits; microprogrammed computer design using bit-serial microprocessors; current hardware topics related to computer design; hands-on design experience; use of logic analyzer for system debugging. Prerequisites: C E 321, 330, 360, 371, 381.

C E 629: Organization of Computers, 3 cr. (3 and 0) F, S
Computer organization and architecture including a review of logic circuits, bus structures, memory organization, interrupt structures, arithmetic units, input-output structures, state generation, central processor organization, control function implementation, and data communication; Registered Transfer Language (RTL) for description and design of digital systems. Prerequisite: CP SC 230 or C E 250 or 272 or permission of instructor.

C E 631: Digital Electronics, 3 cr. (2 and 2) F, S
Digital devices and circuits of importance to digital computer operation and to other areas of electrical engineering, active and passive waveshaping, waveforms, memory elements, switching and logic circuits. Experimentation with various types of circuits is provided by laboratory projects. Prerequisite: C E 321. Corequisite: MTHSC 311 or 434.

C E 633: Sensors and Microcomputer Control for Robots, 3 cr. (1 and 4) F
Current robotics technology with emphasis on robots suitable for industrial applications that require locomotion and sophisticated sensors. Class design project will be coordinated to produce a working modular robot. Prerequisite: C E 302 or 409, 371 or permission of instructor.

C E 636: Transmission Lines and Microwave Circuits, 3 cr. (3 and 0) F
Theoretical and practical aspects of transmission lines and waveguides; Smith Chart applications and design impedance matching networks, scattering parameters, interconnection and design of multiports. Prerequisite: C E 381 or equivalent. Corequisite: MTHSC 311 or 434.

C E 638: Computer Communications, 3 cr. (3 and 0) F
Digital data transmission techniques, modems and communications channels, communications software and protocols, multiprocessors and distributed processing; concurrency and cooperation of distributed processors. Prerequisite: Senior standing in electrical or computer engineering or computer science or permission of instructor.

C E 639: Fiber Optics, 3 cr. (3 and 0) F
Principles of design for optical fibers in practical systems; examination of optical fiber as a wave-guide using wave optics and ray optics; design criteria for using mono- and multi-mode fibers; fabrication and measurement. Prerequisite: C E 381. Corequisite: MTHSC 434 or permission of instructor.

C E 640: Performance Analysis of Local Computer Networks, 3 cr. (3 and 0) S
Design and performance analysis of local computer networks with emphasis on performance analysis of representative multi-access procedures. Three common types of networks are considered in detail. Prerequisites: C E 272, 317 or MTHSC 400 or equivalent.

C E 642: Knowledge Engineering, 3 cr. (3 and 0) F
The theoretical and practical aspects of knowledge engineering or applied artificial intelligence; symbolic representation structures and manipulation, unification, production systems and structures, rule-based and expert systems, planning and AI system architectures; system design in PROLOG and LISP. Project required. Prerequisites: C E 329, 352.
E C E 646: Antennas and Propagation, 3 cr. (3 and 0) S
Theoretical and practical aspects of antenna design and utilization, input impedances, structural considerations and wave propagation. Prerequisites: E C E 330, 381 or 436, MTHSC 311 or 434.

E C E 653: Software Practicum, 3 cr. (1 and 6)
Student must design and implement a software system that satisfies both a requirements and specifications document. The resulting system will be tested for compliance. Prerequisites: E C E 352, 417.

E C E 660: Computer-Aided Analysis and Design, 3 cr. (3 and 0) F
Principles and methods suited to the solution of engineering problems on the digital computer; methods for the solution of the systems of algebraic and/or differential equations which arise in modeling of engineering systems, data approximation and curve fitting, continuous system simulation languages and design-oriented programming systems. Prerequisites: E C E 262, MTHSC 311, 434, or permission of instructor.

E C E 667: Introduction to Digital Signal Processing, 3 cr. (3 and 0) S
Characteristics, design and applications of discrete time systems; design of digital filters; Fast Fourier Transform (FFT); LSI hardware for signal processing applications. Prerequisite: E C E 330.

E C E 668: The Embedded Microprocessor, 3 cr. (2 and 2) S
Interfacing, architecture and design issues that arise when the microprocessor is embedded in electromechanical and human systems. Applications and design projects include guidance systems, robotics, process control, artificial limbs, etc. Prerequisites: E C E 302 or 330 or 409 and 371, MTHSC 311 or 434 or permission of instructor.

E C E 692: Special Problems, 1-3 cr. (0 and 2)
Special assignment in electrical or computer engineering. Typical assignments include consulting, term papers, technical literature searches, hardware projects and design project leadership. May be taken only once for credit.

E C E 693: Selected Topics, 1-3 cr. (1-3 and 0)
Current and new technical developments in electrical and computer engineering. May be repeated for a maximum of six credit hours, but only if different topics are covered. Prerequisite: Permission of instructor.

E C E 801: Analysis of Linear Systems, 3 cr. (3 and 0) F
Foundations of linear system analysis; matrix algebra, linear graph theory and operational mathematics applied to formulation and solution of system equations in time and frequency domains.

E C E 802: Electric Motor Control, 3 cr. (3 and 0)
Dynamic modeling and analysis of electrical machines for design of AC and DC drive systems; implementation of such models on a digital computer; voltage-fed inverters; pulse width modulation and analysis techniques for inverters; harmonic generation and reduction. Prerequisite: E C E 434/634.

E C E 811: Integrated Circuit Design, 3 cr. (2 and 2) F
Design concepts and factors influencing the choice of technology; fundamental MOS device design; silicon foundries; custom and semi-custom integrated circuits; computer-aided design software/hardware trends and future developments; the hands-on use of CAD tools to design MOS structures, testing and packaging. Prerequisite: E C E 459/659.

E C E 816: Electric Power Distribution System Engineering, 3 cr. (3 and 0) S
Radial circuit analysis techniques, feeder and transformer modeling, loss modeling, voltage control, and power quality problems, motor starting analysis, strategies for analyzing impacts of disturbances. Prerequisites: E C E 418 and 419 or permission of instructor.

E C E 818: Random Process Applications in Engineering, 3 cr. (3 and 0)
Theory of random processes emphasizing engineering applications; stochastic convergence and limit theorems; martingales; mean-square calculus; Karhunen-Loeve expansions, systems with stochastic inputs; Poisson processes; shot noise; Weiner processes; white noise processes; Markov systems; queuing systems; and estimate theory. Prerequisites: E C E 317 and 330 or permission of instructor.

E C E 824: Power System Protection, 3 cr. (3 and 0)
Coordination of power system protection components including microprocessor based relay-adaptive protection of power systems, power system disturbance identification, and system restoration following a major disturbance. Prerequisites: E C E 418 or permission of instructor. Corequisite: MTHSC 434 or permission of instructor.

E C E 830: Electromagnetics, 3 cr. (3 and 0)
Wave equations and waves, electromagnetic potentials, theorems and advanced concepts, guided waves, radiation, boundary value problems, and simple Green's functions. Prerequisites: E C E 380 and 381 or their equivalents.

E C E 838: Special Topics in Electromagnetics, 1 cr. (1 and 0)
Methods of solving selected electromagnetic problems with emphasis on Green's functions, equivalence principle, dynamic potential theory and boundary value techniques. May be repeated for credit. Prerequisite: Permission of instructor.

E C E 839: Integral Equations in Electromagnetics, 3 cr. (3 and 0)
Integral equation formulation in electromagnetics, solution techniques, moment methods and application to practical problems. Prerequisite: E C E 830 or permission of instructor.

E C E 841: Distributed Computing and Networks, 3 cr. (3 and 0) S
Design oriented toward distributed computing and computing concepts; design issues; implementation techniques; communication networks; analytical tools for system evaluation; data transmission principles; data concentration. Prerequisite: E C E 438/638.

E C E 842: Computer Architecture, 3 cr. (2 and 2) S
Fundamental issues that arise in the composition of logic elements into computer systems; design and analysis of processors, busses, memory hierarchies, computer interconnection methods and application to practical problems. Prerequisites E C E 429 or equivalent.

E C E 844: Digital Signal Processing, 3 cr. (3 and 0)
Digital filter design; discrete Hilbert transforms; discrete random processes; effects of finite register length in digital signal processing; homomorphic signal processing; power spectrum estimation; speech processing, radar and other applications. Prerequisite: E C E 467/667.

E C E 845: Computer System Design and Operation, 3 cr. (3 and 0)
Factors involved in design, acquisition and operation of a computer system; analysis methods; alternative computer systems; computer economics; performance evaluation; operational requirements. Prerequisite: Permission of instructor.

E C E 846: Digital Processing of Speech Signals, 3 cr. (3 and 0)
Application of digital signal processing techniques to problems related to speech synthesis, recognition and communication; digital models and representations of speech wave forms; Fourier analysis; homomorphic processing; linear predictive coding; algorithms for recognizing isolated words and continuous speech; man-machine communications by voice. Prerequisite: E C E 467.

E C E 847: Digital Image Processing, 3 cr. (3 and 0)
Digital image fundamentals; comparison of image transforms including KL, Fourier, Walsh, Hadamard, cosine and slant; image data compression techniques; image enhancement algorithms; image restoration; image encoding process; image segmentation and description. Prerequisite: E C E 467.
ECE 848: Telecommunication Network Modeling and Analysis, 3 cr. (3 and 0)
Protocols, modeling and analysis of telecommunication networks with emphasis on quantitative performance modeling of networks and systems using packet switching and circuit switching techniques. Prerequisite: ECE 438/638 or CP SC 825.

ECE 849: Advanced Topics in Computer Communications, 3 cr. (3 and 0)
Performance analysis and design of computer communication networks with emphasis on recent developments; routing flow control, error control and end-to-end performance analysis, local area, packet radio and long haul store-and-forward networks. Prerequisites: ECE 438/638 or 440/640, and permission of instructor.

ECE 850: Computation and Simulation, 3 cr. (3 and 0)
Computer modeling related to engineering problems; matching problems and computers to obtain most effective solution.

ECE 851: Advanced Topics in Computer Architecture, 3 cr. (3 and 0)
Analysis and design of multiprocessor and modular computer systems; recent developments in integration, fabrication and application of multiprocessor systems. Prerequisite: ECE 842.

ECE 852: Software Engineering, 3 cr. (3 and 0) F
Design, construction verification and testing of large-scale computer software systems; software science, requirements writing, design graphics, the calculus of programs, verification proofs and symbolic execution. Prerequisite: Computer engineering major or permission of instructor.

ECE 855: Artificial Intelligence, 3 cr. (3 and 0)
Emulating intelligent behavior by computer; models of cognitive processes; logical foundations; constraint satisfaction problems; natural language understanding; pattern-directed inference and chaining paradigms; goal-directed behavior, planning and search; learning; advanced data base structure and inference strategies; examples of LISP, PROLOG and OPSS. Prerequisite: ECE 442/642.

ECE 856: Pattern Recognition, 3 cr. (3 and 0)
Several approaches to general pattern recognition problems with practical computer-oriented applications; feature extraction; classification algorithms; discriminant functions; learning schemes; statistical methods; information theoretic approaches; applications; current developments.

ECE 857: Coding Theory, 3 cr. (3 and 0)
Principles of algebraic coding and its application to transmission of information over noisy communications channels; introduction to abstract algebra; code performance bounds; code representations; linear codes of the Hamming and Bose-Chandnuri types and burst-error correcting codes; problems of implementation and decoding. Prerequisite: ECE 317 or equivalent.

ECE 872: Artificial Neural Networks, 3 cr. (3 and 0)
Design, analysis and application of artificial neural networks; neuron models, network architectures, training (supervised and unsupervised) and hardware implementation; extended studies of selected applications and simulation exercises. Prerequisites: MTHSC 311 or permission of instructor, and graduate standing.

ECE 890: Engineering Report Research, variable credit hours
Research culminating in writing an engineering report to satisfy one of the requirements for the nonthesis option for the Master of Science degree. The engineering report is similar to the thesis but requires only departmental approval. Graded on a pass/fail basis.

ECE 891: Master's Thesis Research, credit to be arranged

ECE 892: Special Problems in Electrical and Computer Engineering, 1-3 cr. (1-3 and 0)
Term paper, special design or other problems in electrical and computer engineering approved by the instructor; not to be used for investigation associated with the M.S. thesis or the engineering report. May be repeated for additional credit.

ECE 893: Selected Topics in Electrical and Computer Engineering, 1-3 cr. (1-3 and 0)
Topics not covered in other courses; current literature and results of current research. Topics vary from year to year in keeping with developments in the field; may be repeated for additional credit. Prerequisite: Permission of instructor.

ECE 991: Doctoral Dissertation Research, credit to be arranged

Computer Science

Harold Grossman, Acting Chair, Department of Computer Science

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The following are required for unconditional admission to graduate study in computer science:

1. intermediate-level undergraduate computer science including computer organization and data representation, machine and assembly language programming, data structures, file organization and processing, programming systems, theory of computation and software methodology; and
2. basic mathematics including calculus, probability and statistics, and discrete mathematics.

An applicant with minimal deficiencies may be admitted provisionally, while one with several deficiencies may be required to complete satisfactorily prerequisite work as a postbaccalaureate student prior to admission as a graduate student.

A candidate for the M.S. degree must complete satisfactorily an approved program of at least 30 graduate hours. There are three options available to the student to satisfy the degree requirements. Option 1 requires course work only, followed by a written examination. Option 2 requires a research paper, and Option 3 requires a thesis. Students may take up to six hours of approved courses in areas outside the department.

Although formal course requirements for the Ph.D. degree are minimal, a typical program requires two to four years of effort beyond the M.S. degree. Each candidate is required to pass a qualifying examination, a comprehensive examination, a dissertation proposal and a defense of the dissertation.

CP SC 605: Introduction to Graphical Systems Design, 3 cr. (3 and 0) F
Principles, computational techniques and design concepts needed for designing systems for effective graphical displays. Prerequisites: MTHSC 108, 311, CP SC 241.

CP SC 611: Virtual Reality Systems, 3 cr. (3 and 0)
Design and implementation of software systems necessary to create virtual environments; techniques for achieving real-time, dynamic display of photorealistic, synthetic images; hands-on experience with electromagnetically tracked, head-mounted displays. Final project requires the design and construction of a virtual environment. Prerequisites: MTHSC 108, 311 and CP SC 241.

CP SC 622: Introduction to Operating Systems, 3 cr. (3 and 0)
Management techniques for the control of computer hardware resources; interrupt systems, primitive level characteristics of hardware; management of memory, processor, devices and data. Credit may not be received for both CP SC 332 and 422. Prerequisites: CP SC 231, 360. Corequisite: CP SC 221.

CP SC 623: Implementation of Operating Systems, 3 cr. (2 and 2)
Detailed review of the implementation of an existing, multi-tasking operating system; extension of concepts in laboratory to development and implementation of a system nucleus supporting multi-tasking and process coordination on an actual computer system. Emphasis is given to design decisions as they apply to performance and complexity. Prerequisite: CP SC 332 or 422, or equivalent.
CP SC 628: Design and Implementation of Programming Languages, 3 cr. (3 and 0)
Overview of programming language structures and features and their implementation; control and data structures found in various languages; runtime organization and environment and implementation models. Prerequisites: CP SC 231 and 241 or equivalent.

CP SC 629: Translation of Programming Languages, 3 cr. (3 and 0)
Techniques and considerations for compiling and interpreting programming languages; scanning, parsing, optimization, code generation and their theoretical foundations. Implementation of a compiler or a major component of a compiler normally will be a term project. Prerequisites: CP SC 350, 428.

CP SC 650: Theory of Computation, 3 cr. (3 and 0)
Models of computation and machine description languages including finite-state automata and regular expressions, pushdown automata and context-free languages, and Turing machines and recursive functions; equivalence and relative computing power of the models studied, enumeration, Church's thesis and undecidability problems. Prerequisite: CP SC 350.

CP SC 662: Data Base Management Systems, 3 cr. (3 and 0)
Database/data communications concepts as related to the design of online information systems; problems and solutions involving structuring, creating, maintaining, and accessing multiple-user databases; comparison of several commercially available teleprocessing monitor and database management systems will be made. Prerequisite: CP SC 350.

CP SC 663: On-Line Systems, 3 cr. (3 and 0)
Design and implementation of transaction processing systems; basic communications concepts; survey of commercially available software; project using one of the systems. Prerequisite: CP SC 462.

CP SC 664: Introduction to Computer Architecture, 3 cr. (3 and 0)
Survey of von Neumann computer architecture at the instruction-set level. Fundamental design issues will be emphasized and will be illustrated using historical and current mainframe, supermini and micro architecture. Prerequisite: CP SC 330 or permission of instructor.

CP SC 672: Software Development Methodology, 3 cr. (3 and 0)
Software development methodology; techniques such as chief programmer teams, structured design and structured walkthroughs; application of these techniques to large-scale software implementation projects; mathematical foundations of structured programming; verification techniques. Prerequisites: CP SC 360 and 372.

CP SC 681: Selected Topics, 1-3 cr. (1-3 and 0)
Areas of computer science in which non-standard problems arise; innovative approaches to problem solutions which draw from a variety of support courses; independent study and projects. May be repeated for a maximum of six credits, but only if different topics are covered. Prerequisite: Permission of instructor.

CP SC 740: Computer Science for High School Teachers I, 3 cr. (2 and 2) N
Modern problem-solving and programming methods for high school teachers; algorithm development, software life cycle concepts, system hardware and software components, and an introduction to programming in PASCAL. Restricted to graduate students and in-service teachers in secondary education. Prerequisite: Introductory computer programming.

CP SC 741: Computer Science for High School Teachers II, 3 cr. (2 and 2) N
Continuation of CP SC 740; problem-solving and programming techniques are considered in greater depth; elementary data structures are introduced. Restricted to graduate students and in-service teachers in secondary education. Prerequisite: CP SC 740 or equivalent.

CP SC 801: An Intensive Introduction to Computer Science for MFAC, 5 cr. (3 and 2)
Fundamental concepts of computing for computer science graduate students who have no undergraduate degree in computing. Topics include object-oriented design and programming, computer organization, software development systems, data structures and graphical user interfaces. Heavy emphasis on laboratory and project work. Prerequisite: Permission of instructor.

CP SC 805: Advanced Modeling Techniques in Computer Graphics, 3 cr. (3 and 0) S
Advanced techniques used in the artificial rendering of natural scenes; brings students to the frontier of current practice in computer graphics; full software implementation of each technique is carried out; extensive coding is required. Prerequisite: CP SC 405/605.

CP SC 808: Computer Animation, 3 cr. (3 and 0) S
Scrip-ting systems, motion control, articulated figures, forward and inverse kinematics, soft object deformation, in-betweening key deformations, morphing, animating analytical models. Prerequisites: MTHSC 311 and CP SC 611 or permission of instructor.

CP SC 810: Introduction to Artificial Intelligence, 3 cr. (3 and 0) S
Problem solving and game playing; knowledge representation; expert systems; natural language processing; perception and learning. Prerequisite: Permission of instructor.

CP SC 815: Special Effects Production, 3 cr. (3 and 0)
Video special effects, compositing problems, effects animation, matchmoving and 3D geometry, color and texture reconstruction from 2D images; extensive use of scripting languages and high-end software platforms. Prerequisites: CP SC 605 or 611 and ART 821 or permission of instructor.

CP SC 820: Parallel Architecture, 3 cr. (3 and 0)
Parallel processing issues; vector and pipeline processors; arrays of processing elements; associative processors; data flow computers; networks of processors; survey of parallel programming languages; design and implementation of parallel algorithms; future trends. Prerequisite: CP SC 664.

CP SC 822: Case Study in Operating Systems, 3 cr. (2 and 2)
Case study of the design of an operating system. Class periods are devoted to reviewing source code and deducing the structure of the system. Lab exercises require students to make major changes to the system to enhance its performance on particular workloads. Prerequisites: CP SC 422/622 and permission of departmental graduate affairs chairperson.

CP SC 823: Operating Systems Design, 3 cr. (3 and 0) F
Analytic, simulation and conceptual models of operating systems and their application to the design and implementation of actual systems; kernel design and its implementation in UNIX-like systems; models of concurrent processes, processors scheduling and memory management. Prerequisites: MTHSC 401/601 and CP SC 423/623.

CP SC 824: Advanced Operating Systems, 3 cr. (3 and 0) S
Recent trends in system design and implementation; operating system structures to support reliable secure systems; verification techniques; fault tolerant systems; operating system considerations for closely coupled multiprocessor systems; network operating systems. Prerequisite: CP SC 623 or permission of instructor.

CP SC 825: Software Systems for Data Communications, 3 cr. (3 and 0) F
Structure of software systems supporting communications among computing devices having diverse processing and communication capabilities; characterization of data communications software in terms of unified network architectures consisting of several functional layers; evaluation of several network architectures. Prerequisite: CP SC 622 or permission of instructor.

CP SC 826: Internetworking, 3 cr. (3 and 0)
Network architecture and communication protocols underlying the global interoperability of the Internet. Topics include addressing and routing, interconnection of autonomous
networks, naming and name resolution, connection management, flow and congestion control and network management. **Prerequisites:** CP SC 825, ECE 638 or permission of instructor.

**CP SC 828: Theory of Programming Languages, 3 cr. (3 and 0) F**
Syntax and semantics of programming languages; finite state and pushdown processors; context-free models of syntax; parsing algorithms and semantic models. **Prerequisites:** CP SC 429/629 and 450/650.

**CP SC 829: Advanced Compiler Topics, 3 cr. (3 and 0) S**
Code generation, register allocation, program optimization, data flow, interprocedural operations, parallel compilation and distributed compilation. **Prerequisites:** CP SC 429/629 and 450/650.

**CP SC 830: Systems Modeling, 3 cr. (3 and 0) S (even numbered years)**
Fundamental concepts and techniques used in the stochastic modeling of computer and computer-based communication systems; applications include hardware configuration design, software performance evaluation and reliability estimation of fault-tolerant systems. **Prerequisites:** CP SC 630 and MTHSC 400 or MTHSC 800, or permission of instructor.

**CP SC 838: Advanced Data Structures, 3 cr. (3 and 0) F (odd numbered years)**
Search trees; data structures for sets; index structures for data bases; data abstraction and automated implementation; implicit data structures; storage compaction of lists; data structures for decision trees; data structures in areas such as computer graphics, artificial intelligence, picture processing and simulation. **Prerequisite:** Permission of instructor.

**CP SC 840: Design and Analysis of Algorithms, 3 cr. (3 and 0) S**
Basic techniques for design and analysis of algorithms; models and techniques for obtaining upper and lower time and space bounds; time/space trade-offs; inherently difficult problems. **Prerequisite:** MTHSC 419/619 or CP SC 650 or equivalent.

**CP SC 841: Computational Complexity, 3 cr. (3 and 0) F (even numbered years)**
Deterministic and nondeterministic polynomial-time algorithms; NP-complete problems and Cook’s Theorem; techniques for establishing NP-completeness; oracle machines; polynomial-time hierarchy; polynomial space; probabilistic algorithms and complexity classes; parallel complexity; provable intractability results. **Prerequisite:** CP SC 650 or 840.

**CP SC 859: Foundations of Theoretical Computer Science, 3 cr. (3 and 0)**
Preparation for the study of advanced issues in computational complexity, algorithm correctness and inherent limits to computing; set theory and proof techniques; classes of the Chomsky hierarchy. **Prerequisite:** CP SC 350 or permission of the department chair.

**CP SC 862: Data Base Management System Design, 3 cr. (3 and 0) S**
Concepts and structures for design and implementation of a DBMS; theoretical foundations for query systems; data modeling and information representation; user interface and internal system design considerations; system performance modeling and measurement; topics from the literature. **Prerequisite:** CP SC 462.

**CP SC 864: Computer Architecture, 3 cr. (3 and 0) F**
Computer architecture and structures from the classical Von Neumann machines to state-of-the-art computer organizations; unconventional architectures such as array, pipeline, associative, data flow, reduction and tree machines. **Prerequisite:** CP SC 664.

**CP SC 870: Software Design and Implementation Using Object Technology, 3 cr. (3 and 0)**
Fundamental concepts of object modeling, using object-oriented analysis and design. Realistic application of software engineering principles within a variety of problem domains. All concepts and examples utilize a mainstream language with facilities for object-oriented programming.

**CP SC 872: Software Specification and Design Techniques, 3 cr. (3 and 0) F**
Techniques, tools, environments and formal methods for software specification and design; verification of design correctness. **Prerequisite:** CP SC 672 or equivalent.

**CP SC 873: Software Verification, Validation and Measurement, 3 cr. (3 and 0) S**
Proofs of correctness; test planning; static and dynamic testing; symbolic execution; automated testing; verification and validation over the software life cycle; software metrics; software maintenance. **Prerequisite:** CP SC 672 or equivalent.

**CP SC 881: Selected Topics, 1-3 cr. (1-3 and 0)**
Advanced topics from current problems of interest in computer science. Topics vary from semester to semester. May be repeated for credit, but only if different topics are covered. **Prerequisite:** Permission of instructor.

**CP SC 888: Directed Projects in Computer Science, 1-6 cr.**
Directed individual project supervised by department faculty. Graded on a pass/fail basis.

**CP SC 901: Master's Thesis Research, credit to be arranged**
**CP SC 951: Seminar in Algorithms, 1-3 cr. (1-3 and 0) N**
Advanced topics from current problems of interest in algorithms. May be repeated for credit. **Prerequisite:** Graduate status.

**CP SC 952: Seminar in Computer Architecture, 1-3 cr. (1-3 and 0) N**
Advanced topics from current problems of interest in computer architecture. May be repeated for credit. **Prerequisite:** Graduate status.

**CP SC 953: Seminar in Database Systems, 1-3 cr. (1-3 and 0) N**
Advanced topics from current problems of interest in database systems. May be repeated for credit.

**CP SC 954: Seminar in Operating Systems, 1-3 cr. (1-3 and 0) N**
Advanced topics from current problems of interest in operating systems. May be repeated for credit. **Prerequisite:** Graduate status.

**CP SC 955: Seminar in Programming Languages, 1-3 cr. (1-3 and 0) N**
Advanced topics from current problems of interest in programming languages. May be repeated for credit. **Prerequisite:** Graduate status.

**CP SC 956: Seminar in Programming Paradigms, 1-3 cr. (1-3 and 0) N**
Advanced topics from current problems of interest in programming paradigms. May be repeated for credit. **Prerequisite:** Graduate status.

**CP SC 957: Seminar in Software Engineering, 1-3 cr. (1-3 and 0) N**
Advanced topics from current problems of interest in software engineering. May be repeated for credit. **Prerequisite:** Graduate status.

**CP SC 981: Seminar in Computer Science, 1-3 cr. (1-3 and 0) N**
Topics of current research interest. May be repeated for credit.

**CP SC 991: Doctoral Dissertation Research, credit to be arranged**

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**Electrical Engineering**

John M. Gowdy, Chair, Department of Electrical and Computer Engineering

<table>
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<tr>
<th>Major</th>
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<td>Electrical Engineering</td>
<td>M.Engr., M.S., Ph.D.</td>
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Students in electrical engineering may direct their programs toward the fields of communications/digital signal process (digital communication, digital signal processing or image processing/artificial intelligence/pattern recognition); computer communications; controls/robotics; computational electromagnetics; electronics; and power systems. For the M.S. program, students may write a thesis or follow a nonthesis option. The thesis option requires a total of 30 credit hours including six hours of thesis research. For the nonthesis option, 33 credit hours of coursework must be completed. The M.Engr. program has the same requirements as the M.S.
thesis option, but the thesis is replaced by an engineering report.

Specially qualified candidates with a B.S. degree may apply for direct entry to the Ph.D. program in any of the above areas. The program of study and hours required beyond the baccalaureate degree are specified by the focus area, but must be at least 66 including course work and research credit.

Some of these programs are also available to off-campus students through the Office of Off-Campus, Distance and Continuing Education. Call 1-888-CLEMSON (1-888-253-6766) for more information.

E C E 604: Semiconductor Devices, 3 cr. (3 and 0) F
Principles of operation, external characteristics and applications of some of the more important semiconductor devices available. Prerequisite: E C E 320. Corequisite: MTHSC 311 or 434.

E C E 606: Introduction to Microelectronics Processing, 3 cr. (3 and 0) S
Microelectronic processing, MOS and bipolar monolithic circuit fabrication, thick and thin film hybrid fabrication, applications to linear and digital circuits, fundamentals of device design. Prerequisite: E C E 320. Corequisite: MTHSC 311 or 434.

E C E 610: Modern Control Theory, 3 cr. (3 and 0) F, S
Modern control theory including fundamentals of matrix algebra, state space analysis and design, nonlinear systems and optimal control. Prerequisite: E C E 409.

E C E 617: Elements of Software Engineering, 3 cr. (3 and 0) F, S
Foundations of software design, reasoning about software, the calculus of programs, survey of formal specification techniques and design languages. Prerequisites: E C E 329, MTHSC 419.

E C E 618: Power System Analysis, 3 cr. (3 and 0) F
Power system planning and operational problems; load flow, economic dispatch, fault studies, transient stability and control of problems. System modeling and computer solutions are emphasized through class projects. Prerequisites: E C E 360, 380.

E C E 619: Electric Machinery, 3 cr. (3 and 0) S
Performance, characteristics and modeling of AC and DC machines during steady-state and transient conditions, introduction to power electronics devices and their use in adjustable speed motor drives. Prerequisites: E C E 321, 360, 380. Corequisite: MTHSC 434 or permission of instructor.

E C E 622: Operational Amplifier Circuits, 3 cr. (2 and 2) S
Analysis and design of circuits, both analog and digital, using operational amplifiers. Prerequisite: E C E 321. Corequisite: MTHSC 431 or 434.

E C E 626: Digital Computer Design, 3 cr. (3 and 0) F, S
Design of high-speed ALUs, control and timing circuitry, memory systems and I/O circuitry; microprogrammed computer design using bit-slice microprocessors; current hardware topics related to computer design; hands-on design experience; use of logic analyzer for system debugging. Prerequisites: E C E 352, 371.

E C E 629: Organization of Computers, 3 cr. (3 and 0) F, S
Computer organization and architecture including a review of logic circuits, bus structures, memory organization, interrupt structures, arithmetic units, input-output structures, state generation, central processor organization, control function implementation, and data communication; Registered Transfer Language (RTL) for description and design of digital systems. Prerequisite: CP SC 230 or E C E 250 or 272 or permission of instructor.

E C E 630: Introduction to Digital Communications, 3 cr. (3 and 0) S
Modern digital communications theory; discrete time signals, discrete Fourier transforms, channel bandwidth, channel distortion, coding of analog information, data signal encoding, introduction to decision theory, matched filter, baseband systems, AM, FM, PM, phase-locked loops, secure communications and contemporary communications systems. Prerequisites: E C E 317 or MTHSC 400, E C E 330, MTHSC 311 or 434, or permission of instructor.

E C E 631: Digital Electronics, 3 cr. (2 and 2) F, S
Electronic devices and circuits of importance to digital computer operation and to other areas of electrical engineering; active and passive waveshaping, waveform generation, memory elements, switching and logic circuits. Experimentation with various types of circuits is provided by laboratory projects. Prerequisite: E C E 321. Corequisite: MTHSC 311 or 434.

E C E 632: Instrumentation, 3 cr. (3 and 0) F
Theory and analysis of transducers and related circuits and instrumentation; generalized configurations and performance characteristics of instruments; transducer devices for measuring physical parameters such as motion, force, torque, pressure, flow, and temperature. Prerequisite: E C E 321. Corequisite: MTHSC 311 or 434.

E C E 634: Power Electronics, 3 cr. (3 and 0) F
Electronic devices and systems designed to control or regulate large amounts of power including SCR applications to inverters, motors controls, high-current switching systems, voltage stabilizers, and other power applications of electronics. Prerequisites: E C E 321, 360. Corequisite: MTHSC 434 or permission of instructor.

E C E 636: Transmission Lines and Microwave Circuits, 3 cr. (3 and 0) F
Theoretical and practical aspects of transmission lines and wave-guides; Smith Chart applications and design impedance matching networks, scattering parameters, interconnection and design of multiports. Prerequisite: E C E 381 or equivalent. Corequisite: MTHSC 311 or 434.

E C E 638: Computer Communications, 3 cr. (3 and 0) F
Digital data transmission techniques, modems and communications channels, communications software and protocols, multiprocessors and distributed processing; concurrency and cooperation of dispersed processors. Prerequisite: Senior standing in electrical or computer engineering or computer science or permission of instructor.

E C E 639: Fiber Optics, 3 cr. (3 and 0) F
Principles of design for optical fibers in practical systems; examinations of optical fiber as a wave-guide using wave optics and ray optics design criteria for using mono- and multi-mode fibers; fabrication and measurement. Prerequisite: E C E 381. Corequisite: MTHSC 434 or permission of instructor.

E C E 640: Performance Analysis of Local Computer Networks, 3 cr. (3 and 0) S
Design and performance analysis of local computer networks with emphasis on performance analysis of representative multi-access procedures. Three common types of networks are considered in detail. Prerequisite: E C E 272, 317 or MTHSC 400 or equivalent.

E C E 642: Knowledge Engineering, 3 cr. (3 and 0) F
Theoretical and practical aspects of knowledge engineering or applied artificial intelligence; symbolic representation structures and manipulation, unification, production systems and structures, rule-based and expert systems, planning and AI system architectures; system design in PROLOG and LISP. Project required. Prerequisite: E C E 329, 352.

E C E 646: Antennas and Propagation, 3 cr. (3 and 0) S
Theoretical and practical aspects of antenna design and utilization, input impedances, structural considerations and wave propagation. Prerequisites: E C E 330, 381 or 436, MTHSC 311 or 434.

E C E 656: Fundamentals of Robotics (M E 656), 3 cr. (3 and 0) F
Introduction to the fundamental mechanics and control of robots including their application to advanced automation. Top-
ics include robot geometry, kinematics, dynamics and control. Emphasis on planar machine structures; methods using computer analysis. Application considerations include the design and operation of robot systems for manufacturing and telerobotics. Prerequisite: ECE 305. 416 (or concurrent enrollment) or permission of instructor.

E C E 659: Integrated Circuit Design, 3 cr. (2 and 2) F, S
Design concepts and factors influencing the choice of technology; fundamental MOS device design; silicon foundries, custom and semicustom integrated circuits; computer-aided design software/hardware trends and future developments; hands-on use of CAD tools to design standard library cells; systems design considerations, testing and packaging. Prerequisite: ECE 321. Corequisite: MTHSC 311 or 434.

E C E 660: Computer-Aided Analysis and Design, 3 cr. (3 and 0) F
Principles and methods suited to the solution of engineering problems on the digital computer; methods for the solution of the systems of algebraic and/or differential equations which arise in modeling of engineering systems, data approximation and curve fitting, continuous system simulation languages and design-oriented programming systems. Prerequisites: ECE 262, MTHSC 311, 434, or permission of instructor.

E C E 667: Introduction to Digital Signal Processing, 3 cr. (3 and 0) F, S Characteristics, design and applications of discrete time systems, design of digital filters; Fast Fourier Transform (FFT); LSI hardware for signal processing applications. Prerequisite: ECE 330.

E C E 668: The Embedded Microprocessor, 3 cr. (2 and 2) S Interfacing, architecture and design issues that arise when the microprocessor is embedded in electromechanical and human systems. Applications and design projects include guidance systems, robotics, process control, artificial limbs, etc. Prerequisites: ECE 302 or 330 or 409 and 371, MTHSC 311 or 434 or permission of instructor.

E C E 692: Special Problems, 1-3 cr. (0 and 2)
Special assignment in electrical or computer engineering. Typical assignments include computer programs, term papers, technical literature searches, hardware projects and design project leadership. May be taken only once for credit.

E C E 693: Selected Topics, 1-3 cr. (1-3 and 0)
Current and new technical developments in electrical and computer engineering. May be repeated for a maximum of six credit hours, but only if different topics are covered. Prerequisite: Permission of instructor.

E C E 701: Master of Engineering Design Project, 1-6 cr. (0 and 0) F, S Practical problems in engineering analysis and design culminating in the written report required for the Master of Engineering (M.Eng.) degree. Graded on a pass/fail basis. May be repeated for up to six hours total credit.

E C E 817: Power System Transients, 3 cr. (3 and 0) Electrical transients in power systems; frequency domain and time domain techniques for power system transient analysis; capacitor switching, load switching, fault-induced transients, line reclosing and single pole switching. Prerequisite: Permission of instructor.

E C E 818: Random Process Applications in Engineering, 3 cr. (3 and 0) Theory of random processes emphasizing engineering applications; stochastic convergence and limit theorems; martingales; mean-square calculus; Karhunen-Loeve expansions; systems with stochastic inputs; Poisson processes; shot noise; Wiener processes; white noise processes; Markov systems; queueing systems; and estimate theory. Prerequisites: ECE 317 and 330 or permission of instructor.

E C E 819: Detection and Estimation Theory, 3 cr. (3 and 0) Theory of statistical testing of hypotheses applied to detection and estimation of communication signal parameters; detection of signals with random amplitude, phase and arrival time in noise; detection of single and multiple observations; estimates and their properties; signal resolution. Prerequisite: ECE 820.

E C E 820: Digital Communication Systems I, 3 cr. (3 and 0) Modern communications systems emphasizing modulation and methods of taking into account effects of noise on various systems. Prerequisite: ECE 429/628 or equivalent.

E C E 821: Digital Communication Systems II, 3 cr. (3 and 0) Continuation of ECE 820.

E C E 822: Information Theory, 3 cr. (3 and 0) Statistical problems encountered in information handling; relations of probability, information and coding theory; unified treatment of set theory, sample space, random variables, information measure and capacity applied to communication.

E C E 823: Integrated Circuit Technology, 3 cr. (3 and 0) Physical and chemical principles underlying the major processing operations used in the fabrication of integrated circuit semiconductor devices, process simulation, diagnostic testing, and factors affecting device yield and reliability. Prerequisite: Permission of instructor.

E C E 825: Solid-State Electronics, 3 cr. (3 and 0) Modern physics approach to electrons in solids; elementary quantum mechanics; statistics; plasmas; band theory; application of these principles to modern amplifiers; e.g. the traveling-wave tube, tunnel diode, masers and parametric amplifiers.
E C E 830: Electromagnetics, 3 cr. (3 and 0)
Wave equations and waves, electromagnetic potentials, theorems and advanced concepts, guided waves, radiation, boundary value problems and simple Green's functions. Prerequisites: E C E 380 and 381 or their equivalents.

E C E 831: Advanced Electromagnetic Theory, 3 cr. (3 and 0)
Advanced boundary-value problems in cylindrical and spherical coordinates, special functions. Sommerfeld integrals, Green's functions and integral equations. Prerequisite: E C E 830.

E C E 834: Asymptotic Methods and Diffraction Theory, 3 cr. (3 and 0)
Canonical diffraction problems for which exact solutions are available; asymptotic reevaluation of these solutions in terms of incident, reflected and diffracted rays leads to Keller's postulates for an extended theory or geometrical theory of diffraction; diffraction from edges and curved surfaces is applied to scattering and antenna problems. Prerequisite: E C E 830.

E C E 836: Microwave Circuits and Systems, 3 cr. (3 and 0)
Application of the mathematics and physical principles of electromagnetic field theory and electrical circuit analysis to the geometries that are of interest in modern microwave engineering; transmission lines, waveguides, discontinuities, interconnection of multiports and periodic structures. Prerequisite: E C E 436. Corequisite: E C E 830.

E C E 837: Advanced Antenna Theory, 3 cr. (3 and 0)
The antenna as a radiating and receiving device; examination by classical and numerical techniques of the relations between structure and performance, gain and terminal conditions. Prerequisite: E C E 446. Corequisite: E C E 830.

E C E 838: Special Topics in Electromagnetics, 1 cr. (1 and 0)
Methods of solving selected electromagnetic problems with emphasis on Green's functions, equivalence principle, dynamic potential theory and boundary value techniques. May be repeated for credit. Prerequisite: Permission of instructor.

E C E 839: Integral Equations in Electromagnetics, 3 cr. (3 and 0)
Integral equation formulation in electromagnetics, solution techniques, moment methods and application to practical problems. Prerequisite: E C E 830 or permission of instructor.

E C E 840: Physics of Semiconductor Devices, 3 cr. (3 and 0)
Semiconductor device physics emphasized rather than circuits; detailed analysis of the p-n junction, traps, surface states and conduction processes in devices; analysis and models of Schottky diode, MIS diode, MOSFET, charge coupled devices and solar cells; charge control concepts, transit time effects, surface-type devices and practical aspects of device process. Prerequisites: E C E 404 and 406/606.

E C E 841: Distributed Computing and Networks, 3 cr. (3 and 0) S
Design oriented toward distributed computing and computer concepts; design issues; implementation techniques; communication networks; analytical tools for system evaluation; data transmission principles; data concentration. Prerequisite: E C E 438/638.

E C E 842: Computer Architecture, 3 cr. (3 and 0) S
Fundamental issues that arise in the composition of logic elements into computer systems; design and analysis of processors, buses, memory hierarchies, communications controllers and associated software. Prerequisite: E C E 429 or equivalent.

E C E 844: Digital Signal Processing, 3 cr. (3 and 0)
Digital filter design; discrete Hilbert transforms; discrete random signals; effects of finite register length in digital signal processing; homomorphic signal processing; power spectrum estimation; speech processing, radar and other applications. Prerequisite: E C E 467/667.

E C E 845: Computer System Design and Operation, 3 cr. (3 and 0) S
Factors involved in design, acquisition and operation of a computer system; analysis methods; alternative computer systems, computer economics; performance evaluation; operational requirements. Prerequisite: Permission of instructor.

E C E 846: Digital Processing of Speech Signals, 3 cr. (3 and 0)
Application of digital signal processing techniques to problems related to speech synthesis, recognition and communication; digital models and representations of speech wave forms; Fourier analysis; homomorphic processing; linear predictive coding; algorithms for recognizing isolated words and continuous speech; man-machine communications by voice. Prerequisite: E C E 467.

E C E 847: Digital Image Processing, 3 cr. (3 and 0) S
Digital image fundamentals; comparison of image transforms including KL, Fourier, Walsh, Hadamard, cosine and slant; image data compression techniques; image enhancement algorithms; image restoration; image encoding process; image segmentation and description. Prerequisite: E C E 467.

E C E 849: Advanced Topics in Computer Communications, 3 cr. (3 and 0)
Performance analysis and design of computer communication networks with emphasis on recent developments; routing flow control, error control and end-to-end performance analysis, local area, packet radio and long haul store-and-forward networks. Prerequisites: E C E 438/638 or 440/640, and permission of instructor.

E C E 850: Computation and Simulation, 3 cr. (3 and 0)
Computer modeling as related to engineering problems; matching problems and computers to obtain most effective solution.

E C E 851: Advanced Topics in Computer Architecture, 3 cr. (3 and 0)
Analysis and design of multiprocessor and modular computer systems; recent developments in integration, fabrication and application of multiprocessor systems. Prerequisite: E C E 842.

E C E 852: Software Engineering, 3 cr. (3 and 0) F
Design, construction verification and testing of large-scale computer software systems; software science, requirements writing, design graphics, the calculus of programs, verification proofs and symbolic execution. Prerequisite: Computer engineering major or permission of instructor.

E C E 854: Analysis of Robotic Systems (E E 854), 3 cr. (3 and 0)
Methods of designing and operating robotics systems for advanced automation; on-line identification and description of 3D objects by digitized images; off-line collision-free path planning and on-line collision avoidance traveling using artificial intelligence. Prerequisite: E C E/M E 456 or permission of instructor.

E C E 855: Artificial Intelligence, 3 cr. (3 and 0)
Emulating intelligent behavior by computer; models of cognitive processes; logical foundations; constraint satisfaction problems; natural language understanding; pattern-directed inference and chaining paradigms; goal-directed behavior, planning and search; learning; advanced data base structure and inference strategies; examples of LISP, PROLOG and OPS5. Prerequisite: E C E 442/642.

E C E 856: Pattern Recognition, 3 cr. (3 and 0)
Several approaches to general pattern recognition problems with practical computer-oriented applications: feature extraction; classification algorithms; discriminant functions; learning schemes; statistical methods; information theoretic approaches; applications; current developments.

E C E 857: Coding Theory, 3 cr. (3 and 0)
Principles of algebraic coding and its application to transmission of information over noisy communications channels; introduction to abstract algebra; code performance bounds; code representations; linear codes of the Hamming
and Bose-Chandnuri types and burst-error correcting codes; problems of implementation and decoding. **Prerequisite:** E C E 317 or equivalent.

**E C E 859** (M E 859): Intelligent Robotic Systems, 3 cr. (3 and 0) Integration and fusion of data from multiple sensors on multiple robots; intelligent decision making on motion planning and execution based on sensed data, involving mutual compliance, simultaneous force and position controls using computers. **Prerequisite:** E C E/M E 854 or permission of instructor.

**E C E 861:** Computer Relaying of Power Systems, 3 cr. (3 and 0) Principles of digital protection schemes; application to the digital protection of power system components; transmission lines, generators, motors and transformers; detection of power system frequency deviation and load shedding techniques; fault location techniques and identification of power systems disturbances. **Prerequisites:** E C E 418/618 and permission of instructor.

**E C E 862:** Real Time Computer Application in Power Systems, 3 cr. (3 and 0) Principles of monitoring, control and operation of power systems; load frequency control, on-line load flow, power system state estimation, unit commitment and load forecasting. **Prerequisite:** E C E 418/618.

**E C E 863:** Power System Dynamics and Stability, 3 cr. (3 and 0) Modeling of synchronous machines and their control systems; power system stability for small and large disturbances; excitation systems, governor control, power system stabilizers and state variables formulation for power systems dynamic stability studies. **Prerequisites:** E C E 418/618 and 419/619.

**E C E 872:** Artificial Neural Networks, 3 cr. (3 and 0) Design, analysis and application of artificial neural networks, neuron models, network architectures, training (supervised and unsupervised) and hardware implementation; extended studies of selected applications and simulation exercises. **Prerequisites:** MTHSC 311 or permission of instructor, and graduate standing.

**E C E 890:** Engineering Report Research, variable credit hours Research culminating in writing an engineering report to satisfy one of the requirements for the nonthesis option for the Master of Science degree. The engineering report is similar to the thesis but requires only departmental approval. Graded on a pass/fail basis.

**E C E 891:** Master's Thesis Research, credit to be arranged

**E C E 892:** Special Problems in Electrical and Computer Engineering, 1-3 cr. (1-3 and 0) Term paper, special design or other problems in electrical and computer engineering approved by the instructor; not to be used for investigation associated with the M.S. thesis or the engineering report. May be repeated for additional credit.

**E C E 893:** Selected Topics in Electrical and Computer Engineering, 1-3 cr. (1-3 and 0) Topics not covered in other courses; current literature and results of current research. Topics vary from year to year in keeping with developments in the field. May be repeated for additional credit. **Prerequisite:** Permission of instructor.

**E C E 8991:** Doctoral Dissertation Research, credit to be arranged

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**Fine Arts in Computing**

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<tr>
<td>Fine Arts in Computing</td>
<td>M.F.A.C.</td>
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The Master of Fine Arts in Computing (MFAC) at Clemson University is a professional degree program aimed at producing graduates who will be sought by the growing electronic arts industry, particularly by those companies engaged in special effects production within the entertainment and commercial video and film industries. For more information on this interdisciplinary program refer to page 178.

**Management Science**

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<td>Management Science</td>
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See the College of Business and Public Affairs for information on this program.

**Mathematical Sciences**

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Entering students are expected to have courses in linear algebra, differential equations, a computer language and statistics. For the master's program, both thesis and nonthesis options are available. The curriculum for both options includes foundation courses (advanced calculus, modern algebra, probability and discrete computing—courses often taken prior to entering the master's program); a breadth requirement (a course from each of algebra, analysis, computing, operations research and statistics plus one additional course in operations research or statistics); and a concentration area (six courses selected to define an identifiable specialty area). Every student's program is required to include at least one course, possibly chosen from outside the Department of Mathematical Sciences, that emphasizes mathematical modeling. A minimum of 36 graduate hours is required for the master's degree. In addition, students in the nonthesis option are required to complete a one-credit-hour project course.

Students in the doctoral program are expected to satisfy the master's program requirements prior to receiving their doctorate. Including master's study, a doctoral program must have two courses from each of the major areas of the mathematical sciences (algebra, analysis, computing, operations research and probability/statistics), and generally consists of 60 hours of graduate course work. Students are admitted to candidacy for the Ph.D. degree upon successful completion of a qualifying examination and the comprehensive examination. The preliminary examination consists of tests in three areas chosen from algebra, analysis, computing, operations research, statistics and stochastic processes. The comprehensive exam assesses the student's readiness to perform independent research and competency in advanced graduate material. A student's Ph.D. program must include both a concentration area and a supporting area.

The departments of Management (College of Business and Public Affairs) and Mathematical Sciences jointly offer and administer a doctoral program in management science. It is described under Management Science in the College of Business and Public Affairs. Mathematical sciences courses at the 700-level are applicable to master's degree programs in the School of Education only.

**MTHSC 600:** Theory of Probability, 3 cr. (3 and 0) Combinatorial theory, probability axioms, random variables, expected values; special discrete and continuous distributions, jointly distributed random variables, correlation, conditional expectation, law of large numbers, central limit theorem. **Prerequisite:** MTHSC 206 or permission of instructor.

**MTHSC 603:** Introduction to Statistical Theory, 3 cr. (3 and 0) Sampling distributions, point and interval estimation, maximum likelihood estimators, method of moments, least squares estimators, tests of hypotheses, likelihood ratio methods, regression and correlation analysis, analysis of variance. **Prerequisite:** MTHSC 400 or equivalent.

**MTHSC 605:** Statistical Theory and Methods II, 3 cr. (3 and 0) Simple linear regression, multiple regression and correlation analysis, one-way analysis of variance, multiple comparison, multifact analysis of variance, experimental design. Computation and interpretation of results are facilitated through use of statistical computer packages. **Prerequisite:** MTHSC 301.
MTHSC 606: Sampling Theory and Methods, 3 cr. (3 and 0)
Probability-based treatment of sampling methodology. Theory and application of estimation techniques will be treated using simple and stratified random sampling cluster sampling, and systematic sampling. Prerequisites: MTHSC 302 and 400 or permission of instructor.

MTHSC 607: Regression and Time Series Analysis, 3 cr. (3 and 0)
Theory and application of the regression and time series approaches to empirical model building and data analysis. Computation and interpretation of results are facilitated through the use of interactive statistical packages. Prerequisites: MTHSC 302, 311 and 400 or permission of instructor.

MTHSC 608: Topics in Geometry, 3 cr. (3 and 0)
Topics in special geometries which include non-Euclidean space concepts such as projective geometry, finite geometries and intuitive elementary topology; introduction to vector geometry. Prerequisite: MTHSC 206.

MTHSC 612: Introduction to Modern Algebra, 3 cr. (3 and 0)
Concepts of algebra including the number system and the elementary theory of groups, rings and fields. Prerequisite: MTHSC 311.

MTHSC 619: Discrete Mathematical Structures, 3 cr. (3 and 0)
Approach theoretical concepts of sets, functions, binary relations, graphs, Boolean algebras, propositional logic, semigroups, groups, homomorphisms, and permutations to computer characteristics and design, words over a finite alphabet and concatenation, binary group codes, and other communication or computer problems. Prerequisite: MTHSC 311.

MTHSC 641: Introduction to Stochastic Models, 3 cr. (3 and 0)
Stochastic processes, finite-state Markov chains, queueing, dynamic programming, Markov decision processes, reliability, decision analysis and simulation. Both theory and applications will be stressed. Prerequisite: MTHSC 400.

MTHSC 653: Advanced Calculus I, 3 cr. (3 and 0)
Limits, continuity and differentiation of functions of one and several variables, the Riemann integral, and vector analysis. Prerequisite: MTHSC 206.

MTHSC 654: Advanced Calculus II, 3 cr. (3 and 0)
Continuation of MTHSC 453; transformations, multiple integrals, line and surface integrals, infinite sequences and series, and improper integrals. Prerequisite: MTHSC 453.

MTHSC 660: Introduction to Numerical Analysis, 3 cr. (3 and 0)
Problems of numerical analysis emphasizing computational procedures and application; sources of error and conditioning, matrix methods, systems of linear equations, nonlinear equations, interpolation and approximation by splines, polynomials, and trigonometric functions. Prerequisites: MTHSC 206 or 207 and 360 or equivalent.

MTHSC 663: Mathematical Analysis I, 3 cr. (3 and 0)
Basic properties of the real number system, sequences and limits, continuous functions, uniform continuity and differentiability, integration, differentiation, functions of several real variables, implicit function theory. Prerequisite: MTHSC 206.

MTHSC 703: Modern Mathematics for Elementary School Teachers — Geometry, 3 cr. (3 and 0)
Concepts of geometry; informal geometry; measurement of geometric figures; metric measurements; deductive geometry; functions in geometry; coordinate and vector geometry. Restricted to graduate students in elementary and secondary education.

MTHSC 708: Introductory Discrete Mathematics, 3 cr. (3 and 0)
A survey of discrete mathematics emphasizing topics of interest to the elementary and middle school curriculum: counting techniques, graphs and networks, elements of logic, planning and scheduling, linear programming, game theory, codes, patterns and tilings, and fractals.

MTHSC 709: Geometry for the Middle Grades, 3 cr. (3 and 0)
A hands-on approach to constructions with straight-edge and compass; polygons, including tessellations and polyhedra; symmetry and transformational geometry; coordinate geometry measurement with dimensional analysis; perspective drawing and related topics; history of geometry; reasoning and informal proof with congruence; and computer software, calculator use and the Internet.

MTHSC 710: Elementary Calculus from an Advanced Viewpoint I, 3 cr. (3 and 0)
Origins of calculus; limits; derivative; maxima and minima; continuity; area and other applications of the integral. Restricted to graduate students in elementary and secondary education. Prerequisite: MTHSC 108 or its equivalent.

MTHSC 715: Quantitative Literacy I, 3 cr. (3 and 0)
Data analysis and gathering data from surveys including box-and-whisker plots, bar charts, circle graphs, and stem-and-leaf plots. Construction of surveys to gather data to test a hypothesis. All material will be presented by student activities using cooperative learning and manipulatives.

MTHSC 716: Quantitative Literacy II, 3 cr. (3 and 0)
Probability and simulation; application of these concepts to simulate various processes such as traffic control. All material will be presented by student activities using cooperative learning and manipulatives.

MTHSC 717: Problem Solving, 3 cr. (3 and 0)
Problem solving methods and techniques used to teach problem solving to K-8 students. Techniques include draw a picture, find a pattern, make a list, make a table, guess and check, solve a simpler problem, acting out, working backwards and using deduction.

MTHSC 719: Discrete Mathematics, 3 cr. (3 and 0)
Discrete mathematics emphasizing applications to computer science; propositions and logic; Boolean Algebra and switching circuits; recursion and induction; relations and partially ordered sets, graphs and trees.

MTHSC 721: Matrix Algebra, 3 cr. (3 and 0)
Matrices and systems of equations; determinants; vector spaces and linear transformations; eigenvalues. Restricted to graduate students in secondary education.

MTHSC 723: Applications of Linear and Modern Algebra, 3 cr. (3 and 0)
Various applied problems whose solutions rely on techniques and results of linear and modern algebra; problems selected from such areas as economics, forest management, genetics, population growth, transportation networks, crypography, satellite communications, electronic switching circuits, chemistry, physics, sociology and others. Prerequisite: MTHSC 712, 721 or equivalent or permission of instructor.
MTHSC 725: Combinatorial Mathematics for Teachers, 3 cr.
(3 and 0)
Permutations; combinations; generating functions; recurrence relations; principle of inclusion-exclusion; partitions; Latin squares; block designs; finite geometries; graphs; codes; Polya’s theorem; recreational mathematics. Restricted to graduate students in secondary education.

MTHSC 727: Analysis Concepts for Teachers, 3 cr. (3 and 0)
Elementary functions, differential calculus and integral calculus; enrichment material and a theoretical perspective of calculus. Restricted to teachers who hold a current teaching certificate in secondary mathematics. Completion of this course satisfies the special certification requirements for AB-calculus teachers in South Carolina.

MTHSC 730: Modern Geometry for Teachers, 3 cr. (3 and 0)
Concepts of Euclidean geometry reviewed and extended by means of coordinates, vectors, matrices; conic sections. Restricted to graduate students in secondary education.

MTHSC 741: Introduction to Linear Programming with Applications, 3 cr. (3 and 0)
Development of mathematical theory of simplex algorithm and theory of mathematical background; matrix algebra, systems of linear equations and vector spaces; problem formulation emphasized. Restricted to graduate students in secondary education.

MTHSC 761: Probability and Statistics for Teachers, 3 cr. (3 and 0)
Probability; conditional probability; descriptive statistics; random variables; probability functions; binomial distribution; normal distribution; sampling; estimation; decision making. Restricted to graduate students in secondary education.

MTHSC 770: Technology and Computing for the Middle School Teacher, 3 cr. (3 and 0)
Technology and computing appropriate to middle school; overview of the computer science field, including use of the Internet, ethical issues arising from the impact of computing on society, and an introduction to programming.

MTHSC 783: Theory of Numbers, 3 cr. (3 and 0)
Properties of integers, divisors and prime numbers; fundamental properties of congruence; polynomial and primitive roots; quadratic residues. Restricted to graduate students in secondary education.

MTHSC 791: Selected Topics in Mathematics Education, 1-3 cr. (1-3 and 0)
Mathematical problems in curriculum of elementary or secondary school. Restricted to graduate students in elementary or secondary education. May be repeated for credit, but only if different topics are covered.

MTHSC 800: Probability, 3 cr. (3 and 0) F
Basic probability theory with emphasis on results and techniques useful in operations research and statistics; axiomatic probability, advanced combinatorial probability, conditional informative expectation, functions of random variables, moment generating functions, distribution theory and limit theorems. Prerequisite: MTHSC 206.

MTHSC 801: General Linear Hypothesis I, 3 cr. (3 and 0) F
Least-square estimates: Gauss-Markov theorem; confidence ellipsoids and confidence intervals for estimable functions; tests of hypotheses; one- and higher-way layouts; analysis of variance for other models. Prerequisites: MTHSC 403/603 and 311.

MTHSC 802: General Linear Hypothesis II, 3 cr. (3 and 0) S
Continuation of MTHSC 801.

MTHSC 803: Stochastic Processes, 3 cr. (3 and 0) S, SS
Theory and analysis of time series; recurrent events; Markov chains; random walks; renewal theory; application to communication theory; operations research. Prerequisite: MTHSC 400/600 or 800.

MTHSC 805: Data Analysis, 3 cr. (3 and 0) F, S
Methodology in analysis of statistical data emphasizing applications to real problems using computer-oriented techniques: computer plots, transformations, criteria for selecting variables, error analysis, multiple and stepwise regression, analysis of residuals, model building in time series and ANOVA problems, jackknife and random subsampling, multidimensional scaling, clustering. Prerequisites: MTHSC 301 and 400/600, or MTHSC 401/601 and 800.

MTHSC 806: Nonparametric Statistics, 3 cr. (3 and 0) F
Order statistics; tolerance limits; rank-order statistics; Kolmogorov-Smirnov one-sample statistics; Chi-square goodness-of-fit test; two-sample problem; linear rank statistics; asymptotic relative efficiency. Prerequisite: MTHSC 600 or 800.

MTHSC 807: Applied Multivariate Analysis, 3 cr. (3 and 0) F
Applied multivariate analysis: computer plots of multivariate observations; multidimensional scaling; multivariate tests of means, covariances and equality of distributions; univariate and multivariate regressions and their comparisons; MANOVA; principle components analysis; factor analysis; analytic rotations; canonical correlations. Prerequisites: MTHSC 403/603 and 805 or permission of instructor.

MTHSC 808: Reliability and Life Testing, 3 cr. (3 and 0) S
Probability models and statistical methods relevant to parametric and nonparametric analysis of reliability and life testing data. Prerequisites: MTHSC 400/600 and 401/601 or equivalent.

MTHSC 809: Time Series Analysis, Forecasting and Control, 3 cr. (3 and 0) F
Modeling and forecasting random processes; autocorrelation functions and spectral densities; model identification, estimation and diagnostic checking; transfer function models; feedforward and feedback control schemes. Prerequisites: MTHSC 600 and 605, or MTHSC 800 and 605, or equivalent.

MTHSC 810: Mathematical Programming, 3 cr. (3 and 0) F, S
Formulation and solution of linear programming models; mathematical development of the simplex method; revised simplex method; duality; sensitivity analysis; parametric programming, implementation, software packages. Prerequisite: MTHSC 311.

MTHSC 811: Nonlinear Programming, 3 cr. (3 and 0) S
Theoretical development of nonlinear optimization with applications; classical optimization; convex and concave functions; separable programming; quadratic programming; gradient methods. Prerequisites: MTHSC 440 and 454.

MTHSC 812: Discrete Optimization, 3 cr. (3 and 0) F
Principal methods used in integer programming and discrete optimization; branch and bound, implicit enumeration, cutting planes, group knapsack, Lagrangian relaxation, surrogate constraints, heuristics (performance analysis), separation/branching strategies and polynomial time algorithms for specific problems on special structures. Prerequisite: MTHSC 810 or equivalent.

MTHSC 813: Advanced Linear Programming, 3 cr. (3 and 0) S
Development of linear programming theory using inequality systems, convex cones, polyhedra and duality; solution algorithms and computational considerations for large scale and special structured problems using techniques of upper bounded variables, decomposition, partitioning and column generation; game theory; nonlinear representations and other methods such as ellipsoid and Karmarkan. Prerequisite: MTHSC 440/640, 810 or equivalent.

MTHSC 814: Network Flow Programming, 3 cr. (3 and 0) F
Max-flow/min-cut theorem; combinatorial applications; minimum cost flow problems (transportation, shortest path, transshipment); solution algorithms (including the out-of-kilter); implementation and computational considerations. Prerequisite: MTHSC 440/640, 810 or equivalent.
MTHSC 816: Network Algorithms and Data Structures, 3 cr. (3 and 0) F
Design, analysis and implementation of algorithms and data structures associated with the solution of problems formulated as networks and graphs; applications to graph theory, combinatorial optimization and network programming.
Corequisite: MTHSC 640, 810, 854, 863 or permission of instructor.

MTHSC 817: Stochastic Models in Operations Research I, 3 cr. (3 and 0) F
Stochastic control; structure of sequential decision processes; stochastic inventory models; recursive computation of optimal policies; discrete parameter finite Markov decision processes; various optimality criteria; computation by policy improvement and other methods; existence of optimal stationary policies; stopping-rule problems; examples from financial management, maintenance and reliability, search, queuing and shortest path.
Prerequisite: MTHSC 803.

MTHSC 818: Stochastic Models in Operations Research II, 3 cr. (3 and 0) S
Introduction to queuing theory: Markovian queues, repairman problems, queues with an embedded Markov structure, the queue GI/G/1, queues with a large number of servers, decision making in queues; introduction to reliability theory; failure distributions; stochastic models for complex systems; maintenance and replacement policies; reliability properties of multicomponent structures. Prerequisite: MTHSC 817.

MTHSC 819: Multicriteria Optimization, 3 cr. (3 and 0) S
Theoretical and methodology of optimization problems with vector-valued objective functions; preference orders and domination structures; generating efficient solutions; solving multicriteria decision-making problems, noninteractive and interactive methods with applications. Prerequisite: MTHSC 810 or equivalent.

MTHSC 820: Complementarity Models, 3 cr. (3 and 0) S
Theory, algorithms and applications of linear and nonlinear complementarity; classes of matrices and functions and corresponding algorithms; applications to economics, mechanics and networks; generalizations to fixed-point problems and nonlinear systems of equations. Prerequisite: MTHSC 810.

MTHSC 821: Linear Analysis, 3 cr. (3 and 0) S, SS
Normed spaces; Hilbert spaces, Banach spaces, linear functionals, linear operators, orthogonal systems. Prerequisites: MTHSC 454/654 or MTHSC 453 and 853.

MTHSC 822: Measure and Integration, 3 cr. (3 and 0) F
Rings and algebras of sets, inner and outer measures, measurability and additivity, examples on the line and in space, Lebesque integration, types of convergence, Lebesque spaces; integration and differentiation, product measure, Fubini theorem. Prerequisite: MTHSC 454/654.

MTHSC 823: Complex Analysis, 3 cr. (3 and 0)
Topological concepts; complex integration; local and global properties of analytic functions; power series; representation theorems; calculus of residues. Designed for nonengineering majors. Prerequisite: MTHSC 464/664.

MTHSC 825: Introduction to Dynamical Systems Theory, 3 cr. (3 and 0) F
Techniques of analysis of dynamical systems: sensitivity analysis, linear systems, stability and control; theory of differential and difference equations. Prerequisites: MTHSC 454/654 and 311, or MTHSC 453 and 853.

MTHSC 826: Partial Differential Equations, 3 cr. (3 and 0) F
First-order equations: elliptic, hyperbolic and parabolic; second-order equations: existence and uniqueness results, maximum principles, finite difference and Hilbert Space methods. Prerequisite: MTHSC 821 or permission of instructor.

MTHSC 827: Dynamical System Neural Networks, 3 cr. (3 and 0)
Modeling problems in the context of dynamical systems theory; useful methods from Lyapunov stability, local linearization, qualitative analysis using graph theory and numerical approximations; several dynamical systems neural networks including binary code recognizers and binary matrix choosers. Prerequisites: MTHSC 206 and MTHSC 311.

MTHSC 831: Fourier Series, 3 cr. (3 and 0) SS
Fourier series with applications to solution of boundary value problems in partial differential equations of physics and engineering; introduction to Bessel functions and Legendre polynomials. Prerequisite: MTHSC 464/664.

MTHSC 837: Calculus of Variations and Optimal Control, 3 cr. (3 and 0) SS
Fundamental theory of the calculus of variations; variable end points; the parametric problem; the isoperimetric problem; constraint inequalities; introduction to the theory of optimal control; connections with the calculus of variations; geometric concepts. Prerequisite: MTHSC 453/653 or 463/663.

MTHSC 841: Applied Mathematics I, 3 cr. (3 and 0) F
Derivation of equations from conservation laws, dimensional analysis, scaling and simplification; methods such as steepest descent, stationary phase, perturbation series, boundary layer theory, WKBJ theory, multiple-scale analysis and ray theory applied to problems in diffusion processes, wave propagation, fluid dynamics and mechanics. Prerequisites: MTHSC 208 and 453/653 or MTHSC 463/663.

MTHSC 842: Applied Mathematics II, 3 cr. (3 and 0)
Continuation of MTHSC 841.

MTHSC 851: Abstract Algebra I, 3 cr. (3 and 0) S
Basic algebraic structures: groups, rings and fields; permutation groups, Sylow theorems, finite abelian groups, polynomial domains, factorization theory and elementary field theory.

MTHSC 852: Abstract Algebra II, 3 cr. (3 and 0) F
A continuation of MTHSC 851 including selected topics from ring theory and field theory.

MTHSC 853: Matrix Analysis, 3 cr. (3 and 0) F, S
Topics in matrix analysis that support an applied curriculum: similarity and eigenvalues; Hermitian and normal matrices; canonical forms; norms; eigenvalue localizations; singular value decompositions; definite matrices. Prerequisite: MTHSC 311, 453 or 463.

MTHSC 854: Theory of Graphs, 3 cr. (3 and 0) S
Connectivity; path problems; trees; matching theorems; directed graphs; fundamental numbers of the theory of graphs; groups and graphs. Prerequisite: Permission of instructor.

MTHSC 855: Combinatorial Analysis, 3 cr. (3 and 0) F
Combinations; permutations; permutations with restricted position; Polya's theorem; principle of inclusion and exclusion; partitions; recurrence relations; generating functions; Mobius inversion; enumeration techniques; Ramsey numbers; finite projective and affine geometries; Latin rectangles; orthogonal arrays; block designs; error detecting and error correcting codes. Prerequisite: MTHSC 311.

MTHSC 856: Applicable Algebra, 3 cr. (3 and 0) S
Applied algebraic ideas in lattice theory and Boolean Algebra; finite-state sequential machines; group theory as applied to network complexity and combinatorial enumeration; algebraic coding theory. Topics vary with background and interests of students. Prerequisites: MTHSC 851 and 853 or permission of instructor.

MTHSC 860: An Introduction to Scientific Computing, 3 cr. (3 and 0) S, SS
Floating point models, conditioning and numerical stability, numerical linear algebra, integration, systems of ordinary differential equations and zero finding; emphasis is on the use of existing scientific software. Prerequisites: MTHSC 208, 311 and CP SC 110.

MTHSC 861: Advanced Numerical Analysis I, 3 cr. (3 and 0) F
Interpolation and approximation; numerical quadrature; numerical solution of functional differential equations; integral equations and overdetermined linear systems;
Continuation of Examination of many of the elements in the Master of Computing Research, 1-3 cr. (3 and 0) F
Experimental mathematics; pseudo-stochastic processes; analytical and algebraic formulations of time-independent simulation; continuous-time simulation and discrete-time simulation; digital optimization; Fibonacci search; ravine search; gradient methods; current research in digital analysis. Prerequisites: MTHSC 311, 453/653 and digital computer experience.

MTHSC 865: Data Structures, 3 cr. (3 and 0) F
Representation and transformation of information; formal description of processes and data structures; tree and list structures; pushdown stacks; string and formula manipulation; hashing techniques; interrelation between data structure and program structure; storage allocation methods. Prerequisites: Computational maturity and permission of instructor.

MTHSC 881: Mathematical Statistics, 3 cr. (3 and 0) S
Fundamental concepts of sufficiency, hypothesis testing and estimation; robust estimation; resampling (jackknife, bootstrap, etc.) methods; asymptotic theory; two-stage and sequential sampling problems; ranking and selection procedures. Prerequisites: MTHSC 403/603 or equivalent.

MTHSC 885: Advanced Data Analysis, 3 cr. (3 and 0) F
Continuation of MTHSC 805, covering alternatives to ordinary least squares, influence and diagnostic considerations, robustness, special statistical computation methods. Prerequisites: MTHSC 603, 800 and 805.

MTHSC 890: Master's Thesis Research, credit to be arranged, F, S, SS

MTHSC 892: Master's Project Course, 1 cr. (0 and 1) F, S, SS
For students in the nontesis option of the Master of Science degree program in the mathematical sciences. Successful completion includes a presentation of the master's project to the student's advisory committee and acceptance of the paper by the committee.

MTHSC 900: Seminar in Preparing for College Teaching in the Mathematical Sciences, 3 cr. (3 and 0) N
Examination of many of the elements involved in being a college professor with special emphasis on broadening the student's mathematical experiences within a framework of improving classroom performance. Prerequisite: Completion of the departmental Ph.D. qualifying examinations.

MTHSC 901: Probability Theory I, 3 cr. (3 and 0) N
Axiomatic theory of probability; distribution functions; expectation; Cartesian product of infinitely many probability spaces and the Kolmogorov consistency theorem; models of convergence; weak and strong laws of large numbers. Prerequisites: MTHSC 400/600 and 822, or MTHSC 800 and 822, or permission of instructor.

MTHSC 902: Probability Theory II, 3 cr. (3 and 0) N
Continuation of MTHSC 901; characteristic functions, infinitely divisible distributions, central limit theorems, laws of large numbers, conditioning and limit properties of sums of dependent random variables, conditioning, martingales. Prerequisite: MTHSC 901.

MTHSC 927: Functional Analysis, 3 cr. (3 and 0) N
Linear operators on specific spaces, spectral theory, semigroups of operators and the Hille-Yosida theorem, applications of linear spaces and operators, convexity. Prerequisite: MTHSC 821.

MTHSC 954: Advanced Graph Theory, 3 cr. (3 and 0) F
Continuation of MTHSC 854; topics not covered in 854 including the four-color theorem, domination numbers, Ramsey theory, graph isomorphism, embeddings, algebraic graph theory and tournaments; research papers are also examined. Prerequisite: MTHSC 854 or permission of instructor.

MTHSC 981: Selected Topics in Mathematical Statistics and Probability, 1-3 cr. (1-3 and 0)
Advanced topics in mathematical statistics and probability of current interest. May be repeated for credit, but only if different topics are covered.

MTHSC 982: Selected Topics in Analysis, 1-3 cr. (1-3 and 0)
Advanced analysis topics from current problems of interest. May be repeated for credit, but only if different topics are covered.

MTHSC 983: Selected Topics in Computational Mathematics, 1-3 cr. (1-3 and 0)
Advanced topics in computational mathematics and numerical analysis from current problems of interest. May be repeated for credit, but only if different topics are covered.

MTHSC 985: Selected Topics in Algebra and Combinatorics, 1-3 cr. (1-3 and 0)
Advanced topics in algebra and combinatorics from current problems of interest. May be repeated for credit, but only if different topics are covered.

Graduate studies in physics and astronomy may be pursued by well-prepared students in the physical and mathematical sciences or engineering. As the basic physical science, physics offers intellectual opportunities of an unparalleled nature. Theoretical, experimental or computer-simulated studies of the physical universe, ranging from the macroscopic studies of cosmology to the microscopic world of quanta, are available.

All graduate student progress is evaluated each spring by the Graduate Student Evaluation Committee. This committee reports its recommendations to the faculty, who, in turn, advise the department chair concerning students' performances. The recommendation of the faculty may be (1) continuing satisfactory progress toward Ph.D. candidacy, (2) satisfactory progress toward the master's degree, (3) unsatisfactory progress toward any graduate degree. The department chair considers continuance of the student based, in part, on these recommendations. Students beginning graduate studies in physics and astronomy usually enter the M.S. program. After two semesters, well-prepared students are ready to begin a research program. This program most often culminates in a thesis, although a nontesis option is available. For the thesis option, 30 credit hours and a final oral examination on the general area of study and thesis defense are required. In the nontesis option, 36 credit hours are required, including six credit hours of PHYS 890. A written report must be submitted on the directed studies. A final oral examination on the general area and directed activities completes the requirements for the nontesis option. A program leading to the M.S. degree in physics with a concentration in health physics is available. Six credits of health physics or biophysics and nine credits of courses in biology, biochemistry or chemistry are required in this option.

Study for the Ph.D. degree begins with the general qualifying examination. A sufficiently high score on this examination may make it
possible for a student to bypass the master's degree. An oral examination on the general research area is given within six months after completion of the written qualifying examination. At least three weeks prior to the convocation at which the student expects to receive the Ph.D. degree, a final oral examination on the dissertation must be completed.

**PHYS 617: Introduction to Biophysics, 3 cr. (3 and 0)**
Application of physics to biological problems; elementary chemical and biological principles; physics of biological molecules; fundamentals of radiation biophysics. **Prerequisite:** MTHSC 206, PHYS 221 or permission of instructor.

**PHYS 620: Atmospheric Physics, 3 cr. (3 and 0)**
Physical processes governing atmospheric phenomena; thermodynamics of dry and moist air, solar and terrestrial radiative processes, convection and cloud physics, precipitation processes, hydrodynamic equations of motion and large-scale motion of the atmosphere, numerical weather prediction, atmospheric electricity. **Prerequisite:** MTHSC 108, PHYS 208 or 221.

**PHYS 621: Mechanics I, 3 cr. (3 and 0)**
Statics, motions of particles and rigid bodies, vibratory motion, gravitation, properties of matter, flow of fluids. **Prerequisite:** PHYS 221.

**PHYS 625: Experimental Physics I, 3 cr. (1 and 4)**
Experimental modern physics, measurement of fundamental constants, repetition of crucial experiments of modern physics (Stern-Gerlach, Zeeman effect, photoelectric effect, etc.). **Corequisite:** PHYS 321 or permission of instructor.

**PHYS 626: Experimental Physics II, 3 cr. (1 and 4)**
Continuation of PHYS 325/625.

**PHYS 632: Optics, 3 cr. (3 and 0)**
Selection of topics, depending on the interest of the student, may include the formation of images by lenses and mirrors, design of optical instruments, electromagnetic wave propagation, interference, diffraction, optical activity, lasers and holography. **Prerequisite:** PHYS 221.

**PHYS 641: Electromagnetics I, 3 cr. (3 and 0)**
Foundations of electromagnetic theory; electric fields, electric potential, dielectrics, electric circuits, solution of electrostatic boundary-value problems, magnetic fields and magnetostatics. **Prerequisites:** PHYS 221 and MTHSC 208, or permission of instructor.

**PHYS 642: Electromagnetics II, 3 cr. (3 and 0)**
Continuation of PHYS 441; foundations of electromagnetic theory; magnetic properties of matter, microscopic theory of magnetization, electromagnetic induction, magnetic energy, AC circuits, Maxwell's equations and propagation of electromagnetic waves. Other topics may include waves in bounded media, antennas, electromodynamics, special theory of relativity and plasma physics. **Prerequisite:** PHYS 441 or permission of instructor.

**PHYS 646: Solid State Physics, 3 cr. (3 and 0)**
Introductory treatment of the crystal structure of solids and the properties of solids which depend on crystal structure, free electron model of metals, band theory of solids, Brillouin zones, crystalline defects and diffusion. **Prerequisite:** PHYS 222 or permission of instructor.

**PHYS 652: Nuclear and Particle Physics, 3 cr. (3 and 0)**
Present knowledge concerning subatomic matter stressing experimental results; particle spectra, detection techniques, Regge pole analysis, quark models, proton structure, nuclear structure, scattering and reactions.

**PHYS 655: Quantum Physics I, 3 cr. (3 and 0)**
Solution of the Schrödinger equation for free particles, the hydrogen atom and the harmonic oscillator. **Prerequisites:** PHYS 322 and 441, or permission of instructor.

**PHYS 656: Quantum Physics II, 3 cr. (3 and 0)**
Continuation of PHYS 455; application of principles of quantum mechanics as developed in PHYS 455 to atomic, molecular, solid state and nuclear systems. **Prerequisite:** PHYS 455.

**PHYS 665: Thermodynamics and Statistical Mechanics, 3 cr. (3 and 0)**
Temperature development of the laws of thermodynamics and their application to thermodynamic systems; an introduction to low temperature physics. **Prerequisite:** Six hours of physics beyond PHYS 222 or permission of instructor.

**PHYS 681: Methods of Theoretical Physics I, 3 cr. (3 and 0)**
Analytical methods and techniques used in theoretical physics: vector and tensor analysis as applied to physical problems, use of matrices and groups in classical and quantum mechanics, complex variables and partial differential equations of physics.

**PHYS 815 (M E 815): Statistical Thermodynamics, 3 cr. (3 and 0)**
Fundamental principles of kinetic theory and quantum statistical mechanics; Boltzmann statistics, Fermi-Dirac statistics and Bose-Einstein statistics. **Prerequisite:** A course in thermodynamics or permission of instructor.

**PHYS 816: Statistical Thermodynamics II, 3 cr. (3 and 0)**
Generalized ensemble theory and fluctuations; applications to solids, liquids, gases and blackbody radiation. **Prerequisite:** PHYS 815.

**PHYS 821: Classical Mechanics I, 3 cr. (3 and 0)**
Dynamics of particles; variational principles and Lagrange's equations; two-body central force problems; dynamics of rigid bodies; matrix formulations freely used.

**PHYS 822: Classical Mechanics II, 3 cr. (3 and 0)**
Special relativity in classical mechanics; Hamilton's equations; canonical transformations; Hamilton-Jacobi theory; small oscillations.

**PHYS 841: Electrodynamics I, 3 cr. (3 and 0)**
Field theory of electromagnetism; Maxwell's equations and their application to study of electromagnetic wave production and propagation; wave optics and theories of interference and diffraction.

**PHYS 842: Electrodynamics II, 3 cr. (3 and 0)**
Production and propagation of electromagnetic waves beginning with use of Maxwell's equations; wave guides; diffraction phenomena; boundary effects; theory of electrons and microscopic phenomena.

**PHYS 845: Solid State Physics I, 3 cr. (3 and 0)**
Physical properties of crystalline solids; crystal structure determination by diffraction methods; theories of specific heat; properties of metallic lattices and alloys; lattice energy and ferroelectrics.

**PHYS 846: Solid State Physics II, 3 cr. (3 and 0)**
Continuation of PHYS 845: electronic properties of solids, band theory of solids, physics of semiconductors, theories of magnetism and magnetic resonance phenomena.

**PHYS 852: Radiation Physics, 3 cr. (3 and 0)**
The interactions and basic mechanisms involved in the natural radiation environments of space, which include a variety of energetic, charged particles with sufficient energy to penetrate heavily shielded spacecraft and post potential hazards to astronauts and electronic systems. **Prerequisite:** Undergraduate degree in physics or electrical engineering or permission of instructor.

**PHYS 875: Selected Topics, 1-3 cr. (1-3 and 0)**
Students and interested faculty study areas of physics currently being extensively investigated. May be repeated for
credit, but only if different topics are covered.

PHYS 890: Directed Activities in Applied Physics, 1-6 cr.
Training and work on practical problems; activities are supervised by department faculty or by appropriate adjunct professor; written description of student's activities must be submitted to course supervisor at completion of activity. Maximum credit limits are six credit hours in a semester and three credit hours in a single summer session. Graded on a pass/fail basis.

PHYS 891: Master's Thesis Research, credit to be arranged

PHYS 951: Quantum Mechanics I, 3 cr. (3 and 0)
Review of wave mechanics; operator algebra and theory of representation; approximate methods for stationary problems; theory of scattering applied to atomic and nuclear problems.

PHYS 952: Quantum Mechanics II, 3 cr. (3 and 0)
Continuation of PHYS 951; time-dependent perturbations, radiation, absorption and emission, relativistic quantum mechanics, introduction to quantum electrodynamics.

PHYS 966: Relativity, 3 cr. (3 and 0)
Special and general theory of relativity including tensor calculus, Lorentz transformation and three experimental tests of general theory: (1) planetary motion and advance of perihelion of Mercury, (2) bending of light rays in gravitational fields and (3) gravitational shift of spectral lines.

PHYS 971: Advanced Quantum Theory I, 3 cr. (3 and 0)
Development of quantum theory as encountered in systems with an infinite number of degrees of freedom and in systems where relativistic effects are important; advanced scattering theory; quantization of relativistic field theories; development of covariant forms of perturbation theory. Prerequisite: PHYS 951 or permission of instructor.

PHYS 991: Doctoral Dissertation Research, credit to be arranged
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The College of Health, Education and Human Development offers advanced degrees in these areas of study:

- Administration and Supervision
- Counseling
- Curriculum and Instruction
- Educational Leadership
- Elementary Education
- Health Administration
- Human Resource Development
- Industrial Education
- Nursing
- Parks, Recreation and Tourism Management
- Reading
- Secondary Education
- Special Education
- Vocational/Technical Education

Courses are offered in coaching education and health to provide electives for students in other areas.

The College of Health, Education and Human Development offers the Ph.D. degree in curriculum and instruction and educational leadership. The M.S. degree is offered in nursing. The college also offers professional degree programs leading to the Master of Education, Master of Health Administration, Master of Human Resource Development, Master of Industrial Education, Master of Parks, Recreation and Tourism Management, Specialist in Education and the Doctor of Education degrees. The College of Health, Education and Human Development and the College of Agriculture, Forestry and Life Sciences cooperatively offer a Master of Agricultural Education program. The degree is awarded by the College of Agriculture, Forestry and Life Sciences.

The focus of the graduate program is on preparing students for leadership positions in educational, health care, governmental and business organizations. Clinical and field experiences are common in many graduate programs. Many programs join with local, state and federal agencies to provide real-world experiences and research projects for faculty and students. Many programs and courses are offered off campus and in the evening to accommodate the schedule of public schools, health-care institutions, businesses and other organizations.

The College of Health, Education and Human Development offers graduate courses in the disciplines of education and nursing at various off-campus locations across the state. Off-campus course schedules for fall, spring and summer offerings for school personnel, school districts and other South Carolina agencies are published by the Office of Off-Campus Academic Programs. In addition, courses are taught by contract with local school districts in the Clemson University service region.

### Counseling and Educational Leadership

Jackson L. Flanagan, Chair, Department of Counseling and Educational Leadership

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Students may seek admission to the Master of Education degree programs with majors in administration and supervision or counseling. Some of these programs are also available to off-campus students through the Office of Off-Campus Distance and Continuing Education. Call 1-888-CLEMSON (253-6766) for more information.

### M.Ed. Programs in Counseling

A major in counseling requires 48 semester hours and is offered to those desiring to specialize in counseling in the public schools, student affairs in higher education or the community agency field. Admission requirements for all counseling programs are a 2.7 cumulative GPA (or 3.0 for the last 60 hours), or a minimum score of 1350 on the GRE (verbal, quantitative and analytical), and two letters of recommendation. Degree candidates are required to complete a minimum of 48 hours, including field experience in the area of specialization, course work in statistics and research, and the core counseling curriculum. In the areas of elementary counseling or secondary counseling, students are required to have a valid professional teacher's certificate on the appropriate level prior to entering the program. In the area of student affairs in higher education, students are required to have experience in higher education as an undergraduate or be currently employed in higher education. In the area of community agency counseling, students are required to have a combined 12 hours of psychology and/or sociology.

**ED C 760: Program Administration and Leadership in Higher Education, 3 cr. (3 and 0)**

Process of organizing the personnel and financial resources needed to meet effectively student development and institutional goals and objectives. Prerequisite: Permission of instructor.

**ED C 762: The American College Student, 3 cr. (3 and 0)**

How college students change and develop and how college can enhance that development.

**ED C 764: Theoretical and Practical Application of Student Development and Leadership in a University Setting, 3 cr. (3 and 0)**

Development of leadership, programming, problem-solving, conflict-resolution, confrontation and referral skills; legal and ethical issues and the implications for practitioners; comparative studies of housing programs and utilization of resources and support services available on the campus.

**ED C 801: Foundations of Counseling in the Elementary School, 3 cr. (3 and 0)**

Specialized information concerning theory and practice of elementary school counseling; opportunity to explore elementary school counseling techniques.

**ED C 802: Foundations of Secondary School Counseling and Guidance, 3 cr. (3 and 0)**

Counseling and guidance programs in the secondary school; principles and policies underlying programs.

**ED C 803: Student Development Services in Higher Education, 3 cr. (3 and 0)**

Pupil personnel services offered by institutions of higher education.

**ED C 804: Theories of Student Development in Higher Education, 3 cr. (3 and 0)**

Developmental aspects of the young adult age group and the relationship to postsecondary schools and training programs.

**ED C 805: Community Counseling, 3 cr. (3 and 0)**

History and description of various counseling services provided in agency settings, the type of client populations served and existing legislative acts mandating these services; emphasis on theoretical perspectives of mental disorders, diagnostic concepts and frameworks, treatment and intervention models, and counseling theory.

**ED C 806: Student Affairs Issues, 3 cr. (3 and 0)**

Introduction to the current issues in the student personnel profession and those future challenges facing student affairs.
ED C 810: Theories and Techniques of Counseling, 3 cr. (3 and 0)
Rationale, content and consultation process in school and nonschool settings; study of and practice in various consulting activities. Prerequisite: ED C 801 or permission of instructor.

ED C 820: Introduction to Marriage and Family Counseling, 3 cr. (3 and 0)
Major models and techniques of marriage and family counseling. History research, legal, ethical and other professional issues will be surveyed as well as concepts related to family life cycle, healthy family functioning, divorce, ethnicity, problem conceptualization and nontraditional structures. Prerequisites: ED C 810 or 814 or permission of instructor.

ED C 821: Career Counseling, 3 cr. (3 and 0)
Gathering, interpreting and utilizing educational, social and occupational information; techniques used in placement, survey and follow-up.

ED C 822: Addictions Counseling, 3 cr. (3 and 0)
Comprehensive overview of the phenomenon of chemical dependence and addiction; current methods of identification and intervention; and awareness of how addictions affect individuals, families, schools and communities. Prerequisite: Permission of instructor.

ED C 823: Advanced Counseling Techniques and Strategies, 3 cr. (3 and 0)
Development of in-depth counseling skills; techniques for working with a wide variety of populations and/or problems. Prerequisites: ED C 810, 814, 815 and completion of 30 hours in a master's program in counseling or certification as a school counselor.

ED C 830: Elementary School Counseling Practicum, 3 cr. (1 and 6)
Supervised field experience in counseling and other services in an elementary school. Prerequisites: ED C 801, 810, 814 or permission of instructor.

ED C 831: Elementary School Counseling Practicum II, 3 cr. (1 and 6)
Additional field experiences in counseling, consulting and coordinating services for the elementary school child. Prerequisites: ED C 801, 810, 814, 830 or permission of instructor.

ED C 832: Secondary School Counseling Practicum, 3 cr. (1 and 6)
Supervised field experience in counseling and other services in a secondary school setting. Prerequisites: ED C 810 and 814.

ED C 833: Secondary School Counseling Practicum II, 3 cr. (1 and 6)
Additional field experiences in counseling, consulting and coordinating services for a secondary school student. Prerequisites: ED C 810, 814, 832 and 30 hours completed in the program.

ED C 834: Student Affairs Practicum, 3 cr. (1 and 6)
Supervised field experience in counseling and other student services in a postsecondary school setting. Prerequisite: ED C 803, ED C 804 or permission of instructor.

ED C 835: Student Affairs Practicum II, 3 cr. (1 and 6)
Additional supervised field experience in counseling and other student services in a postsecondary school setting. Prerequisite: ED C 810, 814, 834 or permission of instructor.

ED C 836: Community Practicum, 3 cr. (1 and 6)
Supervised field experiences in counseling and other services in a community agency setting. Prerequisite: ED C 810, 814 or permission of instructor.

ED C 838: Community Internship I, 6 cr. (1 and 15)
Students apply previous knowledge to professional settings through individual, group, family and ancillary professional counseling services. Students will integrate previous theoretical and technique courses into beginning level of intervention strategies and counseling skills. Prerequisites: ED F 701, ED C 805, 810, 813, 814, 815 and permission of instructor.

ED C 839: Community Internship II, 6 cr. (1 and 15)
Students apply previous knowledge to professional settings through individual, group, family and ancillary professional counseling services. Students will integrate previous theoretical and technique courses into beginning level of intervention strategies and counseling skills. Prerequisites: ED C 838 and permission of instructor.

ED C 840: Independent Study in Counseling, 1-3 cr. (1-3 and 0)
Individualized, in-depth study of a particular topic not offered in other courses. Reading, research and independent study are supervised by a faculty member. Prerequisite: Permission of instructor.

ED C 885: Selected Topics, 1-3 cr. (1-3 and 0)
Developing trends in counseling not covered in other courses. May be repeated as topic varies.

ED C 915: Internship in a Counseling Setting, 3 cr. (1 and 6)
A post-master's degree supervised internship in counseling designed to provide experience in counseling as well as coordination of service for a diverse client population; participation in direct services with clients in an approved agency. May be repeated for a total of six hours of credit. Prerequisites: Master's degree in counseling or a closely related field approved by program coordinator.

ED C 920: Counselor Supervision, 3 cr. (3 and 0)
Overview of conceptual and empirical literature on counselor supervision that includes models, approaches, techniques, relationship/ process issues, legal concerns and ethical considerations; develop supervision skills through readings, seminar discussions and supervision of master's level students. Prerequisite: Master's degree in counseling or related area or permission of instructor.

M.Ed. and Ed.S. Programs in Administration and Supervision
A major in administration and supervision is offered to experienced teachers (at least one year) who wish to prepare as elementary or secondary school administrators or supervisors. Appropriate scores on the GRE or the MAT are required. The 39 hours and courses are selected from four areas as prescribed by the Department of Counseling and Educational Leadership.
The Specialist in Education degree program in educational administration consists of a minimum of 30 hours beyond the master's degree selected from areas prescribed by the Department of Counseling and Educational Leadership. Admission requirements include a master's degree and appropriate GRE/MAT scores.

**Ph.D. Program in Educational Leadership**

The Doctor of Philosophy degree in educational leadership requires a minimum of 72 semester hours beyond the master's degree, selected from either K-12 administration or ED L 715: Educational Leadership, 3 cr. (3 and 0)

Requirements include a master's degree and appropriate GRE scores.

**ED L 700: Public School Administration, 3 cr. (3 and 0)**
Theoretical bases of school administration; organizational principles, patterns and practices in public schools; decision making; administration of programs and services. Prerequisite: Three graduate education classes or permission of instructor.

**ED L 705: The Principalship, 3 cr. (3 and 0)**
Roles and responsibilities of the principalship including the organization and administration of schools.

**ED L 710: Organizational Theory for School Administrators, 3 cr. (3 and 0)**
Theory of management, communication, human relations, social systems, motivation, contingency, decision making and change. Prerequisite: ED L 700.

**ED L 715: School and Community Relationships, 3 cr. (3 and 0)**
Interdependence of school and community; identifying and defining societal expectations of schools and effect of these expectations on educational policy, impact of social, political, economic and demographic change on educational policy.

**ED L 720: School Personnel Administration, 3 cr. (3 and 0)**
School personnel selection, practices and problems. Prerequisites: ED L 700 and 705.

**ED L 725: Legal Phases of School Administration, 3 cr. (3 and 0)**
Legal principles involved in school administration and in court actions. Prerequisites: ED L 700 and 710.

**ED L 730: Techniques of Supervision — the Public Schools, 3 cr. (3 and 0)**
Improving, coordinating and evaluating instruction; modern trends of supervisory practices. Prerequisites: ED L 700 and 710.

**ED L 735: Educational Evaluation, 3 cr. (3 and 0)**
Evaluation theory and design applied to classroom instruction and to evaluation procedures applicable to school center and district programs and projects. Prerequisites: ED L 700 and 710.

**ED L 740: Curriculum Planning and Improvement for School Administrators, 3 cr. (3 and 0)**
Role of leadership in curriculum planning and improvement: curriculum evaluation and development, change, programmatic requirements, program organization, scheduling, planning, management and technology. Prerequisites: ED L 700 and 710.

**ED L 745: School Finance, 3 cr. (3 and 0)**
School finance relative to programs, revenues, and experience. Prerequisites: ED L 700 and 735.

**ED L 750: Field Experience in Elementary Administration and Supervision, 3 cr. (1 and 4)**
Practicum with an experienced elementary administrator or supervisor. May be repeated for a maximum of six credits. Prerequisites: ED L 700 and 710.

**ED L 755: Field Experience in Secondary Administration and Supervision, 3 cr. (1 and 4)**
Practicum with an experienced secondary administrator or supervisor. May be repeated for a maximum of six credits. Prerequisites: ED L 700 and 710.

**ED L 765: Assessment in Higher Education, 3 cr. (3 and 0)**
Outcomes assessment and institutional effectiveness movement including assessment techniques, instrument selection, analysis of assessment data and reporting of assessment findings. Prerequisite: Permission of instructor.

**ED L 780: Field Problems in School Administration and Supervision of Instruction, 3 cr. (2 and 3)**
Application of research techniques and practices in solution of field problems in school administration and supervision. Prerequisites: ED L 700 and ED F 778.

**ED L 800: Practicum in School System Administration and Supervision, 3 cr. (1 and 4)**
Practicum with an experienced school-system-level administrator or supervisor. May be repeated for a maximum of six credits. Prerequisites: ED L 800, 805 and permission of instructor.

**ED L 850: Applied Research and Evaluation in Higher Education, 3 cr. (3 and 0)**
Basic issues of measurement emphasizing questionnaire development, scales and measures commonly used in higher education research, assessment and program evaluation.

**ED L 885: Selected Topics in Educational Administration, 1-3 cr. (1-3 and 0)**
Current literature and results of current research. Topics vary from year to year. May be repeated for a maximum of six credits.

**ED L 890: Policy and Management of School Discipline, 3 cr. (3 and 0)**
Theory and practice involved in student management and discipline in today's schools, particularly preventative man-
ED L 900: Principles of Educational Leadership, 3 cr. (3 and 0)
Advanced leadership theory; the nature of leadership, major theories of leadership, and their application in educational organizations. Prerequisite: Must have passed the preliminary examination in the Ph.D. program in educational leadership.

ED L 905: Theory and Practice in Educational Leadership, 3 cr. (3 and 0)
Advanced organizational and leadership theory; major theories of organization and their applications in understanding the roles of governmental agencies in society. Prerequisite: Admission to the doctoral program.

ED L 910: Introductory Doctoral Seminar, 3 cr. (3 and 0)
Educational leadership for beginning doctoral students providing an introduction to the conceptual and theoretical frameworks of educational leadership for both public school and higher education administration. Prerequisite: Permission of instructor.

ED L 915: Educational Planning, 3 cr. (3 and 0)
Systems approach to planning and management, and the measurement and interpretation of performance results.

ED L 925: Instructional Leadership, 3 cr. (3 and 0)
Preparation for a career in educational leadership; the principal's functions regarding the effective school's movement as incorporated in instructional leadership.

ED L 930: Complex Organizations at the Edge of Chaos, 3 cr. (3 and 0)
Formal and informal social organization relative to recent advances in chaos and complexity theories; chaos and complexity theory, organizational theory, philosophical premises, network analysis, mathematical modeling, artificial life simulations, game theory, catastrophe theory, social evolution, social morphology and nonlinearities of social organization. Prerequisite: One graduate level organizational theory course or permission of instructor.

ED L 935: History of Higher Education, 3 cr. (3 and 0)
Development of higher education from the 11th century to the present, with emphasis on the United States.

ED L 940: Advanced Design and Analysis of Research in Educational Leadership, 3 cr. (2 and 2)
A cumulative research course for Ph.D. students in educational leadership; emphasizes conceptual understanding of field research strategies, design qualitative studies and independence as a researcher. Prerequisite: Advanced research and statistics.

ED L 950: Educational Policy Studies, 3 cr. (3 and 0)
Critical analysis of the sources and nature of educational policy and how policy is developed, administered and assessed for public schools. Prerequisite: Admission to doctoral studies.

ED L 955 (VT ED 955): The Two-Year College, 3 cr. (3 and 0)
Historical developments, functions, organization and administration of the two-year college. Prerequisite: Admission to doctoral studies or permission of instructor.

ED L 960: Legal Principles in the Administration of Institutions of Higher Education, 3 cr. (3 and 0)
General principles of higher education law from the points of view of statute and common law practice. Prerequisite: Admission to doctoral studies or permission of instructor.

ED L 965: Higher Education Finance, 3 cr. (3 and 0)
Higher education finance relative to sources of revenue, expenditures and planning.

ED L 970: Foundations of Higher Education, 3 cr. (3 and 0)
Survey of American higher education including its historical, political, philosophical and social aspects. Prerequisite: Admission to doctoral studies.

ED L 972: Ethics in Educational Leadership, 3 cr. (3 and 0)
The ethical issues involved in administering educational institutions; moral leadership, ethical work environments and decision making models.

ED L 976: External Effectiveness in Higher Education, 3 cr. (3 and 0)
Optimum structures and strategies for fundraising, public relations, constituent relations, governmental affairs and governing boards necessary for a college or university to communicate effectively with its constituents.

ED L 980: Current Issues in Educational Leadership, 1-3 cr. (1-3 and 0)
Topics and issues as determined by the needs of the students and the instructor. Prerequisites: Graduate status and permission of instructor.

ED L 985: Internship in Educational Leadership, 3 cr. (1 and 4)
Experience working in a chosen area of specialization in educational leadership, either in public schools or institutions of higher education. Experience planned to build competence in the student's field of specialization. May be repeated for a maximum of six credits. Graded on a pass/fail basis. Prerequisites: ED L 900, 905, 910 and permission of major advisor.

ED L 988: Advanced Doctoral Seminar I, 3 cr. (3 and 0)
Exploration of educational leadership topics. Culminates in the selection of a topic for presentation and approval, and the development of Chapter I of a prospectus. Graded on a pass/fail basis. Prerequisites: ED L 900, 905, 910 and permission of instructor.

ED L 990: Advanced Doctoral Seminar II, 3 cr. (3 and 0)
Seminar for advanced students focusing on the preparation of dissertation Chapters I-III.

ED L 991: Doctoral Dissertation Research, credit to be arranged

ED L 995: Directed Research, 1-4 cr. (1-4 and 0)
Research option for graduate students to pursue a line of inquiry in education under the direction of faculty. Specific educational qualifications are determined and reported using appropriate methodology. Graded on a pass/fail basis. May be repeated for a total of four hours. Prerequisite: Admission to doctoral studies or permission of instructor.

Curriculum and Instruction

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The Doctor of Philosophy degree in curriculum and instruction requires a minimum of 70 semester hours beyond the master's degree, selected from the areas prescribed by the Department of Curriculum and Instruction. Admission requirements include a master's degree and appropriate GRE scores. Students seeking admission to the Master of Education degree programs with majors in elementary education, reading and secondary education should have a valid professional teacher's certificate on the appropriate level.

A major in elementary education is offered to teachers who hold professional early childhood or elementary certificates. The 36 hours and courses may be selected from six areas as prescribed by the Department of Curriculum and Instruction.

A major in reading is offered for reading specialists, consultants and/or supervisors. The 36 semester hours are prescribed by the Department of Curriculum and Instruction. A major in secondary education is offered to high school or prospective junior college teachers in the subject areas of English, history and government, mathematics and natural sciences. Candidates are required to complete a minimum of 15 semester hours in
ED 631: Special Institute Course: Early Childhood Education, 1-3 cr. (1-3 and 0)
Subject areas organized according to institute needs. May be repeated for credit if topics vary.

ED 632: Special Institute Course: Elementary School, 1-3 cr. (1-3 and 0)
Subject areas organized according to institute needs. May be repeated for credit if topics vary.

ED 633: Special Institute Course: Secondary School, 1-3 cr. (1-3 and 0)
Subject areas organized according to institute needs. May be repeated for credit if topics vary.

ED 634: Special Institute Course: Current Problems in Education, 1-3 cr. (1-3 and 0)
Subject areas organized according to institute needs. May be repeated for credit if topics vary.

ED 635: Special Institute Course: Curriculum, 1-3 cr. (1-3 and 0)
Subject areas organized according to institute needs. May be repeated for credit if topics vary.

ED 640: Advanced Physical Education Methods of the Classroom Teacher, 3 cr. (3 and 0)
Advanced knowledge and understanding of physical education for experienced teachers in public schools. Prerequisite: ED 321 or equivalent and minimum grade-point ratio of 2.0.

ED 641: Middle School Curriculum, 3 cr. (3 and 0)
Concepts and methods for teaching middle school students; nature of middle school students, teacher characteristics, curricular and co-curricular programs, organization and teaching.

ED 700 (IN ED 700): Supervising the Student Teacher in the Public School, 2-3 cr. (2-3 and 0)
Knowledge and skills desirable for supervisors of student teachers; use of observation instruments for recording objective data and evaluating teaching performance. Graded on a pass/fail basis. Prerequisites: A professional teaching certificate; at least one year of teaching experience, a recommendation from the employing school district or permission of instructor.

ED 750: Reading Recovery Teacher I, 3 cr. (3 and 0)
First in a two-semester, two-course sequence designed to prepare teachers to implement and teach a Reading Recovery Program; issues related to reading theory and process, instructional processes, program implementation and evaluation. Prerequisite: Permission of instructor. Corequisite: ED 752.

ED 751: Reading Recovery Teacher II, 3 cr. (3 and 0)
Second in a two-course sequence designed to prepare teachers to implement and teach in a Reading Recovery Program; issues related to reading theory and process, instructional process, program implementation and evaluation. Prerequisites: Admission into the Clemson Reading Recovery Program and ED 750 and 752. Corequisite: ED 753.

ED 752: Reading Recovery Teacher Practicum I, 3 cr. (0 and 9)
Teaching experience allowing teachers to develop and practice responsibilities of implementing and teaching first grade children in a Reading Recovery Program. Participants implement content studied in ED 750, which is taken concurrently. Prerequisite: Permission of instructor. Corequisite: ED 750.

ED 753: Reading Recovery Teacher Practicum II, 3 cr. (0 and 9)
Teaching experience and practice in implementing and teaching in a Reading Recovery Program. Participants implement content studied in ED 751, which is taken concurrently. Prerequisites: Admission into the Clemson University Reading Recovery Program and ED 750 and 752. Corequisite: ED 751.

ED 754: Reading Recovery Clinical I, 3 cr. (3 and 0)
First in a two-course sequence aimed at providing leadership experiences in implementing a Reading Recovery Program in an elementary school setting. Prerequisites: Admission into the Clemson University Reading Recovery Teacher Leader program. Corequisites: ED 756 and 854.

ED 755: Reading Recovery Clinical II, 3 cr. (3 and 0)
Second in a two-course sequence aimed at providing leadership experiences in implementing a Reading Recovery Program in an elementary school setting. Prerequisites: Admission into the Clemson University Reading Recovery Teacher Leader program. Corequisites: ED 757 and 855.

ED 756: Reading Recovery Teacher Leader Practicum I, 3 cr. (0 and 9)
First in a two-course sequence designed to prepare Reading Recovery Teacher Leaders to implement a school-based program, supervise teachers and carry out responsibilities related to maintaining a Reading Recovery site. Prerequisite: Admission into the Clemson University Reading Recovery Teacher program. Corequisites: ED 754 and 854.

ED 757: Reading Recovery Teacher Leader Practicum II, 3 cr. (0 and 9)
Second in a two-course sequence designed to prepare Reading Recovery Teacher Leaders to implement a school-based program, supervise teachers and carry out responsibilities related to maintaining a Reading Recovery site. Prerequisite: Admission into the Clemson University Reading Recovery Teacher program. Corequisites: ED 755 and 855.

ED 759: Fundamentals of Basic Reading, 3 cr. (3 and 0)
Historical progression of the teaching of reading; current theories and reading practices; teaching basic reading skills.

ED 760: Curriculum Development in the Elementary School, 3 cr. (3 and 0)
Analysis of trends and practices relative to elementary curriculum planning. The course is designed to develop an understanding of the essential elements of curriculum decisions followed by the process of improving the curriculum. Prerequisite: ED F 701, 702 or permission of instructor.

ED 761: Reading Instruction in the Elementary School, 3 cr. (3 and 0)
Knowledge and skills necessary for teaching reading to varied types of elementary school learners. Prerequisites: Admission to graduate school and permission of instructor.

ED 762: Evaluation and Remediation of Reading Problems, 3 cr. (2 and 3)
Remedial methods and materials for teaching reading; use of diagnostic instruments and interpretation of test results. Student participates in laboratory/field experience and prepares case study with summary of diagnosis emphasizing remediation procedures. Prerequisite: ED 759, 761 or 789.

ED 763: Middle School Reading, 3 cr. (3 and 0)
Techniques, materials and theories for teaching reading to middle school students, emphasizing correlating reading skills into the content area. Prerequisite: Education major or permission of instructor.

ED 764: Using Literature and Technology for Reading Instruction, 3 cr. (3 and 0)
Provides early childhood, elementary and middle school teachers with theory and knowledge needed to utilize technological and library resources and make appropriate literature selections for the teaching of reading. Prerequisite: Admission to the graduate program.

ED 765: Secondary School Curriculum, 3 cr. (3 and 0)
Principles, techniques and trends in secondary school curriculum development
and evaluation. Prerequisite: Graduate status.

ED 780: An Integrated Approach to Reading and Writing Instruction, 3 cr. (3 and 0)
Understanding of the reading/writing processes for early childhood and elementary teachers; investigation of the whole language approach in the classroom. Prerequisite: ED 759 or equivalent.

ED 781: Early Literacy: Strategic Reading and Writing Instruction, 3 cr. (3 and 0)
Enables classroom teachers to use the theoretical base of the Reading Recovery program to modify their current instructional practices to include generalizable instructional procedures. Prerequisite: ED 761 or equivalent.

ED 782: Literacy Across the Curriculum, 3 cr. (3 and 0)
Enables classroom teachers to use the theoretical base of the Reading Recovery program to modify their current instructional practices to include reading and writing activities in all aspects of K-5 curriculum. Prerequisites: ED 761 or equivalent, ED 781 and admission to graduate school.

ED 783: Guided Reading and Guided Writing, 3 cr. (3 and 0)
Enables teachers to effectively use the techniques of Guided Reading, Shared Writing and Interactive Writing appropriately in classrooms. Shows how the difficulty level of teaching practice must change over time as students move from dependence on assistance to independence during the reading and writing processes. Prerequisites: ED 761 or equivalent, ED 781, 782 and admission to graduate school.

ED 784: Models for Balanced Literacy, 3 cr. (3 and 0)
Prepares classroom teachers to organize K-5 classrooms for balanced literacy instruction. Participants will apply classroom organization procedures in actual K-5 classrooms. Prerequisites: ED 761 or equivalent, ED 762, 781, 782, 783 and admission to graduate school.

ED 798: Teaching Secondary School Reading, 3 cr. (3 and 0)
Methods and materials for secondary reading programs in developmental, corrective, remedial, adapted, content and recreational areas.

ED 803: Advanced Methods of Teaching in the Secondary School, 3 cr. (3 and 0)
Principles and practices involved in promoting effective active learning in secondary schools.

ED 804: Advanced Methods of Teaching in the Elementary School, 3 cr. (3 and 0)
Principles and practices involved in promoting effective learning in elementary schools; analysis and evaluation of educational models and research. Prerequisite: ED 760 or permission of instructor.

ED 837: Advanced Methods in Elementary Science, 3 cr. (3 and 0)
Current research and trends in elementary science teaching methods and curriculum development. Students examine recent literature and proposed standards for science teaching and develop strategies to implement recommended practices in their own classrooms. Prerequisite: Elementary teaching experience.

ED 840: Program Development and Implementation in Early Childhood Education, 3 cr. (2 and 0)
Current issues in early childhood curriculum, their sources and the beliefs supporting them; design of a modified curriculum for a specific content area and level; for graduate students with teaching experience. Prerequisites: ED 701 and relevant teaching experience, or permission of instructor.

ED 841: Advanced Studies in the Teaching of Secondary School English, 3 cr. (3 and 0)
Methods of teaching secondary school English based on research and review of current literature. Prerequisite: ED 424 or equivalent, Master's degree or permission of instructor.

ED 842: Advanced Studies in the Teaching of Secondary School Mathematics, 3 cr. (3 and 0)
This post-Masters course focuses on the relationship between mathematics teaching theory and practice as shown in the research literature; emphasis on inquiry and other student-centered strategies; issues and techniques in secondary mathematics. Prerequisite: ED 426 or equivalent, Master's degree or permission of instructor.

ED 843: Advanced Studies in the Teaching of Secondary School Science, 3 cr. (3 and 0)
Methods of teaching secondary school science based on research and review of current literature. Prerequisite: ED 427 or equivalent, Master's degree or permission of instructor.

ED 844: Advanced Studies in the Teaching of Secondary School Social Studies, 3 cr. (3 and 0)
Social studies teaching strategies derived from major theories of learning and contemporary research; curriculum issues in social studies education. Prerequisite: ED 428 or equivalent, Master's degree or permission of instructor.

ED 846: The Current Literature in English Education, 3 cr. (3 and 0)
Research literature in English education; examination of literature in research methods and curriculum in English teaching. Prerequisite: A methods course in English education.

ED 847: The Current Literature in Mathematics Teaching, 3 cr. (3 and 0)
Recent literature of mathematics education; examination of literature in both the research and curriculum in secondary mathematics teaching. Prerequisite: A graduate teaching methods course or permission of instructor.

ED 848: The Current Literature in Science Teaching, 3 cr. (3 and 0)
Recent literature of science education; examination of literature in both the research and curriculum in secondary science teaching. Prerequisite: A graduate teaching methods course or permission of instructor.

ED 849: The Current Literature in Social Studies Teaching, 3 cr. (3 and 0)
Recent literature in social studies education; examination of literature in both curriculum and instruction. Prerequisite: A graduate teaching methods course or permission of instructor.

ED 854: Reading Recovery Theory I, 3 cr. (3 and 0)
First of a two-course sequence designed to examine theoretical principles of the reading process as applied in the Reading Recovery Program; issues related to program implementation and systematic program changes. Prerequisite: Permission of the instructor. Corequisites: ED 754 and 756.

ED 855: Reading Recovery Theory II, 3 cr. (3 and 0)
Second of a two-course sequence designed to examine theoretical principles of the reading process as applied in the Reading Recovery Program; issues related to program implementation and systematic program changes. Prerequisite: Permission of the instructor. Corequisites: ED 755 and 757.

ED 861: Organizing and Supervising Reading Programs, 3 cr. (3 and 0)
Supervisory problems with planning reading programs; analysis of methods and materials of teaching; evaluation of reading programs. Prerequisite: One of the following basic reading courses: ED 759, 761, 762, 780 or 798.

ED 862: Clinical Research in Reading, 3 cr. (3 and 0)
Reading research and literature; original investigation in such problems as development of reading skills and attitudes, clinical procedures and techniques required. Prerequisite: ED 762.
ED 683: Practicum in Reading, 3 cr.
(2 and 2)
Supervised practicum emphasizing diagnostic and remedial work with readers in public schools. Prerequisites: ED 762 and permission of instructor.

ED 864: Special Problems in Reading Education, 3 cr. (1 and 4)
Individual study of a specific topic in reading; student is allowed to study a large diversity of topics. Prerequisites: ED 759 or 761; and ED 762, 808 and 862; or permission of instructor.

ED 865: Advanced Diagnosis and Remediation in Reading, 3 cr.
(2 and 3)
Advanced diagnosis and remediation in reading; review of diagnostic instruments and instructional materials. Prerequisites: ED 759 or 761 and 762, and/or permission of instructor.

ED 866: The Psychology of Teaching Reading, 3 cr. (3 and 0)
Psychological basis of reading process; principles applied in teaching reading. Prerequisite: ED 759, 761 or permission of instructor.

ED 867: Advanced Practicum in Reading, 3 cr. (2 and 3)
Diagnosis and remediation testing; remediation; extensive case studies with recommendation for the classroom teacher required. Prerequisites: ED 865 and permission of instructor.

ED 868: Teaching Reading Through a Literature Emphasis, 3 cr. (3 and 0)
Strategies for integrating literature into the traditional reading program. Prerequisite: An introductory reading class or equivalent.

ED 869: The Reading-Writing Connection: An Integrated Approach, 3 cr. (3 and 0)
Theoretical bases and practical techniques for teaching reading and writing in an integrated manner; reading and writing as processes; basic skills instruction in a coordinated program; multiple subject areas; use of student interest and ability. Prerequisite: Basic reading methods course.

ED 889 (IN ED 889) (AG ED 889): Research in Education, 3 cr. (3 and 0)
Problem selection: types of educational research and techniques employed; use of ERIC system and computer program packages; interpretation of research findings.

ED 891: Master's Thesis Research, credit to be arranged.
Student participates in a new or existing research project with a faculty member; develops basic skills in a selected research methodology. Prerequisite: Advanced methods course, ED 889, ED F 808 or permission of instructor.

ED 894 (ED F 894) (ED SP 894): Directed Research, 1-4 cr.
(1-4 and 0)
Research in a line of inquiry in education under the direction of faculty; a specific educational question is investigated and reported using appropriate methodology. Graded on a pass/fail basis. Prerequisite: ED F 778, 808 or permission of instructor.

ED 937: Designing Elementary Curriculum, 3 cr. (3 and 0)
Theoretical issues and guidelines for educators engaged in the curriculum development process at the elementary level. Prerequisite: Admission to the Ph.D. program in curriculum and instruction, ED 954, 955 and 956.

ED 938: Teacher as Researcher, 3 cr.
(3 and 0)
Various methodologies of field-based research. The student will complete a literature review and design a field-based research project. Prerequisites: Admission to the Ph.D. program in curriculum and instruction, ED 878, 879, EX ST 801 and one of the following: ED 846, 847, 848, 849 or 962.

ED 954: Curriculum Theory, 3 cr.
(3 and 0)
Main currents of curriculum theory in American education. Prerequisite: ED 760 or 765.

ED 955: Theoretical Bases of Instruction, 3 cr. (3 and 0)
Theories of learning to instructional practice emphasizing instructional strategies in the classroom. Prerequisite: ED 702.

ED 962: Reading Research: Review and Critique of the Literature, 3 cr.
(3 and 0)
A survey and analysis of historical and contemporary research in reading and related literacy fields. Prerequisites: Admission to the Ph.D. program in curriculum and instruction, ED 878 and 879.

ED 980 (ED F 980) (ED SP 980): Internship in Curriculum and Instruction, 1-6 cr. (0 and 3-18)
Practical experiences linking the student's program of study to his or her field of professional service. Graded on a pass/fail basis. Prerequisite: Permission of the student's major advisor.

ED 991 (ED F 991) (ED SP 991): Doctoral Dissertation Research, credit to be arranged.

The following course in coaching education is offered by the Department of Curriculum and Instruction for recertification or as electives.

C ED 653: Athletic Injuries: Prevention, Assessment and Rehabilitation, 3 cr. (3 and 0)
Prevention, treatment and rehabilitation procedures of injured athletes. Prerequisite: C ED 349.

ENGL 700: Children's Literature for Teachers, 3 cr. (3 and 0)
Literature for preschool through junior high.

ENGL 701: Literature for Teachers, 3 cr. (3 and 0)
Literary studies of special interest to secondary school teachers.

ENGL 702: Writing Projects, 3 cr.
(3 and 0)
Exchange and development of methods for teaching writing that have a firm theoretical foundation.

History and Government

Robert P. Green, Jr., Advisor

ECON 750: Economic Concepts and Classroom Applications for Teachers, 3 cr. (3 and 0)
Economic concepts, analysis and methods emphasizing microeconomics and the market system; development of approaches to teaching economic concepts in public schools.

ECON 751: Selected Topics for Teachers, 3 cr. (3 and 0)
Current economic policy issues, such as inflation, regulation, protectionism and energy policy, emphasizing the presentation of these topics to secondary school students. Topics vary from year to year. May be taken more than once for credit. Prerequisite: ECON 200, 211 or 750.

GEOG 710: Geography for Teachers, 3 cr. (3 and 0)
Investigating world regions as a set of problems posed to teachers of geography; comparative analysis of basic geographic concepts. Oriented to public school teachers of geography.

HIST 710: United States Since 1865, 3 cr. (3 and 0)
Problems in United States history since 1865; bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate stu-
HIST 770: Europe to the 18th Century, 3 cr. (3 and 0)
Problems in European history to 1700; bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.

HIST 775: Europe Since the 18th Century, 3 cr. (3 and 0)
Problems in European history since 1700; bibliography and teaching methods. Primarily for Master of Education candidates, but open to all graduate students. May be repeated with permission of graduate program director.

Mathematical Sciences

MTHSC 700: Mathematical Computer Applications for Elementary Teachers, 3 cr. (3 and 0)
Use of readily available software as tools in the elementary mathematics curriculum; LOGO language is used in a discovery approach to geometry; spreadsheets are employed to facilitate the organization and statistical processing of classroom data; word processing is integrated with spreadsheets applied to mathematics problem sets, examinations and parental reports.

MTHSC 703: Modern Mathematics for Elementary School Teachers — Geometry, 3 cr. (3 and 0)
Concepts of geometry; informal geometry; measurement of geometric figures; metric measurements; deductive geometry; functions in geometry; coordinate and vector geometry. Restricted to graduate students in elementary and secondary education.

MTHSC 707: Mathematics for Middle School Teachers — Algebra, 3 cr. (3 and 0)
Algebraic concepts in middle-school mathematics: elementary number theory; the rational, real and complex number systems; polynomials and rational expressions; equations and inequalities. Restricted to graduate students in elementary and secondary education.

MTHSC 709: Mathematics for Middle School Teachers — Geometry, 3 cr. (3 and 0)
Geometric concepts in middle-school mathematics: lines and planes, angles and triangles, congruence and similarity, circles and spheres, area and volume. Restricted to graduate students in elementary and secondary education.

MTHSC 710: Elementary Calculus from an Advanced Viewpoint I, 3 cr. (3 and 0)
Origins of calculus; limits; derivative; maxima and minima; continuity; area and other applications of the integral. Restricted to graduate students in elementary and secondary education. Prerequisite: MTHSC 108 or its equivalent.

MTHSC 719: Discrete Mathematics, 3 cr. (3 and 0)
A survey of discrete mathematics emphasizing applications to computer science, propositions and logic; Boolean Algebra and switching circuits; recursion and induction; relations and partially ordered sets, graphs and trees.

MTHSC 721: Matrix Algebra, 3 cr. (3 and 0)
Matrices and systems of equations; determinants; vector spaces and linear transformations; eigenvalues. Restricted to graduate students in secondary education.

MTHSC 723: Applications of Linear and Modern Algebra, 3 cr. (3 and 0)
Various applied problems whose solutions rely on techniques and results of linear and modern algebra; problems selected from such areas as economics, forest management, genetics, population growth, transportation networks, cryptography, satellite communications, electronic switching circuits, chemistry, physics, sociology and others. Prerequisite: MTHSC 712, 721 or equivalent, or permission of instructor.

MTHSC 725: Combinatorial Mathematics for Teachers, 3 cr. (3 and 0)
Permutations; combinations; generating functions; recurrence relations; principle of inclusion-exclusion; partitions; Latin squares; block designs; finite geometries; graphs; codes; Polya's theorem; recreational mathematics. Restricted to graduate students in secondary education.

MTHSC 727: Analysis Concepts for Teachers, 3 cr. (3 and 0)
Elementary functions, differential calculus and integral calculus; enrichment material and a theoretical perspective of calculus. Restricted to teachers who hold a current teaching certificate in secondary mathematics. Completion of this course satisfies the special certification requirements for AB-calculus teachers in South Carolina.

MTHSC 730: Modern Geometry for Teachers, 3 cr. (3 and 0)
Concepts of Euclidean geometry reviewed and extended by means of coordinates, vectors, matrices; conic sections. Restricted to graduate students in secondary education.

MTHSC 741: Introduction to Linear Programming with Applications, 3 cr. (3 and 0)
Development of mathematical theory of simplex algorithm; survey of mathematical background; matrix algebra, systems of linear equations and vector spaces; problem formulation emphasized. Restricted to graduate students in secondary education.

MTHSC 751: Fundamental Concepts of Calculus, 3 cr. (3 and 0)
Set theory; real number system; functions and relations; metric sets and limits; continuity and differentiation; integration. Restricted to graduate students in secondary education. Prerequisite: One year of undergraduate calculus.

MTHSC 761: Probability and Statistics for Teachers, 3 cr. (3 and 0)
Probability, conditional probability; descriptive statistics; random variables; probability functions; binomial distribution; normal distribution; sampling; estimation; decision making. Restricted to graduate students in secondary education.

MTHSC 771: Numerical Methods in Secondary School Mathematics, 3 cr. (3 and 0)
Update of traditional techniques for teaching high school mathematics through introduction of computer methods for investigation of processes and reinforcement of concepts; development of programs requiring participants to invent algorithms to solve problems in the typical high school mathematics course; use of general purpose programming language; methods of teaching this language to high school students. Restricted to graduate students in secondary education.

MTHSC 783: Theory of Numbers, 3 cr. (3 and 0)
Properties of integers, divisors and prime numbers; fundamental properties of congruence; polynomial and primitive roots; quadratic residues. Restricted to graduate students in secondary education.

MTHSC 791: Selected Topics in Mathematics Education, 1-3 cr. (1-3 and 0)
Mathematical problems in curriculum of elementary or secondary school. Restricted to graduate students in elementary or secondary education. May be repeated for credit, but only if different topics are covered.

Natural Sciences

AGRON 701: Soils and Man, 3 cr. (3 and 0)
Different kinds of soils, their properties, uses, management, conservation and their relationship with the environment and other human endeavors. Not open to agronomy majors pursuing the M.S. or Ph.D. degrees.
W F B 712: Wildlife Conservation for Teachers, 2-3 cr. (2-3 and 0)
Principles and practices of wildlife conservation providing an overview of wildlife diversity, ecology and management in the state; population census, wildlife identification, capture and habitat management of game and nongame species. For in-service teachers only. Prerequisite: Permission of instructor.

W F B 716: Biology of Fishes for Teachers, 3 cr. (3 and 0) SS
Biology of fishes for in-service science teachers; fish diversity, ecology, conservation and management. Prerequisite: Permission of instructor.

BIOL 710: Selected Topics for Teachers, 1-6 cr. (0-6 and 0-18)
One or more topics organized according to institute needs; lecture and laboratory emphasize the incorporation of new or updated subject matter into classroom instruction. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered.

ENT 700: Entomology for Teachers, 3 cr. (2 and 2) SS
General entomology course for secondary school science teachers with emphasis on collecting and identifying the more common insects. Additional topics include insect morphology, physiology, metamorphosis and methods available for control of destructive species. Not open to entomology majors pursuing the M.S., M.Ag. or Ph.D. degrees. Prerequisite: Permission of instructor.

GEOL 790: Selected Topics in Earth Sciences, 1-6 cr. (0-6 and 0-18)
One or more earth science topics; lecture and laboratory emphasize the incorporation of new or updated subject matter into classroom instruction. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered.

HORT 701: Horticulture: Plant and Environmental Science, 3 cr. (2 and 3) SS
Scope of South Carolina horticulture and how it affects the quality of life economically and aesthetically; exploration of environmental responsibilities; demonstration of methods of teaching plant principles; includes a three-day statewide field trip to horticultural industries. Not to be taken for credit by graduate students in horticulture.

NUTR 706: Nutrition for Teachers, 3 cr. (3 and 0) SS
Principles of nutrition applied to nutrition education. Prerequisite: Permission of instructor.

PHYS 710: Selected Topics for Teachers, 1-6 cr. (0-6 and 0-18)
One or more topics are discussed; lecture and laboratory emphasize the incorporation of new or updated subject matter into classroom instruction. Restricted to elementary and secondary school teachers. May be repeated for credit, but only if different topics are covered. Prerequisite: Permission of instructor.

ED F 615 (PRTM 615): Methods in Reducing Risks for Middle Childhood, 3 cr. (2 and 3)
Designed to develop a knowledge base for professionals who work with at-risk children. Students will work in a field setting to apply knowledge, develop and practice skills, and cooperate with professionals from various disciplines. Prerequisite: Junior standing.

ED F 636: Selected Topics in Educational Foundations, 1-3 cr. (1-3 and 0)
Current issues and topics not covered in other courses for majors. May be repeated for a maximum of 6 credits if different topics are covered. Prerequisite: Junior standing in education.

ED F 680 (AG ED 680) (THRD 680): Educational Applications of Microcomputers, 3 cr. (2 and 2)
Fundamentals of computer applications for teachers; competency in general computer applications such as word processing and database management; educational uses of the Internet and computer-assisted instruction; legal and ethical issues and the impact of computer technology upon society. Prerequisites: Admission to a teacher education program; graduate standing.

ED F 682 (AG ED 682) (THRD 682): Advanced Educational Applications of Microcomputers, 3 cr. (2 and 2)
Knowledge and skills needed to apply microcomputer technology to the utilization and generation of educational software in accordance with sound educational principles. Prerequisite: ED F (AG ED, THRD) 480.

ED F 690: Student Management and Discipline, 3 cr. (3 and 0)
Aids pre-service and in-service teacher development and refines knowledge, skills and values important for managing students in school settings; practical application of theory and research and legal and ethical considerations. Prerequisites: ED F 302 or PSYCH 201; ED F 334 and 335 or suitable alternative; and minimum grade-point ratio of 2.0.

ED F 697: Instructional Media in the Classroom, 3 cr. (3 and 0)
Integrated approach to the use of audiovisual media stressing systematic planning, selection, utilization and evaluation as well as production of materials and equipment operation. Prerequisite: Minimum grade-point ratio of 2.0.

ED F 701: Human Growth and Development, 3 cr. (3 and 0)
Theory and research in human development and instruction in the teaching/learning process. Prerequisites: ED F 334, 335, 336 or equivalent; classroom teaching experience.

ED F 702: Advanced Educational Psychology, 3 cr. (3 and 0)
Educational applications of research and theory on objectives, motivation, class climate, class management and learning theory. Prerequisite: ED F 302 or equivalent; classroom teaching experience recommended.

ED F 766: Integrating Service Learning into Curriculum, 3 cr. (2 and 3)
Opportunities for certified teachers to build competence in service learning through personal participation in service and in reflection; students develop a plan to integrate service learning activities into the curriculum of their school and/or district; classes meet 0-25; elementary, middle-school, high-school and adult-education teachers. Prerequisite: Teaching certification.

ED F 778: Experimental and Nonexperimental Research Methods in Education, 3 cr. (3 and 0)
Types of educational research and uses; logical bases of quantitative and qualitative analysis techniques; basic research issues important in education; educational research design and procedures, introduction to measurement and evaluation; applications to special problems in classroom settings and program development; and evaluation in curriculum, administration and educational support services. Prerequisite: EX ST 301 or equivalent or permission of instructor; ED F 308 recommended.

ED F 808: Educational Tests and Measurements, 3 cr. (3 and 0)
Construction, use and interpretation of subjective and standard tests; measurement applications.
ED F 870: Schooling as a Cultural Process, 3 cr. (3 and 0)
Critical analysis of the interdependence of schooling and culture. Prerequisite: Graduate standing.

ED F 872: History of American Education, 3 cr. (3 and 0)
Historical development of educational purpose and the social and cultural forces which shaped that development. Prerequisite: Graduate standing.

ED F 875: Seminar in Human Growth and Development, 3 cr. (3 and 0)
Selected topics in human development from any area of the life span; development topics examined for their impacts on the teaching/learning process, administrative processes and/or counseling approaches. Prerequisites: ED F 701 or equivalent and teaching, counseling or administrative experience.

ED F 876: Seminar in Learning Theory and Environments, 3 cr. (3 and 0)
Selected topics in learning theory and variables affecting learning environments. Topics vary with student interests and needs and for their impacts on the teaching/learning process, administrative processes and/or counseling approaches. Prerequisites: ED F 702 or equivalent and classroom, counseling or administrative experience.

ED F 878: Experimental and Nonexperimental Research Methods in Education II, 3 cr. (3 and 0)
Advanced concepts and skills necessary to analyze, conduct, and evaluate educational research; nonexperimental, quasi-experimental and experimental design specific to problems in educational research; complementary educational research methods involving qualitative approaches; coding and computer analysis of sample data; summarization and interpretation of data; applications of measurement and evaluation in educational research. Prerequisite: ED F 778, 808 and EX ST 801, or equivalent.

ED F 879: Qualitative Research in Education, 3 cr. (3 and 0)
Application of qualitative studies to educational questions; nature of qualitative research; rationale and applications of qualitative research methods; integration of qualitative and quantitative research methods in educational research. Prerequisite: ED F 778, 878 or equivalent.

ED F 894 (ED 894) (ED SP 894): Directed Research, 1-4 cr. (1-4 and 0)
Research in a line of inquiry in education under the direction of faculty; a specific educational question is investigated and reported using appropriate methodology. Graded on a pass/fail basis. Prerequisite: ED F 778, 808 or permission of instructor.

ED F 980 (ED 980) (ED SP 980): Internship in Curriculum and Instruction, 1-6 cr. (0 and 3-18)
Practical experiences linking the student's program of study to his or her field of professional service. Graded on a pass/fail basis. Prerequisite: Permission of major advisor.

ED F 991 (ED 991) (ED SP 991): Doctoral Dissertation Research, credit to be arranged

ED SP 602: The Exceptional Child, 3 cr. (3 and 0)
Survey of exceptionality including students who are gifted; nature, cause and treatment of difficulties; and educational problems. Prerequisite: Minimum grade-point ratio of 2.0.

ED SP 614 (PRTM 614): Recreation and Leisure for Special Populations, 3 cr. (3 and 0)
Practical experience in designing recreation and leisure activities for special populations (e.g., handicapped, elderly).

ED SP 636: Selected Topics in Special Education, 1-3 cr. (1-3 and 0)
Current issues and topics not covered in other special education courses. May be repeated for a maximum of 6 credits if different topics are covered. Prerequisite: Junior standing in education.

ED SP 669: Characteristics of Children with Emotional Disorders, 3 cr. (3 and 0)
Meaning and concepts associated with students with emotional disorders; analysis of the cause and characteristics of these students with emotional disorders. Prerequisites: ED F 302 or PSYCH 201, ED SP 402/602 and a minimum grade-point ratio of 2.0, or permission of instructor.

ED SP 670: Characteristics of Individuals with Learning Disabilities, 3 cr. (3 and 0)
Definitions, evaluation procedures, cognitive, social, academic and functional skills of individuals with learning disabilities across the lifespan. Prerequisites: ED F 302, ED SP 402, PSYCH 201, admission to the professional program or permission of instructor.

ED SP 672: Characteristics of Individuals with Mental Retardation, 3 cr. (3 and 0)
Characteristics of mental retardation across the lifespan: learning, behavioral and developmental aspects. Prerequisite: Admission to the professional program or permission of instructor for graduate credit.

ED SP 673: Educational Procedures for Individuals with Mental Retardation, 3 cr. (3 and 0)
Identification, selection and preparation of functional curriculum materials and pedagogy for teaching students with mental retardation; multidisciplinary, student-centered approach to program planning. Prerequisite: Admission to the professional program or permission of instructor for graduate credit.

ED SP 674: Educational Procedures for Children with Emotional Disorders, 3 cr. (3 and 0)
Practical experience in teaching students with emotional disorders; curriculum and instructional modifications, program planning, facility adaptation, behavior control, communicating with mental health specialists, and developing readiness for return to regular class. Prerequisite: Admission to the professional program or permission of instructor for graduate credit.

ED SP 675: Educational Procedures for Individuals with Learning Disabilities, 3 cr. (3 and 0)
Practical experience in teaching students with learning disabilities; curriculum and instructional modifications, program planning, facility adaptation, behavior control, communicating with mental health specialists, and developing readiness for return to regular class. Prerequisite: Admission to the professional program or permission of instructor for graduate credit.

ED SP 676: Practicum in Learning Disabilities, 3 cr. (2 and 3)
Practical experience in teaching students with learning disabilities; curriculum and instructional modifications, program planning, facility adaptation, behavior control, communicating with mental health specialists, and developing readiness for return to regular class. Prerequisite: ED SP 402, 470, 475, admission to the professional program; or permission of instructor.

ED SP 677: Characteristics of Children Who Are Gifted, 3 cr. (3 and 0)
Definitions, incidences, characteristics, identification procedures and curriculum options for the gifted. Prerequisites: ED SP 402 and minimum grade-point ratio of 2.0.

ED SP 678: Practicum in Emotional Disorders, 3 cr. (2 and 3)
Practical experience in teaching students with emotional disorders; curriculum and instructional modifications, program planning, facility adaptation, behavior control, communicating with mental health specialists, and developing readiness for return to regular class. Prerequisite: ED SP 402, 469, 474, admission to the professional program; or permission of instructor.

ED SP 679: Practicum in Mental Retardation, 3 cr. (2 and 3)
Practical experience in teaching students with mental retardation; curriculum and instructional modifications, program planning, facility adaptation, behavior control, communicating with mental health specialists, and developing readiness for return to regular class. Prerequisite: ED SP 402, 472, 473, admission to the professional program; or permission of instructor.

ED SP 820: Language Arts Instruction for Individuals with Disabilities, 3 cr. (3 and 0)
Focus on research-based methods for instructing individuals with disabilities. Emphasizes principles of effective language arts instruction in reading, writing, speaking and listening skills. Prerequisites: A course in reading methods or permission of instructor.
ED SP 821: Educational Assessment of Individuals with Disabilities, 3 cr. (3 and 0) Introduction to the assessment process in special education by addressing procedural safeguards; data collection via informal and standardized procedures; issues in assessment; psychometric properties of standardized tests; and administration, scoring and interpretation of selected instruments. Prerequisites: ED SP 402/602 or permission of instructor.

ED SP 822: Teaching Mathematics to Individuals with Disabilities, 3 cr. (3 and 0) Procedures for teaching mathematics to individuals with disabilities using direct instruction as an approach to assessment, instructional planning and evaluation; research in mathematics instruction for individuals with disabilities and mathematics program.

ED SP 823: Teaching Individuals with Disabilities in Integrated Settings, 3 cr. (3 and 0) Strategies for teaching individuals with disabilities in integrated settings. Focus on appropriate instruction, accommodations, natural supports, collaboration and consultation. Prerequisite: ED SP 402/602 or permission of instructor.

ED SP 824: Instructional Strategies for Individuals with Disabilities in Secondary School Settings, 3 cr. (3 and 0) Instructional procedures for teaching individuals with disabilities in middle and high schools. Focus on research-validated practices in learning strategies, content-area instruction, functional skills and community-based instruction. Prerequisite: ED SP 402/602 or permission of instructor.

ED SP 825: Career/Vocational Education for Individuals with Disabilities, 3 cr. (3 and 0) Career and vocational options for individuals with disabilities; assessment of post-school goals, future service needs and transition. Emphasis on the role of the secondary special educator in facilitating transition for individuals with disabilities. Prerequisite: ED SP 402/602 or permission of instructor.

ED SP 853: Legal and Policy Issues in Special Education, 3 cr. (3 and 0) A study of the impact of legislation-IDEA, Section 504 and litigation on special education. The six major principles of special education law; interpretation of court cases; residential placements, discipline, extended school year services, compensatory education, inclusion, strategies to minimize litigation; and trends in special education. Prerequisite: ED SP 402/602 or permission of instructor.

ED SP 854: Applied Behavior Analysis, 3 cr. (3 and 0) Class members will accurately recognize, observe, record and chart inappropriate behaviors, develop behavioral plans based on functional assessment data, determine behavioral objectives, apply behavior analysis principles and foster student self-management skills. Prerequisites: ED SP 402/602, ED F 778 or permission of instructor.

ED SP 881: Individual Testing, 3 cr. (3 and 0) Interpretation of Wechsler scales with supervised practice in their administration. Prerequisites: ED 701, 702, 809, ED F 808 and permission of instructor.

ED SP 884: School Psychology, 3 cr. (3 and 0) Roles and function of the school psychologist; legal/ethical issues; planning and evaluating school psychology service delivery systems; specialized practice techniques to evaluate learning and behavior problems. Prerequisites: ED 701 or behavior analysis. ED SP 402/602 and ED F 808, and permission of instructor.

ED SP 894 (ED F 894) (ED 894): Directed Research, 1-4 cr. (1-4 and 0) Research in a line of inquiry in education under the direction of faculty; a specific educational question is investigated and reported using appropriate methodology. Graded on a pass/fail basis. Prerequisite: ED F 778, 808 or permission of instructor.

ED SP 930: Advanced Studies in Special Education, 3 cr. (3 and 0) Historical, psychological and sociological foundations of special education emphasizing current state and federal legislation; case law and policy that impact special education. Prerequisites: Graduate standing, ED L 725 and ED 853 or permission of instructor.

ED SP 931: Advanced Research in Learning Disabilities, 3 cr. (3 and 0) History, theory, research and practice pertaining to selected issues in methods and curriculum within the field of learning disabilities. Emphasis is on research-based interventions in the preparation, selection, and adaptation of instruction for students with learning disabilities. Prerequisites: Graduate standing, ED F 778 and ED 821 or permission of instructor.

ED SP 932: Advanced Research in Emotional/Behavioral Disorders, 3 cr. (3 and 0) History, theory, research and practice pertaining to selected issues in the fields of emotional/behavioral disorders. Emphasis is on the influence of various theoretical approaches in the field and research-based interventions and curriculum development. Prerequisites: Graduate standing and ED 821.

ED SP 933: Advanced Research in Mental Retardation, 3 cr. (3 and 0) History, theory, research and practice pertaining to selected issues in the field of mental retardation. Emphasis is on historical treatment, theoretical approaches, research-based interventions, and community-based and lifespan curriculum development for individuals with mental retardation. Prerequisites: Graduate standing and ED 821.

ED SP 934: Program Models, Evaluation and Current Trends in Special Education, 3 cr. (3 and 0) Program models, program evaluation, current trends and issues in programming that impact the growth of special education. Prerequisites: Graduate standing and ED 930.

ED SP 980 (ED F 980) (ED 980): Internship in Curriculum and Instruction, 1-6 cr. (0 and 3-18) Practical experiences linking the student's program of study to his or her field of professional service. Graded on a pass/fail basis. Prerequisite: Permission of major advisor.

ED SP 991 (ED F 991) (ED 991): Doctoral Dissertation Research, credit to be arranged
in a research-related position. Candidates must complete a minimum of 30 hours of course work and six hours of research culminating in a thesis.

The Doctor of Philosophy is an advanced research degree requiring performance of original research leading to a dissertation. Comprehensive and final examinations and 18 hours of dissertation research are required. Course work is determined by each student’s doctoral committee.

PRTM 600: Supervision of Recreation Personnel Patterns and Processes, 3 cr. (3 and 0)
Supervisory process in relation to individuals, programs and groups in recreation agencies.

PRTM 611: Therapeutic Recreation for Selected Populations, 3 cr. (2 and 3)
Therapeutic recreation services for the developmentally disabled persons and for youth and adult corrections populations. Emphasis is on planning and implementation of therapeutic recreation services to the needs of clients and the goals of agencies and institutions.

PRTM 612: Therapeutic Recreation and Mental Health, 3 cr. (3 and 0)
Therapeutic recreation services in mental health clinics, institutions and outdoor settings; disorders and current modes of treatment as they relate to therapeutic recreation. Prerequisite: PRTM 311 or permission of instructor.

PRTM 613: Recreation Therapy in Physical Rehabilitation, 3 cr. (3 and 0)
Examination of the characteristics of chronic disabilities and their implications to the individual and to the planning and directing of Recreation Therapy Services. Prerequisite: PRTM 311 and 3 credit hours of human anatomy and physiology or permission of instructor.

PRTM 614 (ED SP 614): Recreation and Recreation Special Populations, 3 cr. (3 and 0)
Practical experience in designing recreation and leisure activities for special populations (e.g., handicapped, elderly).

PRTM 615 (ED F 615): Methods in Reducing Risks for Middle School, 3 cr. (2 and 0)
Development of knowledge base for professionals who work with at-risk children. Students will work in a field setting to apply knowledge, develop and practice skills, and cooperate with professionals from various disciplines.

PRTM 621: Recreation Financial Resource Management, 3 cr. (3 and 0)
Recreation financial resources management; revenue sources and their allocation. Prerequisites: PRTM 321 and senior standing in parks, recreation and tourism management.

PRTM 630 (GEOG 630): World Geography of Recreation and Parks, 3 cr. (3 and 0)
Major international patterns in the provision and use of urban and rural parks and recreation.

PRTM 631: Methods of Environmental Interpretation, 3 cr. (2 and 3)
Practice and instruction in the use of equipment and methods available to the interpreter in public contact work; coaching in presentation and evaluation of live programs and in design, execution and evaluation of recorded programs. Programs will be delivered to public audiences in the Clemson area. Prerequisite: PRTM 330; senior standing in parks, recreation and tourism management; or permission of instructor.

PRTM 641: Commercial Recreation, 3 cr. (3 and 0)
Components of offering leisure services and products to the public by individuals, partnerships and corporations for the purpose of making a profit.

PRTM 642: Conference/Convention Planning and Management, 3 cr. (3 and 0)
Problems and solutions to conference and convention planning and management from both the organizational and facility manager’s perspectives. Prerequisite: PRTM 342 or permission of instructor.

PRTM 644: Tour Planning and Operations, 3 cr. (3 and 0)
The psychology of touring with emphasis on packaged and group tours; how tours of different types and scale are planned, organized, marketed and operated. Prerequisite: PRTM 342 or permission of instructor.

PRTM 654: Community Tourism Development, 3 cr. (3 and 0)
Community-based perspective of the organizational, planning, development and operational needs for a successful tourism economy at the local level. Prerequisite: PRTM 342 or permission of instructor.

PRTM 647: Perspectives on International Travel, 3 cr. (3 and 0)
Using the United States as a destination, international travel patterns and major attractions are presented. Factors that restrain foreign travel to the United States are analyzed.

PRTM 652: Campus Recreation, 3 cr. (3 and 0)
Basic components required for administration of successful college union and intramural-recreation sport programs.

PRTM 672: Historic Site Interpretation, 3 cr. (3 and 0)
Development and implementation of the specialized interpretive programs required at historic sites; overview of the historic movement in the United States and its presentation to the American people. Prerequisite: PRTM 330.

PRTM 701: Foundations of Parks, Recreation and Tourism Management, 2 cr. (2 and 0)
Basic concepts and principles in the parks, recreation and tourism management field. Does not count toward degree requirements for PRTM students. Prerequisite: Graduate standing.

PRTM 705: Internship, 1-3 cr. (0 and 9+)
Field placement in an approved agency under qualified supervision. Graded on a pass/fail basis. Prerequisite: PRTM student or permission of instructor.

PRTM 708: Independent Study, 1-3 cr. (1-3 and 0)
Topics in recreation, leisure and tourism; students study an area not covered in other courses; a written report of findings is required. May be repeated for a maximum of three credits. Prerequisite: Permission of the supervising faculty before registration.

PRTM 709: Special Problems, 1-3 cr. (1-3 and 0)
Directed, individual comprehensive investigation of a special problem to use knowledge gained in formal courses, provide experience and training in research, and prepare for professional goals; report of findings required. May be repeated with a maximum of three credit hours applied toward graduation requirements. Graded on a pass/fail basis.

PRTM 710: Current Issues in Recreation, 1 cr. (1 and 0)
Seminar in current topics emphasizing student preparation, organization and communication of material and ideas not covered in formal courses. May be repeated for a maximum of three semester hours of credit.

PRTM 801: Philosophical Foundations of Recreation and Park Administration, 3 cr. (3 and 0)
Current theories and philosophies in recreation as they are influenced by and have influence on leisure and the changing environment in America. Student develops his or her own professional philosophy of recreation and leisure.

PRTM 802: Group Processes in Leisure Services, 3 cr. (3 and 0)
Improvement in human relations skills; knowledge of interpersonal needs and problems of individuals and groups. Students gain understanding of how others affect them and how they affect others and become more effective professional recreators, park administrators, supervisors, interpreters and educators.
PRTM 803: Seminar in Recreation and Park Administration, 3 cr. (3 and 0)
Case problems relating to administration of a park, recreation or tourism agency.

PRTM 804: Comprehensive Recreation Planning, 3 cr. (3 and 0)
Comprehensive recreation planning theories and practices at federal, state and local levels. Selected case study projects are undertaken in cooperation with other university departments and government agencies.

PRTM 807: Recreation Behavior in Natural Environments, 3 cr. (3 and 0)
The social, psychological and environmental influences on human behavior; identification of theoretical perspectives to explain behavior and to resolve problems in recreation resource management. Prerequisite: Graduate standing.

PRTM 808: Behavioral Aspects of Parks, Recreation and Tourism Management, 3 cr. (3 and 0)
Behavioral aspects of recreation, focusing on the social and psychological dimensions of the recreation experience in a variety of environments and activities. Prerequisite: Graduate standing.

PRTM 812: Leisure Services for the Elderly, 3 cr. (3 and 0)
The elderly and the role of leisure services in later life; needs of community-based and institutionalized elderly; service delivery systems to meet these needs.

PRTM 815: Therapeutic Recreation and Activity Therapy Administration, 3 cr. (3 and 0)
Service delivery structures; interdisciplinary relationships; consultation methods; in-service training; funding sources; service evaluation in therapeutic recreation and activity therapy programs.

PRTM 816 (FOR 816): Remote Sensing and GIS in Natural Resources, 3 cr. (2 and 3) S (odd numbered years)
Practical application of computer mapping, spatial analysis and natural resource inventory using remote sensing and geographical information systems. Prerequisite: Permission of instructor.

PRTM 820: Recreation Resource Policy Issues and Processes, 3 cr. (3 and 0)
Outdoor recreation policy-formation structures and processes are surveyed through case studies involving past and current public policy issues.

PRTM 840: Tourism Planning, 3 cr. (3 and 0)
Tourism planning procedures and techniques; planning process and associated concerns such as market, facility, infrastructure, environment, culture and economics. Prerequisite: Graduate standing.

PRTM 843: Tourism Analysis, 3 cr. (3 and 0)
Selected theories, methods, techniques, practices and principles that govern tourism behavior. Prerequisite: Graduate standing or one graduate level statistics course or permission of instructor.

PRTM 844 (C R P 844): Outdoor Recreation Resource Management and Planning, 3 cr. (3 and 0)
Issues related to the planning and development of natural areas for recreational purposes; policy-making process at the federal, state, regional and local levels. Prerequisite: Permission of instructor.

PRTM 891: Master's Thesis Research, credit to be arranged

PRTM 900: Selected Topics, 1-3 cr. (1-3 and 0)
In-depth, timely study of trends or problems in parks, recreation and tourism not covered in other courses. May be repeated for a maximum of six credits.

PRTM 908: Advanced Topics, 1-3 cr. (1-3 and 0)
Topics not covered in other PRTM courses and not directly related to a thesis or dissertation topic; a formal paper is required. May be taken for a maximum of three credits per semester. May be repeated for a maximum of six credits. Prerequisite: Permission of instructor.

PRTM 910: Research Seminar, 1 cr. (1 and 0)
Current research developments in PRTM and presentation of research projects. May be taken for credit for two semesters. Graded on a pass/fail basis.

PRTM 991: Doctoral Dissertation Research, credit to be arranged

Public Health Sciences

Clemson University and the Medical University of South Carolina jointly offer the Master of Health Administration (MHA) degree. The program is designed for individuals who wish to prepare for administrative roles and responsibilities in a variety of health care settings. Graduates of the program will: (a) have a comprehensive understanding of the health care system including socio-behavioral components of health and their impact on health care delivery; (b) be able to apply managerial concepts and skills in areas of human resources, strategic planning, decision-making, finance and information systems; and (c) be able to implement an integrated approach to the management of health care facilities. The MHA program consists of 50 semester hours of course work. All classes are taught at the University Center of Greenville by faculty from Clemson University or the Medical University of South Carolina. The program faculty are a major resource for the citizens of the state, region, national and international health care communities.

These are the core courses in the MHA program.

MHA 717: Health Care Management, 3 cr. (3 and 0)
Structure and function of the well-managed and appropriately led acute care hospital; other health service organizations and general management and operations theory.

MHA 721: Health Care Delivery Systems, 3 cr. (3 and 0)
Development of the health services delivery system in the United States.

MHA 722: Health Behavior and Epidemiology, 2 cr. (2 and 0)
Health behavior of a population and individuals; concept of the health status of a population, methods of measurement and sources of data.

MHA 729: Health Care Finance, 3 cr. (3 and 0)
Selected financial management topics including working capital management, capital budgeting, debt and equity instruments, and financial statement analysis.

MHA 734: Health Care Economics and Policy, 3 cr. (3 and 0)
Economic and policy concepts and analyses as applied to health care.

MHA 735: Health Law and Risk Management, 2 cr. (2 and 0)
Legal concepts and issues related to health care management.

MHA 752: Health Administration Field Project, 3 cr. (3 and 0)
Application of principles, theories and concepts to a well-defined problem or issue currently confronting the health service administrator.

MHA 853: Seminar in Health Administration and Leadership, 2 cr. (2 and 0)
Integration of knowledge and skills acquired across all courses in the context of strategic management.

M B A 803: Statistical Analysis of Business Operations, 3 cr. (3 and 0)
The role of statistical inference in the decision making of business managers; techniques and proper applications of modern statistical methods in business; univariate and multivariate analysis including analysis of variance, regression and covariance; sample theory and design, basic experimental designs and time series analysis. Prerequisite: Basic statistics.
MBA 804: Managerial Accounting and Information Systems, 3 cr. (3 and 0)
Preparation, analysis, interpretation and use of accounting information in the guidance and control of a business enterprise. Case material and problems are used. Prerequisites: Principles of accounting and a demonstrated proficiency in basic finance.

MBA 806: Operations Management, 3 cr. (3 and 0)
Analytical methods as applied to business and industrial problems; basic mathematical and statistical models useful to management decision making in the functions of production, marketing, finance and general management. Emphasis is on development and application of deterministic and probabilistic models to problems in forecasting, production scheduling, inventory, maintenance, queuing, plant location, product lines, line balancing, critical path methods and simulation. Prerequisites: MBA 803 and a demonstrated proficiency in basic management.

MBA 808: Managerial Problems in Marketing, 3 cr. (3 and 0)
Major decisions facing marketing executives and top management in their attempt to harmonize the objectives and resources of the organization with the opportunities found in the marketplace; recent theoretical developments in marketing and related disciplines and their application in management; readings, case analysis and discussions are used. Prerequisite: Principles of marketing.

MBA 809 (MGT 809): Organization Theory and Behavior, 3 cr. (3 and 0)
Advanced consideration of theories and models as they apply to managing individual and work-group behavior in organizations. Topics include leadership, decision making, motivation, power, conflict, communication, job design and group processes. Prerequisite: Graduate standing.

MBA 810: Managerial Policy, 3 cr. (3 and 0)
Decisions involved in the establishment of managerial policy. Problems, resources and alternative courses of action are analyzed and discussed relative to the selection of company objectives and the most feasible means for achieving company goals. Integrates material and treats the coordination of the affairs of the firm as a whole. Case studies are emphasized. This course should be completed as the final course in the program.

MGT 815: Personnel Management, 3 cr. (3 and 0)
Personnel management activities including recruitment, selection, training and development, performance appraisal, discipline, grievance handling, wage and salary administration, and employee benefit programs. Prerequisite: Graduate standing.

These courses offered by MUSC and by Clemson University are elective courses for the MBA.

MHA 717: Selected Topics in Health Administration, 1-3 cr. (1-3 and 0)
Current issues and topics in health administration. May be repeated for a total of six credit hours if topics vary. Graded on a pass/fail basis.

MHA 724: Health Care Ethics, 3 cr. (3 and 0)
Examination and analysis of the professional standards, laws, political and economic forces that establish a context for health care ethics.

MHA 732: Outcomes Assessment and Evaluation in Health Services, 3 cr. (3 and 0)
General application of evaluative research in a variety of health care settings, administrative purposes of evaluation of organizational components and/or programs, and the design and implementation of evaluative efforts.

MHA 741: Seminar in Community and Rural Health, 3 cr. (3 and 0)
Community health planning concepts and methods and the unique aspects of rural health among the population residing there.

MHA 743: Managing with Health Professionals, 3 cr. (3 and 0)
Learning about clinical professionals and exploring ways to facilitate effective and efficient team relationships in the management and delivery of health services.

ACCT 830: Governmental and Not-for-Profit Accounting, 3 cr. (3 and 0)
Fund accounting and financial reporting for governments and other not-for-profit organizations; managerial control issues in the not-for-profit environments. Prerequisites: ACCT 202 or 203 and permission of instructor.

HLTH 620: Health Promotion and Wellness Internship, 1-6 cr. (0 and 3-18)
Under competent supervision in an approved agency, the student will have opportunities for on-the-job experiences. The student will select an agency and develop personal goals and objectives appropriate to the setting, population and health issues. May be repeated for a maximum of six credits. To be taken pass/fail only. Prerequisites: Minimum grade-point ratio of 2.5 and permission of instructor.

HLTH 600: Selected Topics in Health, 1-6 cr. (1-6 and 0)
Topics selected to meet special and individualized interest of students in health. May be repeated for a maximum of six credits, but only if different topics are covered. Prerequisites: Permission of instructor, junior standing.

HLTH 601: Health Care Consumerism, 3 cr. (3 and 0)
Exploration of consumer decisions regarding health products and services with emphasis on strategies for decision making. Health majors and minors will be given enrollment priority. Prerequisite: A two-semester sequence in science or permission of instructor.

These are additional graduate courses offered within Public Health Sciences.
HLTH 610: Concepts of Child Health, 3 cr. (3 and 0)
Analysis and evaluation of health problems commonly occurring in children; concepts of positive health behavior. Health majors and minors will be given enrollment priority. Prerequisite: Developmental psychology requirement.

HLTH 611: Health Needs of High Risk Children, 3 cr. (3 and 0)
Analysis and evaluation of the health needs of high-risk families and special needs children from the prenatal period to age six; health prevention and early intervention strategies. Enrollment priorities will be provided to students enrolled in the early intervention specialist minor. Prerequisite: HLTH 410.

HLTH 615: Public Health Issues in Obesity and Eating Disorders, 3 cr. (3 and 0)
Prevalences, risk factors, consequences and treatments of obesity and other eating disorders; public health importance. May be repeated for a maximum of six credits. To be taken pass/fail only. Prerequisite: Minimum grade-point ratio of 2.5, permission of instructor and junior standing.

HLTH 620: Health Science Internship, 1-6 cr. (0 and 3-18)
Under competent supervision in an approved agency, the student will have opportunity for on-the-job experiences. The student will select an agency and develop personal goals and objectives appropriate to the setting, population and health issues. May be repeated for a maximum of six credits. To be taken pass/fail only. Prerequisite: Minimum grade-point ratio of 2.5, permission of instructor and junior standing.

HLTH 630: Health Promotion of the Aged, 3 cr. (3 and 0)
Analysis and evaluation of health issues and health concerns of the aged; concepts of positive health behaviors. Health majors and minors will be given enrollment priority. Prerequisites: Developmental psychology; a two-semester sequence in science; or permission of instructor.

HLTH 631: Public and Environmental Health, 3 cr. (3 and 0)
Principles of environmental health with an emphasis on understanding various health concerns created by the interactions of people with their environment; evaluation of the impact of environmental factors on public health policy decisions. Meets specific area of need in environmental health issues.

HLTH 650: Applied Health Strategies, 3 cr. (3 and 0)
Students plan, implement and evaluate strategies to promote health through individual behavior changes. Both healthful and unhealthful behaviors are included. Examples include smoking cessation, weight management and stress management. Restricted to Health Science Majors. Prerequisites: HLTH 480.

HLTH 698: Improving Population Health, 3 cr. (3 and 0)
Current and emerging issues in improving public health practice and population health. Examples in empirical and applied research revealing future trends in population health. Health majors and minors will be given enrollment priority. Prerequisite: HLTH 298, 240, 380 or permission of instructor.

HLTH 809 (MICRO 809): Epidemiological Research, 3 cr. (3 and 0)
Basic concepts of epidemiology with emphasis on applied aspects rather than theoretical; examples drawn from clinical practice; use of relevant PC-based computer packages required. Prerequisite: MTHSC 405/605 or EX ST 801 or permission of instructor.

Technology and Human Resource Development
Gerald G. Lovedahl, Chair, Department of Technology and Human Resource Development

<table>
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<th>Majors</th>
<th>Degrees</th>
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<tr>
<td>Human Resource Development</td>
<td>M.H.R.D.</td>
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<tr>
<td>Industrial Education</td>
<td>M. in Ed.</td>
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<tr>
<td>Vocational/Technical Education</td>
<td>Ed D.</td>
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The human resource field is a specialized blend of education, counseling, psychology, management and sociology. The human resource development (HRD) program is designed to prepare industrial training directors, educational specialists, training coordinators and personnel for HRD occupations in industry.

HRD specialists commonly provide training related to the areas of technical and interpersonal skills, motivation, and utilization. The HRD program is designed to involve and enhance a variety of professional management activities. The program serves professionals working in the areas of manufacturing, construction, health occupations, secretarial sciences, graphic communications, transportation, loss control, quality assurance and personnel management.

Graduates of the program are capable of utilizing contemporary instructional technologies and methodologies. Program participants gain valuable skills and knowledge related to the varied roles of the training specialist.

Applicants to the HRD program are reviewed on undergraduate course work, academic performance and employment experience. The HRD program requires 36 hours including 15 hours in core human resource development courses, six hours in research methods and 15 hours in course work appropriate to individual career objectives.

Some of these programs are also available to off-campus students through the Office of Off-Campus, Distance and Continuing Education. Call 1-888-CLEMSON (253-6766) for more information.

THRD 610 (G 610): Selected Topics, 1-3 cr. (1-3 and 0)
Subject areas organized according to program needs. Content will be planned cooperatively by the University and the school system or agency requesting the course. May be repeated for a maximum of 18 credits, but only if different topics are covered. Prerequisite: Permission of instructor.

THRD 613: Contemporary Technological Problems, 3 cr. (3 and 0)
Problems and contributions of technology with examples taken from historical accounts and from analyses of contemporary technological intervention both in industrialized and nonindustrialized countries.

THRD 615: History and Philosophy of Industrial and Vocational Education, 3 cr. (3 and 0)
Study of industrial and vocational education programs with the intent of developing a sound individual philosophy. Topics include historical; local, state and federal legislation; types of vocational-technical programs; professional organizations; manpower utilization, vocational guidance and training; industry, labor and school relationships.

THRD 620: Manufacturing Technology II: Materials and Processes, 3 cr. (2 and 3)
Continuation of THRD 220 with emphasis on materials and processes of manufacturing; specific materials; separating, forming and combining practices and equipment; competitive aspects of manufacturing. Prerequisite: THRD 220 or permission of instructor.

THRD 630: Construction Technology II: Practices and Systems, 3 cr. (2 and 3)
Industrial practices and systems affecting main, materials and equipment associated with construction industries. Activities are directed toward developing a working knowledge of construction technology and a framework for incorporating this instruction into programs in the public and private sectors. Prerequisite: THRD 230.

THRD 640: Power Technology II: Transmission and Control Systems, 3 cr. (2 and 2)
Continuation of THRD 240; transmitting and controlling power for utilization in such areas as manufacturing, communications, construction and transportation; concepts of automation and robotics. Prerequisite: THRD 240.

THRD 641: Internal Combustion Engines, 3 cr. (2 and 3)
Internal combustion engine: theory of operation, applications, methods of analyzing performance and troubleshooting malfunctions. Intended as an elective for industrial technology education and vocational-technical education option ma-
THRD 650: Electronics for Educators, 3 cr. (3 and 0)
Principles of electronics as applied in communications and automatic controls involving transistors, integrated circuits, and other electronic devices and materials for the preparation of teachers of industrial arts and vocational-technical electricity and electronics. Prerequisite: THRD 250 or equivalent.

THRD 660: Developing Training Programs for Industry, 3 cr. (3 and 0)
Identification, selection and organization of subject matter appropriate for industrial training programs; analysis techniques, session and demonstration planning, written instructional materials development, trainee evaluation and planning instructional schedules. Prerequisite: THRD 160, 460 or permission of instructor.

THRD 665: Conducting and Evaluating Training Programs for Industry, 3 cr. (3 and 0)
Basic concepts of supervision, administration and management of training programs; determining training requirements; planning, directing and evaluating training programs. Prerequisite: THRD 660.

THRD 666: Public Relations, 3 cr. (3 and 0)
Techniques and methods of effective public and industrial relations that contribute to understanding and cooperation of labor, business, professional, educational and industrial groups.

THRD 670: Course Organization and Evaluation, 3 cr. (3 and 0)
Problems, techniques and procedures in the preparation, selection and organization of subject matter for instructional purposes; methods, techniques and preparation of materials used in the evaluation of student achievement in industrial education subjects.

THRD 671: Teaching Industrial Subjects, 3 cr. (3 and 0)
Effective methods and techniques of teaching industrial subjects; class organization, preparation of lesson outlines and audio-visual aids. Prerequisite: ED F 335.

THRD 673: Competency Testing in Vocational Subjects, 3 cr. (3 and 0)
Competency testing in vocational education, which includes educational objectives and measurement, construction and use of oral, objective, short answer, matching, essay and performance tests; treatment of test data for grade assignment and statistical analysis.

THRD 674: School Safety, 3 cr. (3 and 0)
Principles of school safety emphasizing safety analyses, accident prevention, remediation of unsafe conditions, development and use of instructional materials, and school liability.

THRD 680 (ED F 680) (AG ED 680):
Educational Applications of Microcomputers, 3 cr. (2 and 2)
Fundamentals of computer applications for teachers; competencies in general computer applications such as word processing and database management; educational uses of the Internet and computer-assisted instruction; emphasis on legal and ethical issues and the impact of computer technology upon society. Prerequisites: Admission to a teacher education program; graduate standing.

THRD 682 (ED F 682) (AG ED 682):
Advanced Educational Applications of Microcomputers, 3 cr. (2 and 2)
Knowledge and skills needed to apply microcomputer technology to the utilization and generation of educational software in accordance with sound educational principles.

THRD 683: Architectural Drafting for Industrial Education, 3 cr. (1 and 6)
Major aspects of architectural drawing such as plot, floor and foundation plans; wall sections; elevations. Prerequisite: THRD 180.

THRD 684: Communications Technology II: Systems, 3 cr. (2 and 2)
Continuation of THRD 280: theory and operation of communications systems: telegraph, telephone, radio, television, satellites, sound/video recorders, lasers, and computers; strategies for interpreting this area of technology to industry personnel and public school students. Prerequisite: THRD 280.

THRD 686: Instructional Video Production, 3 cr. (1 and 4)
Basic instructional media development techniques. Students will develop material using authoring software such as HyperCard, transparencies using Persuasion and/or PowerPoint, and fully storyboarded, scripted, and edited digital as well as analog video.

THRD 692: Advanced Projects, 1-6 cr. (1-6 and 0)
Student gains depth in content by completing a project under the supervision of an instructor in one of the following subject areas: arts and crafts, drawing and design, electricity and electronics, graphic arts, metalworking, occupational education, power, and woodworking. Written project approval required before registering. Prerequisite: Permission of instructor.

H R D 830: Concepts of Human Resource Development, 3 cr. (3 and 0)
Theory and practice of contemporary applications of human resource development (HRD) programs; training and development functions; strategies for designing and developing programs; and application of methods, techniques and resources in the context of changing needs, technologies, demographics and economic circumstances that create the need for different skills and knowledge in the work force. Prerequisite: Permission of instructor.

H R D 845 (IN ED 845): Needs Assessment for Education and Industry, 3 cr. (3 and 0)
Theory and practice of needs assessment activities in human resource development (HRD) programs; importance of the process to the identification of content/curricula topics and the overall training environment; specific methodologies used in the needs assessment process; supportive components of various program planning systems. Prerequisite: H R D 830 or permission of instructor.

H R D 846 (IN ED 846): Applied Public Relations, 3 cr. (3 and 0)
Practical and theoretical approaches to problem identification and the development of respective solutions in the public relations process; action and message generation, media development and evaluation of public relations techniques in existing organizations. Prerequisites: Employment or ready access to an employer and place of employment; THRD 486/686 is desirable.

H R D 847 (IN ED 847): Instructional Systems Design, 3 cr. (3 and 0)
Theory and practice of instructional systems development activities in human resource development (HRD) programs; identification, selection and organization of subject matter appropriate for competency-based training (CBT) programs; occupational analysis techniques; rationale statements, goals and objectives; related instructional materials; participant evaluation; and instructional scheduling. Prerequisites: H R D 830 and 845 or permission of instructor.

H R D 849: Evaluation of Training and Development/H R D Programs, 3 cr. (3 and 0)
Theory and practice of evaluation processes related to training and development in human resource development (HRD) programs; developing a results-oriented approach based on specific criteria or standards; designing instruments; determining program costs; and collecting, analyzing and interpreting data to ascertain return on investment. Prerequisites: H R D 830, 845, 847, 860 and IN ED 889 or permission of instructor.
H R D 860 (IN ED 860): Instructional Materials Development, 3 cr.
(3 and 0)
Development and application of instructional materials and laboratory activities for training programs in education and industry; reinforcement of instructional training concepts and instructional materials development procedures that are applied across human resource development (HRD) programs. Prerequisites: H R D 830 and 845.

H R D 870 (IN ED 870): Consulting for Education and Industry, 3 cr.
(3 and 0)
Theory and practice of external and internal consulting practices in human resource development (HRD) programs; dynamics of a professional helping relationship; methods and techniques for initiating and terminating consulting relationships; diagnosing client situations; identification, selection and implementation of alternative problem solutions; evaluation of professional consulting relationships. Prerequisite: H R D 830 or permission of instructor.

H R D 897: Applied Research and Development, 3 cr.
(3 and 0)
Study of a particular topic under the direction of a faculty member. Students identify a specific problem related to the human resource development (HRD) profession based on their personal interests, experiences, needs, and goals. Prerequisites: Submission of a written proposal, prior approval of advisor, and satisfactory completion of 12 hours of graduate H R D courses and IN ED 889.

Industrial Education

Gerald G. Lovedahl, Chair, Department of Technology and Human Resource Development

<table>
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<tr>
<th>Major</th>
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<td>M.In.Ed.</td>
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The Master of Industrial Education degree allows for specialization in four areas: industrial technology education, vocational/technical education, administration and supervision for the two-year college, and graphic communications. Sufficient flexibility is permitted to structure each student's plan of study to meet the objectives for any of the areas of specialization listed above. The industrial technology area is designed to enhance competencies in teaching industrial technology and prevocational and career education. Those who want to improve their competency in teaching and administering vocational or technical subjects in secondary or postsecondary institutions specialize in the vocational/technical area. The program in administration and supervision for the two-year college is designed specifically for persons preparing for administrative or supervisory positions in the technical colleges. Graphic communications specialists pursue technical and professional study to enter careers in printing management, sales and technical teaching in postsecondary graphic communications programs. In addition to the general requirements for admission to the Graduate School, departmental requirements for admission to each of the areas of specialization are as follows:

1. Industrial technology education applicants must hold or meet the minimum requirements for an industrial arts or technology teacher's certificate.
2. Vocational/technical education applicants must hold or meet the minimum requirements for a trade and industrial teacher's certificate, or show vocational or technical competence through training, work experience or proficiency test results.
3. The program in administration and supervision for the two-year college requires the applicant to show evidence of competency in a teaching area or to have a minimum of 24 semester hours of courses appropriate to the vocational or technical program to be administered or supervised.
4. Graphic communications specialists must have a technical background in one or more phases of graphic communications or complete a specified sequence of prerequisite courses.

Candidates for the Master of Industrial Education degree are required to complete the following:

1. 18 hours in subjects that contribute to the student's technical, administrative, and/or supervisory competence;
2. six hours in research and special problems; and
3. six to 12 hours taken outside the major department.

IN ED 700 (ED 700): Supervising the Student Teacher in the Public School, 2-3 cr.
(2-3 and 0)
Knowledge and skills desirable for supervisors of student teachers; use of observation instruments for recording objective data and evaluating teaching performance. Graded on a pass/fail basis. Prerequisites: A professional teaching certificate, at least one year of teaching experience, a recommendation from the employing school district or consent of the instructor. 

IN ED 815: Seminar in Industrial Education, 1 cr.
(1 and 0)
Students and faculty discuss and study new technological and professional advances. May be taken up to three times. Graded on a pass/fail basis.

IN ED 820: Recent Process Developments, 3 cr.
(3 and 0)
Recent technological innovations, inventions, processes, and products, and their impact on our industrial, labor, educational, and social institutions.

IN ED 845 (H R D 845): Needs Assessment for Education and Industry, 3 cr.
(3 and 0)
Theory and practice of needs assessment activities in human resource development (HRD) programs; importance of the process to the identification of content/curricula topics and the overall training environment; specific methodologies used in the needs assessment process; supportive components of various program planning systems. Prerequisite: H R D 830 or permission of instructor.

IN ED 846 (H R D 846): Applied Human Relations, 3 cr.
(3 and 0)
Practical and theoretical approaches to problem identification and the development of respective solutions in the public relations process; action and message generation, media development and evaluation of public relations techniques in existing organizations. Prerequisites: Employment or ready access to an employer and place of employment; THRD 468/668 is desirable.

IN ED 847 (H R D 847): Instructional Systems Design, 3 cr.
(3 and 0)
Theory and practice of instructional systems development activities in human resource development (HRD) programs; identification, selection, and organization of subject matter appropriate for competency-based training (CBT) programs; occupational analysis techniques; rationale statements, goals, and objectives; related instructional materials; participant evaluation; and instructional scheduling. Prerequisites: H R D 830 and 845 or permission of instructor.

IN ED 851: Current Topics in Communication Technology, 1-3 cr.
(1-3 and 0)
Recent technological processes in the communication industry, such as CAD, desktop publishing and interactive video, for teachers and industrial personnel. Prerequisite: Graduate status.

IN ED 852: Current Topics in Manufacturing Technology, 1-3 cr.
(1-3 and 0)
Contemporary manufacturing practices for public school teachers and industry personnel.

IN ED 853: Current Topics in Construction Technology, 1-3 cr.
(1-3 and 0)
Update for teachers in industrial technology education programs at the secondary level, instructors in construction-related programs at the postsecondary level and industrial trainers in the private sector; contemporary technological processes in construction industries.

IN ED 854: Current Topics in Power Technology, 1-3 cr.
(1-3 and 0)
Contemporary applications of power and energy for public school teachers and industry personnel.

IN ED 860 (H R D 860): Instructional Materials Development, 3 cr.
(3 and 0)
Development and application of instructional materials and laboratory activities for training programs in education and industry; reinforcement of instructional...
training concepts and materials development procedures that are applied across human resource development (HRD) programs. Prerequisites: H R D 830 and 845.

IN ED 865: American Industries, 3 cr. (3 and 0)
Concepts and principles of American industry and technology. Industrial plant visits supplement study of industrial organization, economics, management, production and products.

IN ED 870 (H R D 870): Consulting for Education and Industry, 3 cr. (3 and 0)
Theory and practice of external and internal consulting practices in human resource development (HRD) programs; dynamics of a professional helping relationship; methods and techniques for initiating and terminating consulting relationships; diagnosing client situations; identification, selection and implementation of alternative problem solutions; evaluation of professional consulting relationships. Prerequisite: H R D 830 or permission of instructor.

IN ED 889 (ED 889) (AG ED 889): Research in Education, 3 cr. (3 and 0)
Problem selection; types of educational research and techniques employed; use of ERIC system and computer program packages; interpretation of research findings.

IN ED 894: Project Research, 1-6 cr. (1-6 and 0)
Research related to departmental projects. Open only to students planning to pursue advanced graduate study. Joint use with IN ED 895, 896 not permitted for degree.

IN ED 895 (G C 895): Special Problems I, 3 cr. (3 and 0)
Special problems in industrial education, varying with interests, experiences and needs of students. Prerequisites: Submission of a written proposal, prior approval of advisor and completion of nine hours in the major.

IN ED 896 (G C 896): Special Problems II, 3 cr. (3 and 0)
Continuation of IN ED 895. Prerequisites: Submission of a written proposal, prior approval of advisor and completion of IN ED 895.

VOCATIONAL/TECHNICAL EDUCATION

The Doctor of Education degree in vocational and technical education prepares graduates for leadership positions in the profession. Curricula are designed for vocationally and technically oriented personnel in colleges, universities, public schools, industry and vocationally related agencies.

Areas of specialization are available in the following fields:

1. Administration — technical colleges and public schools.
2. Curriculum and Instruction — technical colleges, industry and public schools. Emphasis is on curriculum development, materials and instructional technologies, and human resource development.
4. Teaching — technical colleges and public schools.

An applicant for the Ed.D. degree must hold bachelor's and master's degrees from approved colleges and must have completed a minimum of three years of successful experience appropriate to his or her proposed field of professional service. (This requirement may be waived for admission, but the applicant cannot become a candidate for the degree until the requirement is met.)

The Ed.D. program consists of graduate coursework in vocational and technical foundations, statistics and research, advanced study and an internship in an appropriate field of professional service, and a dissertation.

VT ED 810: Foundations of Vocational and Technical Education, 3 cr. (3 and 0)
Evolution of vocational and technical education during the twentieth century and current trends; sociological, psychological and philosophical theories underlying current objectives; definition of broad parameters of the field.

VT ED 812: Vocational and Technical Program Finance, 3 cr. (3 and 0)
National, state and local legislation governing financial support of vocational/technical programs; development of budget, audit, and financial administrative plans and systems. Prerequisites: VT ED 810 and ED L 745 or equivalent.

VT ED 833: Curriculum Construction in Vocational and Technical Education, 3 cr. (3 and 0)
Students develop a specific course in a selected vocational and technical education area by specifying performance goals and building around these objectives. Prerequisite: AG ED 640 or THRD 670 or equivalent.

VT ED 850: Programs, Concepts and Issues in Vocational and Technical Education, 3 cr. (3 and 0)
Current activities and debates in vocational and technical education; traditional and innovative programs, career education, school finance, disadvantaged students, handicapped youth, sex equality and other specialized programs.

VT ED 861: Administration and Supervision in Vocational and Technical Education, 3 cr. (3 and 0)
Principles and practices for administering and supervising vocational and technical schools and classes under federal vocational acts, state regulations and local policies. Prerequisite: VT ED 810 or permission of instructor.

VT ED 876: College Teaching, 3 cr. (3 and 0)
Instructional practices; curriculum; techniques of organizing and planning learning experiences; analysis of teaching strategies and systems.

VT ED 882: Seminar, 1 cr. (1 and 0)
Current issues and problems and proposed research projects.

VT ED 893: Advanced Research Design and Analysis, 3 cr. (3 and 0)
Emphasis on the dissertation from the proposal to the fully developed outline of all chapters. Required of all doctoral candidates in the vocational/technical education program. Prerequisite: AG ED 889 or equivalent.

VT ED 955 (ED L 955): The Two-Year College, 3 cr. (3 and 0)
Historical developments, functions, organization and administration of the two-year college. Prerequisite: Admission to doctoral studies or permission of instructor.

VT ED 980: Internship in Vocational/Technical Education, 1-6 cr. (0 and 3-18)
Internship in which the student gains experience working in a chosen area of specialization in vocational/technical education; field experience activities must be planned to build competence in the student's field of specialization. Graded on a pass/fail basis. Prerequisite: Permission of the student's major advisor.

VT ED 991: Doctoral Dissertation Research, credit to be arranged

SCHOOL OF NURSING

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<td>Major</td>
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<td>M.S.</td>
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The Program
The Master of Science degree program with a major in nursing is designed to build upon the first professional degree. The student acquires knowledge and skills in advanced nursing practice: clinical nurse specialist (CNS), or nurse practitioner (NP). The Student may select one of the four study options: child/adolescent nursing (CNS), adult/gerontological nursing (CNS), family nurse practitioner (NP), or gerontological nurse practitioner (GNP). The nurse practitioner and clinical nurse specialist options articulate with the baccalaureate program in the continued acquisition of advanced nursing knowledge and skills of the specialist. This specialization builds toward advanced nursing practice in
selected clinical practice and role areas. Theory, research and role development are 
emphasized to enable the graduate to participate in the development of nursing knowledge and contribute to the advancement of the nursing profession.

The objectives of the Master of Science degree program with a major in nursing are to provide graduates with the ability to:

1. integrate advanced knowledge from nursing and related disciplines into a specialized area of nursing practice;
2. demonstrate competence in a selected functional role (clinical specialist or nurse practitioner);
3. evaluate and apply research findings from nursing and related disciplines to advanced nursing practice;
4. participate in the development of nursing knowledge by identifying researchable nursing problems, conducting research, and selectively integrating research findings in advanced nursing practice;
5. utilize leadership, management, and teaching knowledge and competency to influence nursing practice;
6. participate as a leader to influence health policy and improve the health care delivery system; and
7. contribute to the advancement of the nursing profession.

Selected program offerings are available to off-campus students at the University Center in Greenville, SC.

Admission Requirements

In addition to meeting University admission requirements, applicants should be graduates of baccalaureate nursing programs accredited by the National League for Nursing Accrediting Commission (NLNAC), must have had an undergraduate statistics course, and demonstrate evidence of current basic client assessment skills. In addition, students must document recent significant clinical practice which is defined as 600 hours during the 12 months prior to acceptance into the program of hands-on, direct nursing care.

NURS 801: Advanced Family Nursing, 3 cr. (3 and 0)
Developmental, psychodynamic, social-political, and cultural theories and concepts synthesized and applied to the analysis of health and illness in families across the life cycle; roles and functions of advanced practice nurses in promoting family health.

NURS 804: Knowledge Development in Advanced Nursing, 2 cr. (2 and 0)
Nursing theories and theories relevant to nursing practice and research; processes of theoretical thinking and critical thinking applied to health problems and needs of individuals and their families in the community; theoretical and conceptual models of contemporary practice and research.

NURS 805: Pharmacotherapeutics for Advanced Nursing, 3 cr. (3 and 0)
Prescription administration and patient/family education in use of pharmacological agents emphasizing the drugs pre-scribed for common or chronic illnesses; drug selection; adverse drug reactions; age-related differences in utilization; regulations affecting nurse's prescriptive authority. Prerequisite or Corequisite: NURS 809.

NURS 806: Advanced Assessment for Nursing, 2 cr. (1 and 3)
Comprehensive assessment and diagnosis of health problems and status for individuals of all ages including assessment of families; physical and laboratory/radiologic diagnostic assessments; directed laboratory experiences in advanced assessment of clients of several ages. Prerequisites or Corequisites: NURS 801 and 809.

NURS 807: Clinical Nursing Research, 2 cr. (2 and 0)
Quantitative and qualitative research methodologies useful and appropriate to clinical nursing practice and for the development of nursing knowledge; ethics with human subjects; does not include thesis advisement.

NURS 808: Nursing Research Analysis, 2 cr. (2 and 0)
Quantitative research methods in nursing science including basic elements of statistical design with a focus on the use of nursing informatics and computer applications. Prerequisite: Undergraduate statistics course.

NURS 809: Pathophysiology for Advanced Nursing, 2 cr. (2 and 0)
Human response to health alterations as they impact nursing knowledge and practice. Focus is on recognizing the manifestations of health alterations and developing nursing interventions accordingly.

NURS 811: Advanced Nursing and Health Policy, 2 cr. (1 and 3)
Reciprocal influence of nursing, client health and policy making on the delivery of health care; laboratory experience incorporates a variety of directed activities related to the policy process. Prerequisites: NURS 801, 805 and 809.

NURS 819: Family Nursing I: Developing Families, 4 cr. (2 and 6)
Theories and concepts related to nursing management in the care of developing families; critical thinking applied to health problems and needs of developing families before, during and immediately following pregnancy; application of related nursing issues and current research; clinical practice with developing families in a variety of settings. Prerequisites: NURS 801, 805, 806 and 809.

NURS 820: Family Nursing II: Child and Adolescent, 4 cr. (2 and 6)
Advanced nursing roles and functions applied to health promotion, health maintenance, health restoration, habilitation and rehabilitation of infants, children and adolescents with existing or potential health problems; critical thinking used to assess, diagnose, intervene and promote continuity of care with clients of these ages irrespective of setting. Prerequisites: NURS 801, 805, 806 and 809.

NURS 821: Family Nursing III: Adult, 4 cr. (2 and 6)
Roles and functions embodied in advanced practice applied to the promotion and clinical management of common or chronic health problems of adults within the context of family; clinical practice with adult clients in a variety of settings. Prerequisites: NURS 801, 805, 806 and 809.

NURS 822: Family Nursing IV: Gerontology, 4 cr. (2 and 6)
Roles and functions of advanced practice applied to the preventive, restorative and rehabilitative care of the older adult with existing or potential health problems; clinical practice in a variety of settings. Prerequisites: NURS 801, 805, 806 and 809.

NURS 823: Nurse Practitioner Clinical Pracitcum, 6 cr. (0 and 18)
Guided practice applying advanced nursing knowledge in family nursing and advanced practice roles (clinical nurse specialist, case manager and/or practitioner); joint preceptor and faculty guidance and supervision in the care of selected populations in a variety of health care settings. Prerequisites: NURS 819, 820, 821 and 822.

NURS 825: Theories and Models of Nursing Administration, 3 cr. (3 and 0)
Identification, analysis and synthesis of theoretical models and issues related to nursing management and leadership; organization, attitudes and practices applicable to the middle and executive levels of nursing administration. Prerequisite: NURS 835, 837, 840 or 861.

NURS 826: Administration of Nursing Services, 3 cr. (2 and 3)
Application of theories and models to specific nursing administration issues and problems. Practicum in nursing administration at the middle or executive level permits specific use and evaluation of a conceptual model of nursing administration. Prerequisite: NURS 825. Corequisite: NURS 836, 838, 841 or 862.

NURS 827: Foundations of Nursing Education, 3 cr. (3 and 0)
Exploration of the foundations of nursing education with emphasis on curriculum development in nursing; current issues and research that influence nursing education. Prerequisite: NURS 835, 837, 840 or 861.

NURS 828: The Nurse Educator, 3 cr. (2 and 3)
Continuation of NURS 827; major focus on teaching in nursing education programs; course development and selection of learning experiences; current is-
issues and research in classroom and clinical teaching. A teaching practicum is required. **Prerequisite:** NURS 827. 
**Corequisite:** NURS 836, 838, 841 or 862.

**NURS 829: Theories and Models of Clinical Specialization, 3 cr. (3 and 0)**
The caregiver, researcher, manager, teacher and consultant roles of the clinical nurse specialist in a variety of settings; theories, models and health care issues underlying the role of clinical nurse specialist. **Prerequisite:** NURS 835, 837, 840 or 861.

**NURS 830: Clinical Specialty Practicum in Nursing, 3 cr. (1 and 6)**
Advanced practice in a selected clinical specialty area in nursing that emphasizes application of the clinical specialist role. **Prerequisite:** NURS 829.

**NURS 831: Clinical Problems in Advanced Nursing, 1-3 cr. (1-3 and 0)**
Critical thinking and methodologies of scientific inquiry applied to clinical issues/problems encountered in advanced nursing practice. May be repeated for a maximum of three credits. Graded on a pass/fail basis. **Prerequisites:** NURS 804, 807 and 808. **Corequisites:** NURS 819, 820 or 821, and 822.

**NURS 879: Special Topics in Nursing, 1-3 cr. (1-3 and 0-9)**
In-depth seminar on selected topics such as therapeutic communication, legal and ethical issues in nursing, and health care and political process in health. **Prerequisite:** Permission of instructor.

**NURS 882: Health Promotion in Primary Care of Older Adults, 4 cr. (2 and 6)**
Application of the roles and functions of advanced practice in the management of common health syndromes of older adults; overview of comprehensive assessment; focus on prevention, maintenance of function, independence and self care; cultural, social, legal and ethical issues. **Prerequisites:** NURS 801, 805, 806, 807 and 809.

**NURS 883: Health Maintenance in Primary Care of Older Adults, 4 cr. (2 and 6)**
Application of roles and functions of advanced practice gerontological nursing in the management of common medical problems in older populations. Emphasis is on health promotion, maintaining functional independence, and rehabilitative care of the older adult with existing or potential health problems. **Prerequisites:** NURS 801, 805, 806, 807 and 809.

**NURS 884: Mental Health and Illness in the Primary Care of Older Adults, 4 cr. (2 and 6)**
Psychosocial, developmental, spiritual and cultural theories and concepts synthe-
Graduate Interdisciplinary Programs

Bonnie Holaday, Dean

Graduate Interdisciplinary Programs at Clemson University have emerged in response to the changing face of scholarship and research. Advances in science and technology have altered the ways we perceive scientific research and education. Clemson University recognizes the need for crossing departmental boundaries in offering more integrated approaches to graduate education. Promoting interdisciplinary research and education is one of the ways Clemson University is fostering innovation among its faculty and students. The National Science Foundation has recognized that “many of the challenges and opportunities today and into the next century cross traditional disciplinary boundaries.” Clemson University and its Graduate Interdisciplinary Programs embrace this philosophy and provide excellent research and educational facilities to support these programs.

**Fine Arts in Computing**

Mark McKnew, Program Coordinator, Fine Arts in Computing

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<th>Major</th>
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<td>Fine Arts in Computing</td>
<td>M.F.A.C.</td>
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The Master of Fine Arts in Computing (MFAC) at Clemson University is a professional degree program aimed at producing graduates who will be sought by the growing electronic arts industry, particularly by those companies engaged in special effects productions within the entertainment and commercial video and film industries. The program offers a unique blend of instruction from art, computer science, computer engineering, graphic communications, performing arts, philosophy and psychology, together with newly designed courses targeted at specific production techniques.

**Requirements for Awarding a Degree**

The degree requires 60 hours, 18-24 of which are devoted to the visual arts studio wherein the student produces a professional-quality demonstration video. Of the remaining 36-42 hours, 18 must come from the core courses, six from the master's thesis and 12 from free electives or foundations. It is expected that some beginning students may need post-baccalaureate work in the fundamentals of computing or visual arts (or both), so foundation courses are offered. A maximum of five hours of foundation courses may be counted toward the degree. The normal course of study requires two years.

2. There are six core courses: Photography (ART 613), Art with the Computer (ART 12281), Introduction to Graphical System Design (CP SC 605), Virtual Reality Systems (CP SC 611), Special Effects Production (CP SC 815) and Perception, Cognition and Technology (PSYCH 823).
3. The electives are Twentieth Century Art I (AAH 630), Twentieth Century Art II (AAH 632), Advanced Drawing (ART 805), Advanced Painting (ART 807), Advanced Sculpture (ART 809), Advanced Painting (ART 811), Advanced Modeling Techniques in Computer Graphics (CP SC 805), Computer Animation (CP SC 808), Digital Image Processing (ECE 847), Film Genres (ENGL 650), Film Theory and Criticism (ENGL 651), Visual Communication (ENGL 853), Process Control in Color Reproduction (G C 801), MIDI Applications (MUSIC 604), Aesthetics (PHIL 845), Stage Lighting (THEA 687) and Scene Painting (THEA 697).
4. There are two individual study courses: Visual Arts Studio (ART 860) and Master's Thesis (ART/CP SC 891).

An MFAC supervisory board consisting of five faculty — two from art, two from computer science and one from performing arts — administers the program. The degree capitalizes on Clemson's well-known strengths in computer graphics (virtual reality systems), image processing, photography, art, film and theatrical design.

**Admission and Financial Aid**

Applicants are required to submit GRE general test results and a portfolio of artistic work that may include CD Roms, videos, slides, etc. Assistantships will be available to qualified applicants, and at least one fellowship will be awarded. Interested domestic students are encouraged to apply by April 15 for fall admission.

**Policy Studies**

Bruce Ransom, Chair, Graduate Program in Policy Studies

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<td>Policy Studies</td>
<td>Ph.D., Certificate</td>
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Commencing with the fall 2000 semester, Clemson University will offer graduate studies leading to a Ph.D. and a Certificate in Policy Studies. Graduate work in policy studies enables a student to attain a high degree of specialized competence in policy analysis and to secure a mastery of the policy research, emphasizing quantitative and economic skills. Government, industry, public policy "think tanks" and other policy research organizations, nonprofit organizations and universities offer challenging opportunities in policy analysis, issue development, education and related areas for persons with advanced training.

Special emphasis in the graduate program is placed on quantitative, economic and political organization as well as other social science skills in the analysis and development of policy. Fundamental and rigorous quantitative and analytical skills for effective policy analysis are developed through core courses in public policy for public policy, ethics, statistical methods for policy research, demographic projections and spatial analysis, policy analysis and political choice, organizational theory and management, applied economics and a policy analysis workshop. Ph.D. students will also select a policy concentration in agriculture policy, environmental and natural resource policy, rural and economic development policy, and science and technology. Flexibility is also achieved through enrichment, elective, leadership development courses and the selection of a Ph.D. dissertation topic. The program consists of 84-99 credit hours (beyond the bachelor's degree) of which up to 40 credits may be drawn from master's degree and other postgraduate work. There is no language requirement for the Ph.D. degree in policy studies.

The graduate program in policy studies will also offer students enrolled in related master's and doctoral programs the opportunity to gain competencies and understanding of policy analysis. Depending on the students' background and academic preparation, they may supplement their primary master's course work with a Certificate in Policy Studies. The Certificate in Policy Studies is designed to equip students with a set of explicit public policy research and analytical skills to augment their preparation in a traditional master's program. The certificate program involves 15-18 credit hours of course work, depending upon the students' academic background and preparation.

The graduate faculty in policy studies encourages applications for the Ph.D. in policy studies from recipients of a master's degree who wish to acquire policy research and analytical skills in economic development, agriculture, natural resource allocation, rural development, small town and community development, tourism development, environmental issues, land use, infrastructure, public finance, growth management, and science and technology. Master's-level students with similar interests are encouraged to enhance their graduate studies with a Certificate in Policy Studies.

The faculty encourages applications from students who have backgrounds that will facilitate an interdisciplinary course of study. In many cases students may be admitted to full graduate status in the Ph.D. program without prerequisites other than those required of all graduate students.
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